# Response of Fertility Levels and Bio-fertilizers on Growth of Green gram [Vigna radiata (L.)]

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***Abstract*: The field experiment was carried out during the 2019 and 2020 in kharif season to evaluate the Effect of fertility levels and bio-fertilizers on growth, yield and quality of green gram [Vigna radiata (L.)]. The treatments consisted four fertility levels viz., (i) control, (ii) 50% RDF, (iii) 75% RDF and (iv) 100% RDF were assigned in main plots and four levels of bio-fertilizers inoculation viz., (i) control, (ii) Rhizobium, (iii) Phosphate Solubilizing bacteria (PSB), and (iv) Rhizobium+ PSB were assigned in sub plots, respectively. The result indicated that in the fertility levels significantly improved the growth parameters of green gram. The application of 100% RDF recorded highest growth parameters viz. plant height at 30 DAS (30.67 and 29.65 cm), 45 DAS (56.01 and 54.76 cm) and at harvest (59.56 and 58.26 cm), number of branches plant$^{-1}$ and number of nodules plant$^{-1}$ at 45 DAS (2.46, 2.27 and 22.89, 22.77) and at harvest (4.54, 4.22 and 5.43, 5.21), dry matter accumulation (DMA) at 30 DAS (5.43 and 5.26 g plant$^{-1}$), 45 DAS (11.63 and 11.00 g plant$^{-1}$) and at harvest (22.35 and 21.99 g plant$^{-1}$), however crop growth rate (CGR) and relative growth rate (RGR) at 30-45 DAS (0.414, 0.383 g m$^{-2}$ day$^{-1}$ and 0.0514, 0.0498 g g$^{-1}$ day$^{-1}$), 45 DAS-at harvest (0.715, 0.733 g m$^{-2}$ day$^{-1}$ and 0.0435, 0.0462 g g$^{-1}$ day$^{-1}$) in both years, respectively. Moreover, the application of bio-fertilizers significantly improves the growth parameters of green gram. The application of rhizobium + PSB gave highest growth parameters viz. plant height at 30 DAS (25.19 and 24.17 cm), 45 DAS (45.79 and 44.53 cm) and at harvest (48.67 and 47.37 cm), number of branches plant$^{-1}$ and number of nodules plant$^{-1}$ at 45 DAS (2.01, 1.83 and 18.80, 18.68) and at harvest (3.73, 3.41 and 4.61, 4.39), DMA at 30 DAS (4.61 and 4.44 g plant$^{-1}$), 45 DAS (9.65 and 9.01 g plant$^{-1}$) and at harvest (18.36 and 18.00 g plant$^{-1}$), however CGR and RGR at 30-45 DAS (0.336, 0.305 g m$^{-2}$ day$^{-1}$ and 0.0491, 0.0469 g g$^{-1}$ day$^{-1}$), 45 DAS-at harvest (0.581, 0.599 g m$^{-2}$ day$^{-1}$ and 0.0427, 0.0461 g g$^{-1}$ day$^{-1}$) in both years, respectively. The present study highlighted the practical importance of the fertility levels and bio-fertilizers combination response on growth parameters of green gram.**

***Keywords*: Fertility levels, Bio-fertilizers, Rhizobium, PSB, Growth parameters, Green gram**

## Introduction

Pulses are important not only for their value as human food, but also because of high protein content for livestock. It has been important component of Indian agriculture enabling the land to restore fertility by fixing atmospheric nitrogen, so as to produce reasonable yields of succeeding crops and to meet out the demand of dietary requirement regarding proteins, carbohydrates and other nutrient sources (Kalsaria et al., 2017). On an average, pulses contain 22-24 per cent protein as against 8-10 per cent in cereals. A good amount of lysine is present in the pulses. Pulses vary in maturity periods, hence, are useful in different cropping systems. Green gram locally called as moog or mug (Vigna radiata L. Wilczek) belongs to the family Leguminoceae, which fixes atmospheric nitrogen and improves soil fertility by adding 20-25 kg N ha-1 . Being a short duration crop and having wider adaptability, it can be grown in summer as well as in kharif season. It is an important ruling crop in summer season, locally known as 'Vaishakhi Mug'. The yield of summer green gram is comparatively more than that of kharif crop, mainly because the controlled moisture conditions through irrigation, abundant sunshine and less pest and disease infestation. The green gram foliage left over after picking of mature pods can either be fed to livestock or it may ploughed in situ as a green manure to enrich soil with organic matter. Employment is provided to the farmers and the agricultural labours during off season (Bhat et. Al., 2010).

Green gram is a very short duration crop so it can be grown as catch crop. In India, it occupied an area of 3.24 million hectares having total production of 1.39 million tons of grain with productivity of 346 kg/ha (Anon., 2015a). In India, major green gram producing states are Orissa, Madhya Pradesh, Rajasthan, Maharashtra, Gujarat and Bihar. In Gujarat, it is cultivated in about 2.26 lakh hectares with an annual production of 0.97 lakh tones and average productivity of 429 kg/ha (Anon., 2015b). Green gram crop have direct effect of spacing due to availability of moisture and nutrient depend on spacing.

Greengram [Vigna radiata (L.) Wilczek] gives low seed yield and poor growth performance mainly due to poor management and low soil fertility. Nitrogen due to leaching and volatization and phosphorus due to fixation may not be available adequately at flowering and pod formation stages of crop and result in shading of flowers and pods (Kadam and Khanvilkar, 2015). The crop needs more nitrogen at the reproductive phase, and the nutrient uptake after flowering either becomes slow or stops due to inactivation of roots. The optimum supply of nitrogen and phosphorus significantly influenced on growth and yield of green gram. Yield of green gram increases with the application of nitrogenous and phosphatic fertilization. Usually grain legumes are grown on marginal land and poor yield in such soils are partly due to lack of effective and specific strains of rhizobium in rhizosphere (Patel et al., 2016). Hence, the study was conducted to see the effect of biorfertilizers on growth parameters of green gram under different levels of fertility.

**Materials and methods**

An experiment was conducted during the kharif (summer) seasons of 2019 and 2020. The experimental field has clay loam soil. The ploughing layers of soil have pH (7.60 and 7.90) organic carbon (0.45% and 0.43%), available nitrogen (221.3 and 224.1 kg $ha^{-1}$), available phosphorus (19.28 and 20.85 kg $ha^{-1}$) and available potassium (219.2 and 226.4 kg $ha^{-1}$) during both the years, respectively. The field experiment was laid out in split plot design. The experiment have 16 treatments combinations viz., Main plot treatment– four fertility levels (control, 50% RDF, 75% RDF and 100% RDF) and Sub-plots treatment– four bio-fertilizers (control, PSB, Rhizobium and Rhizobium +PSB). Furrows were opened at a spacing of 30×10 cm for the sowing of green gram variety 'Pusa baisakhi' with seed rate of 12 kg $ha^{-1}$. Nitrogen (N) phosphorus (P) potassium (K) and zinc (Zn) were applied as per treatment by basal application. N and P were applied through diammonium phosphate and urea, K and Zn through murate of potash and zinc sulphate, respectively. The data were analyzed as per the standard procedure for "Analysis of Variance" (ANOVA) (Gomez and Gomez, 1976).

**Results and discussion**

**Response of fertility levels**

The revealed of the data present in table 1&2 indicated that the application of fertility levels significantly increased the growth parameters of the green gram over control. The application of 100% RDF recorded highest growth parameters viz. plant height at 30 DAS (30.67 and 29.65 cm), 45 DAS (56.01 and 54.76 cm) and at harvest (59.56 and 58.26 cm), number of branches $plant^{-1}$ and number of nodules $plant^{-1}$ at 45 DAS (2.46, 2.27 and 22.89, 22.77) and at harvest (4.54, 4.22 and 5.43, 5.21), dry matter accumulation (DMA) at 30 DAS (5.43 and 5.26 g $plant^{-1}$), 45 DAS (11.63 and 11.00 g $plant^{-1}$) and at harvest (22.35 and 21.99 g $plant^{-1}$), however crop growth rate (CGR) and relative growth rate (RGR) at 30-45 DAS (0.414, 0.383 g $m^{-2}$ $day^{-1}$ and 0.0514, 0.0498 g $g^{-1}$ $day^{-1}$), 45 DAS-at harvest (0.715, 0.733 g $m^{-2}$ $day^{-1}$ and 0.0435, 0.0462 g $g^{-1}$ $day^{-1}$) in both years, respectively. Application of phosphorus fertilizers not only increased the plant growth but also improved nutrient availability for prolonged period for plant growth. Phosphorus is the main constituent of ADP and ATP which acts as energy currency within plants. Almost every metabolic reaction of any significance proceeds via phosphate derivatives, phosphorus application influences photosynthesis, biosynthesis of proteins and phospholipids, nucleic acid synthesis, membrane transport and cytoplasmic streaming (Mishra, 2003). It is may be due to higher dose of fertilizer improves nutrient availability to crop. These results are also in agreement with findings of Kumar et al., (2014), Awasarmal et al., (2015), Marimuthu and Surendran (2015) and Twinkle (2016).

**Response of bio-fertilizers**

The data present in table 1 & 2 showed that the application of bio-fertilizers significantly increased the growth parameters of the green gram. The application of rhizobium + PSB gave highest growth parameters viz. plant height at 30 DAS (25.19 and 24.17 cm), 45 DAS (45.79 and 44.53 cm) and at harvest (48.67 and 47.37 cm), number of branches $plant^{-1}$ and number of nodules $plant^{-1}$ at 45 DAS (2.01, 1.83 and 18.80, 18.68) and at harvest (3.73, 3.41 and 4.61, 4.39), DMA at 30 DAS (4.61 and 4.44 g $plant^{-1}$), 45 DAS (9.65 and 9.01 g $plant^{-1}$) and at harvest (18.36 and 18.00 g $plant^{-1}$), however CGR and RGR at 30-45 DAS (0.336, 0.305 g $m^{-2}$ $day^{-1}$ and 0.0491, 0.0469 g $g^{-1}$ $day^{-1}$), 45 DAS-at harvest (0.581, 0.599 g $m^{-2}$ $day^{-1}$ and 0.0427, 0.0461 g $g^{-1}$ $day^{-1}$) in both years, respectively. Inoculation of seeds with proper strain of Rhizobium cultures enhance the N fixation from atmosphere and results in better growth, more active root microbes and consequently enhance proper growth and dry weight of root nodules in green gram. The similar results were also found by Patra and Bhatacharya (1997), Yadav and Tarafdar (2010), Gajera et al., (2014) and Mehta et al. (2012).

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**Table 1. Effect of fertility levels and bio-fertilizers on plant height, number of branches and number of nodules of green gram**

| Treatment | Plant height (cm) | | | | | | Number of branches (plant$^{-1}$) | | | | Number of nodules (plant$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | | 45 DAS | | At harvest | | 45 DAS | | At harvest | | 45 DAS | | At harvest | |
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| **Fertility levels** | | | | | | | | | | | | | | |
| Control | 16.17 | 15.15 | 28.95 | 27.70 | 30.74 | 29.44 | 1.29 | 1.11 | 2.39 | 2.07 | 12.07 | 11.95 | 3.26 | 3.04 |
| 50% RDF | 20.74 | 19.72 | 37.49 | 36.24 | 39.83 | 38.53 | 1.66 | 1.48 | 3.07 | 2.75 | 15.48 | 15.36 | 3.95 | 3.73 |
| 75% RDF | 25.88 | 24.86 | 47.08 | 45.83 | 50.05 | 48.75 | 2.07 | 1.89 | 3.83 | 3.51 | 19.32 | 19.20 | 4.71 | 4.49 |
| 100% RDF | 30.67 | 29.65 | 56.01 | 54.76 | 59.56 | 58.26 | 2.46 | 2.27 | 4.54 | 4.22 | 22.89 | 22.77 | 5.43 | 5.21 |
| SEm± | 0.16 | 0.17 | 0.30 | 0.30 | 0.32 | 0.31 | 0.01 | 0.07 | 0.02 | 0.07 | 0.12 | 0.13 | 0.02 | 0.024 |
| CD (p=0.05) | 0.55 | 0.57 | 1.03 | 1.02 | 1.09 | 1.09 | 0.04 | 0.25 | 0.08 | 0.27 | 0.41 | 0.45 | 0.08 | 0.082 |
| **Bio-fertilizers** | | | | | | | | | | | | | | |
| Control | 21.56 | 20.54 | 39.02 | 37.77 | 41.46 | 40.16 | 1.72 | 1.54 | 3.19 | 2.87 | 16.09 | 15.97 | 4.07 | 3.85 |
| PSB | 22.87 | 21.85 | 41.46 | 40.21 | 44.06 | 42.76 | 1.83 | 1.65 | 3.39 | 3.07 | 17.07 | 16.95 | 4.26 | 4.04 |
| Rhizobium | 23.84 | 22.82 | 43.27 | 42.02 | 45.99 | 44.69 | 1.91 | 1.73 | 3.53 | 3.21 | 17.79 | 17.67 | 4.41 | 4.19 |
| Rhizobium + PSB | 25.19 | 24.17 | 45.79 | 44.53 | 48.67 | 47.37 | 2.01 | 1.83 | 3.73 | 3.41 | 18.80 | 18.68 | 4.61 | 4.39 |
| SEm± | 0.13 | 0.14 | 0.23 | 0.24 | 0.25 | 0.25 | 0.01 | 0.07 | 0.02 | 0.06 | 0.09 | 0.11 | 0.02 | 0.019 |
| CD (p=0.05) | 0.37 | 0.40 | 0.68 | 0.70 | 0.73 | 0.74 | 0.03 | 0.21 | 0.05 | 0.18 | 0.27 | 0.33 | 0.05 | 0.055 |

**Table 2. Effect of fertility levels and bio-fertilizers on DMA, CGR and RGR of green gram**

| Treatment | DMA (g plant$^{-1}$) | | | | | | CGR (g m$^{-2}$ day$^{-1}$) | | | | RGR (g g$^{-1}$ day$^{-1}$) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | | 45 DAS | | At harvest | | 30-45 DAS | | 45 DAS-At harvest | | 30-45 DAS | | 45 DAS-At harvest | |
| | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 | 2019 | 2020 |
| **Fertility levels** | | | | | | | | | | | | | | |
| Control | 3.26 | 3.09 | 6.39 | 5.75 | 11.80 | 11.44 | 0.209 | 0.177 | 0.360 | 0.379 | 0.0448 | 0.0413 | 0.0408 | 0.0458 |
| 50% RDF | 3.95 | 3.78 | 8.05 | 7.41 | 15.13 | 14.77 | 0.273 | 0.242 | 0.472 | 0.491 | 0.0475 | 0.0449 | 0.0421 | 0.0460 |
| 75% RDF | 4.71 | 4.54 | 9.91 | 9.27 | 18.87 | 18.51 | 0.346 | 0.315 | 0.598 | 0.616 | 0.0495 | 0.0475 | 0.0430 | 0.0461 |
| 100% RDF | 5.43 | 5.26 | 11.63 | 11.00 | 22.35 | 21.99 | 0.414 | 0.383 | 0.715 | 0.733 | 0.0514 | 0.0498 | 0.0435 | 0.0462 |
| SEm± | 0.21 | 0.19 | 0.06 | 0.09 | 0.12 | 0.13 | 0.015 | 0.010 | 0.004 | 0.004 | 0.0027 | 0.0023 | 0.0000 | 0.0002 |
| CD (p=0.05) | 0.74 | 0.72 | 0.20 | 0.30 | 0.40 | 0.44 | 0.052 | 0.035 | 0.013 | 0.013 | 0.0092 | 0.0081 | 0.0001 | 0.0007 |
| **Bio-fertilizers** | | | | | | | | | | | | | | |
| Control | 4.07 | 3.90 | 8.34 | 7.70 | 15.73 | 15.37 | 0.285 | 0.254 | 0.492 | 0.511 | 0.0474 | 0.0447 | 0.0420 | 0.0460 |
| PSB | 4.26 | 4.09 | 8.82 | 8.18 | 16.68 | 16.32 | 0.304 | 0.272 | 0.524 | 0.543 | 0.0482 | 0.0457 | 0.0422 | 0.0460 |
| Rhizobium | 4.41 | 4.24 | 9.17 | 8.53 | 17.38 | 17.02 | 0.317 | 0.286 | 0.548 | 0.566 | 0.0485 | 0.0462 | 0.0424 | 0.0461 |
| Rhizobium + PSB | 4.61 | 4.44 | 9.65 | 9.01 | 18.36 | 18.00 | 0.336 | 0.305 | 0.581 | 0.599 | 0.0491 | 0.0469 | 0.0427 | 0.0461 |
| SEm± | 0.08 | 0.07 | 0.05 | 0.08 | 0.09 | 0.11 | 0.005 | 0.006 | 0.003 | 0.003 | 0.0009 | 0.0009 | 0.0000 | 0.0002 |
| CD (p=0.05) | 0.22 | 0.20 | 0.13 | 0.24 | 0.27 | 0.32 | 0.015 | 0.016 | 0.009 | 0.009 | 0.0026 | 0.0026 | 0.0001 | 0.0006 |