The Pharma Innovation Journal 2022; 11(7): 2455-2458

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(7): 2455-2458

www.thepharmajournal.com
Received: 12-04-2022
Accepted: 21-06-2022

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Effect of bio-fertilizers and fertilizers on growth parameters, yield parameters and yield in black gram (*Vigna mungo* L.)

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Abstract
A field experiment entitled "Effect of Biofertilizers and Fertilizers on Growth Parameters, Yield Parameters and Yield in Black Gram (*Vigna mungo* L.)" was conducted during *rabi*, 2021 at Wetland farm, S.V. Agricultural College, ANGRAU, Tirupati, Andhra Pradesh. The experiment was laid out in randomized block design with ten treatments and three replications. Combined application of biofertilizers along with inorganic fertilizers significantly influenced the growth and yield black gram crop. The maximum number of growth parameters and yield attributes *viz.*, dry matter production, plant height, number of branches plant^{-1}, number of nodules plant^{-1}, number of pods plant^{-1} and number of seeds pod^{-1} were numerically highest with application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) and test weight of seed was recorded non-significant. Seed yield and straw yield were recorded significantly highest under 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) followed by 75% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_7).

Keywords: Black gram, liquid *Rhizobium*, liquid PSB, liquid KSB

1. Introduction
Black gram (*Vigna mungo* L.) is one of the major pulse crops that originated in India and is mostly grown in many Asian countries. It requires optimal growing conditions like day temperatures ranging from 25 ºC to 35 ºC and annual rainfall varying from 600-1000 mm. It fixes the atmospheric nitrogen of nearly 22.10 kg of N ha^{-1} in the soil and ameliorates the soil fertility status. This pulse crop plays a key role in the human diet as it contains 26 per cent of protein and various essential amino acids like valine, lysine, *etc*. India ranks first in terms of production as well as consumption of black gram with 2.5 million tonnes of production in 4.6 million hectares of area and productivity of 533 kg ha^{-1} and it accounts for nearly 70% of worlds black gram production.

In Andhra Pradesh, black gram is mainly grown in Guntur, Kurnool, and Krishna districts. Black gram crop grows well on heavier soils such as black cotton soils which retain moisture better. The most ideal soil is a well-drained loam with a pH of 6.5 to 7.8. The extent of black gram cultivation in Andhra Pradesh is 3.82 lakh hectares with 3.43 lakh tonnes of production and 842 kg per hectare of productivity.

Biofertilizers are ready to use live formulations that contain living cells or latent cells of efficient strains of beneficial microorganisms which on application to seed, soil, or root surfaces mobilize the availability of nutrients by increasing biological activity in particular and colonizing the rhizosphere thereby helping in buildup of the micro-flora and in turn the soil health.

2. Materials and Methods
A field experiment entitled "Effect of Biofertilizers and Fertilizers on Growth Parameters, Yield Parameters and Yield in Black Gram (*Vigna mungo* L.)" Was conducted during *rabi*, 2021 at Wetland farm, S.V. Agricultural College, ANGRAU, Tirupati, Andhra Pradesh which is geographically situated at 13^0 57' 582'' N latitude and 79^0 68' 691" E longitude with an altitude of 183.7 m above the mean sea level, which falls under Southern Agro Climatic Zone of Andhra Pradesh. According to Trolls classification, it comes under the Semi-Arid Tropics (SAT). The experimental soil was sandy loam in texture.

The analytical data indicated that the soil was slightly alkaline in reaction, non-saline, low in

Organic carbon and nitrogen and medium in available phosphorus and potassium. The experiment was laid out in randomized block design with ten treatments and three replications. The treatments involve combination of fertilizers with biofertilizers such as *Rhizobium*, PSB and KSB are:
Control (0% RDF) (T_1)**,** 100% RDF (T_2), 75% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB (T_3)**,** 100% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB (T_4)**,** 75% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB (T_5)**,** 100% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB (T_6)**,** 75% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_7), 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8)**,** 75% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB (T_9) and 100% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB (T_{10})**.**

3. Results and Discussion

3.1 Growth Parameters

It was observed from the data presented in table 1 that all the growth parameters *viz.*, plant height, dry significant difference when subjected to different treatments levels of organic and inorganic nutrient sources including control
It was observed from the data presented in table 1 that combined application of biofertilizers and fertilizers significantly influenced the growth parameters *viz.*, dry matter production, plant height, number of branches plant^{-1}, number of nodules plant^{-1} recorded significant difference when subjected to combined application of inorganic fertilizers and biofertilizers including control. Further, from table 1, it was found that numerically highest dry matter production plant height, number of branches plant^{-1}, number of nodules plant^{-1} with the T_8 treatment that constitutes 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB showed significantly maximum dry matter production (4243 kg ha^{-1}), plant height (40.41 cm), number of branches plant^{-1} (8.74) at harvest. While number of nodules plant^{-1} (46.08) at 60 DAS against minimum recorded in control. For dry matter production T_8 treatment was statistically on par with T_7, T_4, T_3, T_{10}, T_9 and T_6 treatments. Plant height (cm), number of branches plant^{-1} and number of nodules plant^{-1} were recorded significantly highest under T_8 treatment that constitutes 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB which was on par with T_7, T_4 and T_3 treatments.
Amongst the treatments the maximum growth parameters were recorded with the application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) might be due to increment of metabolic processes in plants that seems to have promoted meristematic activities through supply of enzymes causing apical growth. The nutrients that are available through supply of inorganic fertilizers and mineralization process by application of liquid bio-fertilizers through soil application and seed treatment accelerates the cell division and cell elongation which ultimately improved the growth attributes of black gram. These findings are similar with Kant *et al*. (2016) [5].

3.2 Yield Parameters

The data pertaining to yield parameters *viz.*, number of pods plant^{-1}, number of seeds pod^{-1} recorded significant difference with combined application of inorganic fertilizers and biofertilizers including control. Further, from table 2 it was found that among all the treatments including control, treatment T_8 that constitutes 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB showed significantly maximum number of pods plant^{-1} (32.2) which was on par with treatment T_7 treatment. Statistically higher number of seeds pod^{-1} was recorded under treatment T_8 (100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB) (7.63) which was on par T_7, T_4, T_3, T_{10}, T_9, T_6, T_5 treatments while the lowest was found in control (0% RDF) (T_1) (6.37) comparable with 100% RDF (T_2) (6.54).
Black gram being a legume, fixes atmospheric-N and improves the soil fertility. The application of inorganic fertilizers in combination with biofertilizers through soil application and seed treatment might enhanced the soil condition through improved biological nitrogen fixation by *Rhizobium*, increased in P availability and K availability by PSB and KSB respectively, thereby improvement in yield parameters in treatment with application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8). These results are supported by findings of Meena (2013) [2] and Singh and Singh (2017) [4].

3.2.1 Test weight

The test weight of seed was not significantly affected by the treatments. The maximum test weight of 39.88 g was recorded with the application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) while the minimum test weight of 38.44 g was noticed with control (0% RDF) (T_1). The results pertaining to test weight of seed are presented in table 2

3.3 Yield

3.3.1 Seed Yield

Data pertaining to seed yield was given in table 3 and depicted in fig 1.Significantly the highest seed yield of 2094 kg ha^{-1} was obtained with the application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) followed by T_7 which was on par with T_4, T_3, T_{10} and T_9 treatments. The lowest seed yield of 1488 kg ha^{-1} was recorded with the control (0% RDF) (T_1).
The increase in seed yield with the application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) treatment might be attributed to a better nutrient supply and an environment that is favourable for root activity and nutrient absorption. This results in better plant growth and superior yield characteristics that are responsible for higher yields. These results were in concurrent with the findings of Yadav *et al.* (2014) [1] and Tyagi *et al*. (2014) [7].

3.3.2 Straw Yield

Data pertaining to straw yield was given in table 3 and depicted in fig 1.The highest straw yield of 4104 kg ha^{-1} was obtained with the application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) which was on par with T_7. The next best treatments were T_4, T_3, T_{10} and T_9. The lowest straw yield of 3083 kg ha^{-1} was recorded with the control (0% RDF) (T_1).
The controllable release of nutrients in the soil caused by the mineralization of organic manure might have permitted higher crop development and yield when inorganic fertilizer and bio-fertilizers were applied together with organic manure. Similar findings were observed in Verma *et al*. (2017) [8].

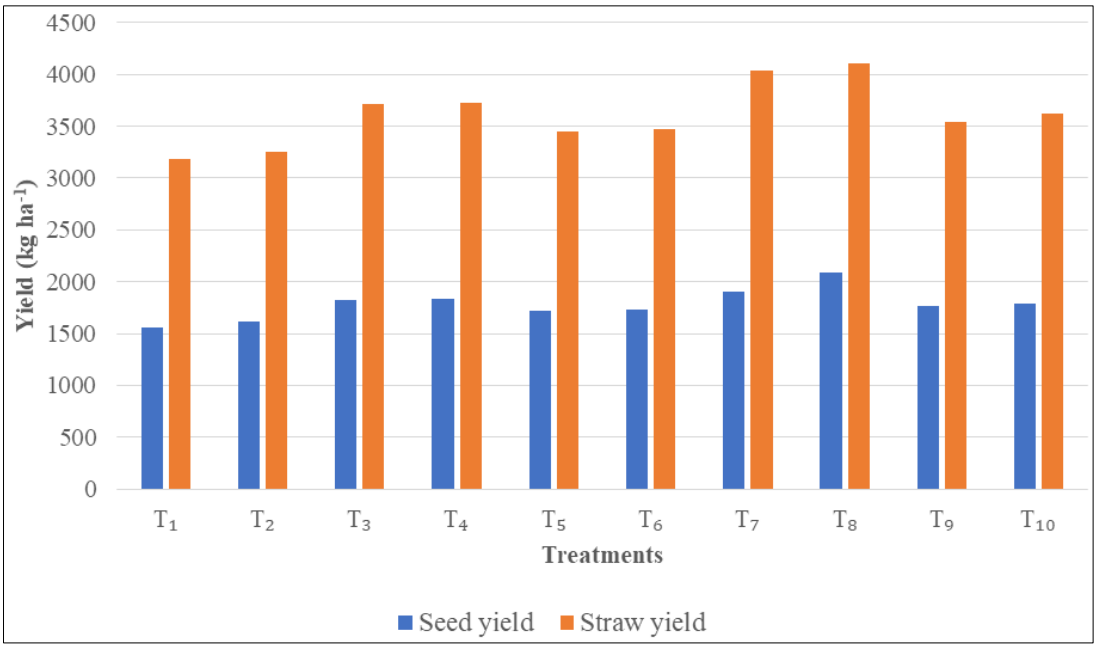

Fig 1: Effect of Biofertilizers and Fertilizers on Yield (Seed and Straw yield) in Black Gram (*Vigna mungo* L.)

Table 1: Effect of Biofertilizers and Fertilizers on Growth Parameters (dry matter production (kg ha^{-1}), plant height (cm) and number of branches plant^{-1}) in Black Gram (*Vigna mungo* L.)

Treatment Details	Growth Parameters			
	Dry matter Production (kg ha^{-1})	Plant height (cm)	Number Of branches plant^{-1}	Number Of nodules plant^{-1}
T_1: Control (0% RDF)	3253^{c}	34.61^{c}	7.04^{c}	40.05^{c}
T_2: 100% RDF	3327^{c}	35.23^{bc}	7.38^{bc}	40.44^{c}
T_3: 75% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB	4106^{ab}	38.76^{ab}	8.44^{a}	43.95^{abc}
T_4: 100% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB	4186^{a}	38.81^{ab}	8.56^{a}	43.99^{abc}
T_5: 75% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB	3628^{bc}	36.72^{bc}	7.43^{bc}	40.72^{c}
T_6: 100% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB	3958^{ab}	36.81^{bc}	7.49^{bc}	40.77^{c}
T_7: 75% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB	4234^{a}	40.31^{a}	8.68^{a}	45.36^{ab}
T_8: 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB	4243^{a}	40.41^{a}	8.74^{a}	46.08^{a}
T_9: 75% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB	4022^{ab}	37.58^{bc}	7.96^{b}	41.28^{bc}
T_{10}: 100% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB	4073^{ab}	37.63^{bc}	8.02^{b}	41.43^{bc}
F- Value	4.887**	3.133**	5.331**	3.128*
p- Value	< 0.01	< 0.01	< 0.01	< 0.05

**Significant at p=0.01 level; *Significant at p=0.05 level
Note: Same set of alphabets indicates no significant difference or at par with each other (DMRT)
Recommended dose of fertilizer: 25- 50- 25 kg N- P_2O_5- K_2O ha^{-1}

Table 2: Effect of Biofertilizers and Fertilizers on Yield Parameters (number of pods plant^{-1}, number of seeds pod^{-1} and test weight (g)) in Black Gram (*Vigna mungo* L.).

Treatment Details	Yield Parameters		
	Number of pods plant^{-1}	Number of seeds pod^{-1}	Test weight (g)
T_1: Control (0% RDF)	23.9^{c}	6.37^{c}	38.44
T_2: 100% RDF	25.2^{c}	6.54^{bc}	38.73
T_3: 75% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB	27.2^{bc}	7.55^{a}	39.65
T_4: 100% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB	27.4^{bc}	7.56^{a}	39.66
T_5: 75% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB	26.2^{bc}	7.01^{abc}	39.16
T_6: 100% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB	26.7^{bc}	7.29^{ab}	39.21
T_7: 75% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB	29.7^{ab}	7.61^{a}	39.84
T_8: 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB	32.2^{a}	7.63^{a}	39.88
T_9: 75% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB	26.9^{bc}	7.48^{a}	39.58
T_{10}: 100% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB	27.1^{bc}	7.54^{a}	39.62
F- Value	4.481**	3.528*	0.093
p- Value	< 0.01	< 0.01	1.000

**Significant at p=0.01 level; *Significant at p=0.05 level
Note: Same set of alphabets indicates no significant difference or at par with each other (DMRT)
Recommended dose of fertilizer: 25- 50- 25 kg N- P_2O_5- K_2O ha^{-1}

Table 3: Effect of Biofertilizers and Fertilizers on Yield (Seed yield and Straw yield) kg ha^{-1} in Black Gram (Vigna mungo L.).

Treatment Details	Seed Yield (Kg ha^{-1})	Straw Yield (Kg ha^{-1})
T_1: Control (0% RDF)	1488^{d}	3083^{d}
T_2: 100% RDF	1714^{cd}	3350^{cd}
T_3: 75% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB	1823^{bcd}	3718^{b}
T_4: 100% RDF + Seed treatment with liquid *Rhizobium* + liquid PSB + liquid KSB	1838^{bc}	3727^{b}
T_5: 75% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB	1717^{cd}	3453^{cd}
T_6: 100% RDF + Seed treatment with solid *Rhizobium* + solid PSB + solid KSB	1733^{cd}	3476^{cd}
T_7: 75% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB	1906^{b}	4040^{a}
T_8: 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB	2094^{a}	4104^{a}
T_9: 75% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB	1771^{bcd}	3546^{bcd}
T_{10}: 100% RDF + Soil application of solid *Rhizobium* + solid PSB + solid KSB	1784^{bcd}	3621^{bc}
F- Value	3.719**	5.774**
p- Value	< 0.01	< 0.01

**Significant at p=0.01 level; *Significant at p=0.05 level
Note: Same set of alphabets indicates no significant difference or at par with each other (DMRT)
Recommended dose of fertilizer: 25- 50- 25 kg N- P_2O_5- K_2O ha^{-1}

4. Conclusion

Finally, it can be concluded that the application of 100% RDF + Soil application of liquid *Rhizobium* + liquid PSB + liquid KSB (T_8) is the most efficient nutrient management practice to obtain better growth, higher yields. Hence, it is best practice to sustain higher productivity and to achieve economic profitability in Southern Agroclimatic Zone of Andhra Pradesh.

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