EFFECT OF *RHIZOBIUM LEGUMINOSARUM BY PHASEOLI, PSEUDOMONAS FLUORESCENS*, ENRICHED FARM YARD MANURE AND NEEM CAKE IN IRRIGATED BLACK GRAM

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ABSTRACT

Field investigations were carried out at the Annamalai University Experimental Farm, Department of Agronomy, Annamalai Nagar to study effect of nutrient management in irrigated black gram during 2015 (February to April). The experiment was laid out in Randomized Block Design (RBD) with three replications. There were altogether nine treatments *viz*., T_1 – 100% Recommended dose of fertilizers (RDF) 25:50:0 NPK kg ha^{-1}, T_2 – 100% RDF + *Rhizobium Leguminosarum by Phaseoli* (RHL). T_3 – 100% RDF + *Pseudomonas fluorescens* (PSF), T_4 – 100% RDF + Enriched farm yard manure (EFYM), T_5 - 100% + Neem cake, T_6 – 100% RDF + RHL + PSF, T_7 – 100% RDF + EFYM + RHL + PSF, T_8 – 100% RDF + Neem cake + RHL + PSF,T_9 – 100% RDF + EFYM + Neem cake + RHL + PSF.

The combined application of organic, inorganic and bio fertilizers significantly influenced on the plant growth and yield components of black gram. Among the treatments, application of 100 % RDF + EFYM + Neem cake + RHL+ PSF(T_9) had favorably influenced the growth components such as plant height, number of branches $plant^{-1}$, leaf area index, and dry matter production and yield components such as number of pods $plant^{-1}$,number of seeds pod^{-1} and test weight. This was followed by 100 % RDF + EFYM + RHL + PSF(T_7). The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. 100 % RDF (25:50:0kg) NPK treatment (T_1) recorded lowest values with above growth and yield attributes.

The study revealed that application of 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9). Significantly registered the highest seed yield of 1286 kg ha_{-1}. 100 % RDF (25:50:0kg) NPK treatment (T_1) recorded lowest seed yield of 852 kg ha_{-1}.

The uptake of N, P_2O_5 and K_2O were found to be significantly higher with 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9). The least uptake of N, P_2O_5, and K2O were noticed under 100 % RDF (25:50:0kg) NPK treatment (T_1).The highest net return and benefit cost ratio were obtained with application

of 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9). It accounted the highest net income of Rs. 40390 and benefit cost ratio of (3.15). The least net income (Rs. 22330). And benefit cost ratio (2.32) were obtained under 100 % RDF (25:50:0kg) NPK treatment (T_1).

KEY Words: *Rhizobium Leguminosarum by Phaseoli*, *Pseudomonas fluorescens*,neem cake and Black gram

INTRODUCTION

Black gram seeds are highly nutritious containing higher amount of protein (24-26%) and are reported to be rich in potassium, phosphorus and calcium with good amount of sodium.Black gram is being grown over an area of 2.42 mega hectare with an annual production of 0, 77 mega tonnes with productivity of 324kg/hectare in the country. In India, it occupies 2.9 million hectares with an annual production of 1.24 million tonnes and in Tamil Nadu it is grown in 3.41 lakh hectares with a production 1.21 lakh tonnes and productivity 354.84 kg ha^{-1}(Anjum *et al*., 2010.In Tamilnadu are black gram cultivation is 2.08lakh hectares with a production of 88,706 tonnes and productivity 425kg ha^{-1} .The yield potential of black gram is very low because of fact that, the crop is mainly grown in rainfed condition with poor management practices and also due to various physiological biochemical as well as inherent factor associated with crop. The nutrient management practices by using chemical fertilizer along causes some negative impact on soil microbial load and fertility status of soil.

Bio fertilizer or microbial inoculants can be generally defined as preparation containing live or latent cells of efficient strains of nitrogen fixing and phosphate solubilizing microorganism used for treatment of seed or soil. Which have the ability to convert nutrionally important elements from un available to available form through biological processes. The Rhizobium as fertilizer in pulses could fix 50-200kg of N/ha/season and is able to meet 80-90 of the crop requirement for nitrogen. Inoculation in these crops was found to increase the crop yield by about 10-15% under on farm conditions (Khurana etal., 1997).

Use of bio fertilizer enriches the microbial population. Hence, there is an ample scope for enhancement of the production and productivity of black gram by proper agronomic practices several strategies were initiated to boost he productivity of black gram. Bio fertilizers are necessary to develop organic agriculture, sustainable agriculture, green agriculture and non-pollution agriculture .Hoshang Naserirad etal.,(2011). and Asad Rokhzadi etal.,(2008). indicated that inoculation with biofertilizers containing Azospirillum increase plant height, Leaf number per plant, Fruit mean weight and yield in compare to control (without biofertilizer).Bio-fertilizers are eco-friendly and environmentally safe. They form not only part of integrated nutrients but are low cost which is of immense help to the farming community. Utilization of biofertilizer increased all growth and yield promoting traits.

Application of Farmyard manure (FYM) into soil, prolongs c-sequestration, protects soil from erosion, supplies essential plant nutrients through decomposition process (Abiven etal., 2009).and (Kale etal.,1986). increases yield attributes and total grain yield of legumes . The addition of Neemcake (NEC) positively affected the available soil organic C (SOC),N,P,K and Mn content of soil resulting better growth and grain yield of (*phaseolus mungo)* or (*Vigna mungo*) and chick pea besides suppressing soil borne pathogen .

The inoculation of seeds with *Rhizobium leguminosarum by phaseoli* (RHL) is known to increase nodulation, nutrient uptake, growth and yield response of crop plants and soil fertility (Selvakumar etal.,2009).The phosphate solubilizing bacteria (PSB) pseudomonas fluorescence (PSF) also improves grain yield and soil nutrients besides suppressing soil borne pathogens (Balakrishnan etal.,2007). Co-inoculatiion of RHL and PSF and their combination with FYM improved plant biomass production, grain yield (Rudresh etal., 2005).and (Gomma etal.,2007).The effects of RHL and PSF with FYM on soil properties and crop yield are still ambiguous and not yet studied combinedly, which is of great potential value to organic agriculture. It is with this view, RHL, PSF, NEC and EFYM were studied for their compatibility and combined effects on soil fertility, grain yield and protein content of black gram.Keeping these in view, field investigations were carried out to study the effect of nutrient management on the growth and yield of black gram

MATERIALS AND METHODS

Field experiments were conducted at the experimental farm, Department of agronomy, Annamalai university, Annamalainagar to study the of Nutrient management in irrigated blackgramVBN3. During (February-April 2015).The Field experiments were carried out at field number (GL12C) of Experimental farm, Department of Agronomy, Annamalai University, Annamalai nagar. The experimental farm is situated at 11°24' North Latitude, 79°44' East Longitude with an altitude of + 5.79 m above mean sea level. The maximum range for temperature ranged from 29.8°C to 34.90°C with mean of 32.50°C.The minimum temperature ranged from 19.8°C to 25.4°C with a mean of 23.14°C. There was no occurrence of rainfall during rice fallow period. The relative humidity ranged from 87 to 90 per cent with a mean of 88.81 per cent. The soil of the experimental field was clay loam texture with low in available N, medium in available P and high in available K. The experiments were laid out in randomized block design (RBD) with three replications in the seasons. There were altogether nine treatments *viz*., T_1 – 100% Recommended dose of fertilizers (RDF) 25:50:0 NPK kg ha^{-1}, T_2 – 100% RDF + *Rhizobium Leguminosarum by Phaseoli* (RHL). T_3 – 100% RDF + *Pseudomonas fluorescens* (PSF), T_4 – 100% RDF + Enriched farm yard manure (EFYM), T_5 - 100% + Neem cake, T_6 – 100% RDF + RHL + PSF, T_7 – 100% RDF + EFYM + RHL + PSF, T_8 – 100% RDF + Neem cake + RHL + PSF,T_9 – 100% RDF + EFYM + Neem cake + RHL + PSF. The economic parameters such as gross income, net income and benefit cost ratio for all the treatments were worked out based on prevailing market price. The

net income was worked out for different treatments by subtracting the cost of cultivation from gross income. The return per rupee was calculated

Results

YIELD COMPONENTS

Among the treatments, application of 100% RDF + EFYM + Neem cake + RHL + PSF (T_9). recorded the higher number of pods plant-1 viz., 29.16 during the experiment. This was statistically significantly with 100% RDF + EFYM + RHL + PSF (T_7). This treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least number of pods plant-1 of 12.53 was recorded in 100% RDF (25:50:0 kg) NPK treatment (T_1). The highest pod length of 9.90 was recorded in 100% RDF + EFYM + Neem cake + RHL + PSF (T_9). The treatment 100% RDF + EFYM + RHL + PSF (T_7) was next best. The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least pod length of 3.09 was observed in 100% RDF (25:50:0kg) NPK treatment. The highest number of seeds pod^{-1} of 12.50 was recorded under 100% RDF + EFYM + Neem cake + RHL +PSF (T_9). The treatment 100% RDF + EFYM + RHL + PSF (T_7). next in order. The treatments 100% RDF +PSF (T_3) and 100% RDF +RHL (T_2) were on par. The least number of seeds pod^{-1} of 7.41 was observed in 100% RDF + PSF (25:50:0kg) NPK treatment (T_1).

The highest number of root nodules plant-1 was recorded in the treatment *viz.,* 100% RDF + EFYM + Neem cake + RHL + PSF (T_9) which recorded 16.90 root nodules during the flowering stage. The treatment 100% RDF + EFYM + RHL + PSF (T_7) was next in order. The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least number of root nodules was 11.77 recorded in 100% RDF (25:50:0kg) NPK treatment (T_1).Yield is the manifestation of yield attributing characters (Matushima, 1979). Higher grain yield was influenced mainly by yield attributing components like number of pods $plant^{-1}$, pod length, no of seeds $plant^{-1}$, test weight, seed yield and haulm yield. Application of urea and superphosphate through enriched FYM product increased pod, straw and soil yield significantly. The present results are in line with the findings of (Sagare et al., 1992). The yield increased significantly with the application of enriched FYM over control in black gram. The similar results was reported by Mathan *et al*.(1996).

YIELD

The seed yield of black gram was significantly influenced by NM practices. Among the treatments T_9 (100 % RDF + EFYM + Neem cake + RHL+ PSF) recorded the maximum seed yield of 1286kg ha^{-1}. This was followed by T_7 (100 % RDF + EFYM + RHL + PSF). The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least grain yield of 852kg ha^{-1} was recorded in 100% RDF (25:50:0kg) NPK treatment (T_1).In case of haulm yield the treatments 100 % RDF + EFYM + Neem cake + RHL+ PSF

(T_9) produced the highest haulm yield of 1893 kg ha^{-1}. This was followed by 100 % RDF + EFYM + RHL + PSF (T_7). The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least haulm yield of 1258 kg ha^{-1} was observed in 100% RDF (25:50:0kg) NPK treatment (T_1).

Among the treatments, 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9) registered the maximum value of harvest index 33.66. This was closely followed by 100 % RDF + EFYM + RHL + PSF (T_7). The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least harvest index of 22.87 was observed in 100% RDF (25:50:0kg) NPK treatment (T_1).Field studies revealed that application of enriched farm yard manure @ 2t ha^{-1} + 100percent of recommended nitrogen and potassium recorded higher microbial population *viz*., bacteria, fungi and actinomycetes with enhanced soil nutrient availability and also significantly higher seed yield. This was also in conformily with the finding of Jagathjothi *et al. (*2008).

NUTRIENT UPTAKE STUDIES

Among the treatments, 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9) recorded the higher nutrient uptake of crop of 52.07 kg ha^{-1} of N. This was closely followed by 100 % RDF + EFYM + RHL + PSF (T_7). The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least nitrogen uptake of 33.92 kg ha^{-1} was recorded in 100% RDF (25:50:0kg) NPK treatment (T_1). The trend on phosphorus uptake was similar to that of nitrogen uptake. The treatments *viz.*, 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9), recorded the higher phosphorus uptake 16.13 kg ha^{-1} respectively. The treatment 100 % RDF + EFYM + RHL + PSF (T_7) was next in order. The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least phosphorus uptake of 11.21 was recorded in 100% RDF (25:50:0kg) NPK treatment (T_1).The trend of potassium uptake was similar to that of nitrogen and phosphorus uptake. The higher value of potassium uptake of 59.33 kg ha^{-1} was recorded in the treatment T_9 (100 % RDF + EFYM + Neem cake + RHL+ PSF). This was closely followed by 100 % RDF + EFYM + RHL + PSF (T_7). The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least potassium uptake of 40.48 was recorded in 100% RDF (25:50:0kg) NPK treatment (T_1). This was in accordance with Sagare *et al.* (1992). The 100% RDF (25:50:0 kg) NPK treatment (T_1) resulted in the lowest uptake of nutrients due to absence of nutrients, which are known to influence the root proliferation and thereby increased uptake of nutrient.

ECONOMICS

The total cost of cultivation, gross return, net return and benefit cost ratio were computed for all the treatments on hectare basis and the data are furnished in Table 3.

In general the combination of organic, inorganic and biofertilizers treatments proved economically best by recording higher gross income, net income and return rupee^{-1} invested. That treatment 100 % RDF + EFYM + Neem cake + RHL+ PSF (T_9) registered the higher gross income of Rs. 59156 ha^{-1}, net income of Rs.40390 and benefit cost ratio of 3.15. This was closely followed by 100 % RDF + EFYM + RHL + PSF (T_7) next in order. The treatments 100% RDF + PSF (T_3) and 100% RDF + RHL (T_2) were on par. The least gross income of Rs.39192 ha^{-1}, net income of Rs.22330 and benefit cost ratio of2.32 were recorded in the 100% RDF (25:50:0kg) NPK treatment (T_1).

Table 1. Effect of nutrient management practiced on the number of pods plant^{-1}, of pod length, Number of seeds pod^{-1},Root nodules,100 seed weight of black gram

Treatments	No of pods plant^{-1}	Pod length	Number of seeds pod^{-1}	Root nodules	100 seed weight(g)	
T_1-100%RDF(25:50: 0 kg)N, P_2O_5,&K_2O	12.53	3.09	7.41	11.77	3.67	
T_2- 100 % RDF + RHL	22.16	4.21	7.95	12.23	3.73	
T_3- 100 % RDF + PSF	22.23	4.33	8.10	12.27	3.79	
T_4 -100 % RDF + EFYM	24.03	6.14	9.66	13.74	3.91	
T_5- 100 % RDF + Neem cake	23.02	5.15	9.16	13.25	3.85	
T_6- 100 % RDF + RHL + PSF	24.98	7.14	10.39	14.50	3.97	
T_7- 100 % RDF + EFYM + RHL + PSF	26.97	9.08	11.86	16.08	4.09	

T_8- 100 % RDF + Neem cake + RHL + PSF	26.03	8.14	11.31	15.54	4.03	
T_9- 100 % RDF + EFYM + Neem cake + RHL + PSF	29.16	9.90	12.50	16.90	4.15	
$S.E_d$	0.17	0.11	0.19	0.17	0.03	
CD (p=0.05)	0.36	0.24	0.41	0.37	NS	

Table 1. Effect of nutrient management practiced on the Seed yield (kg ha^{-1}), Haulm yield, N,P AND K uptake (kg ha^{-1}) of black gram

Treatments	Seed yield (kg ha^{-1})	Haulm yield(kg ha^{-1})	Nitrogen uptake (kg ha^{-1})	Phosphorus uptake (kg ha^{-1})	Potassium uptake (kg ha^{-1})	Benefit cost ratio
T_1-100%RDF(25:50: 0 kg) N, P_2O_5,&K_2O	852	1258	33.92	11.21	40.48	
T_2- 100 % RDF + RHL	895	1322	35.78	11.64	41.83	
T_3- 100 % RDF + PSF	896	1323	36.00	11.75	41.99	
T_4 -100 % RDF + EFYM	1026	1513	41.41	13.13	47.60	
T_5- 100 % RDF + Neem cake	983	1449	39.59	12.67	45.73	
T_6- 100 % RDF + RHL + PSF	1091	1608	44.11	13.85	50.43	
T_7- 100 % RDF + EFYM + RHL + PSF	1221	1798	49.44	15.35	56.24	

T_8- 100 % RDF + Neem cake + RHL + PSF	1178	1734	47.66	14.85	54.28	
T_9- 100 % RDF + EFYM + Neem cake + RHL + PSF	1286	1893	52.07	16.13	59.33	
$S.E_d$	15.32	22.39	0.64	0.16	0.62	
CD (p=0.05)	32.47	47.46	1.36	0.35	1.32	

Table 3. Effect of nutrient management practices on Economics

Treatments	Cost of cultivation (Rs.ha-1)	Gross income (Rs.ha-1)	Net income (Rs.ha-1)	Benefit cost ratio
T_1-100%RDF(25:50: 0 kg) N, P_2O_5,&K_2O	16862	39192	22330	2.32
T_2- 100 % RDF + RHL	16986	41170	24184	2.42
T_3- 100 % RDF + PSF	16990	41216	24226	2.42
T_4 -100 % RDF + EFYM	17123	47196	30073	2.75
T_5- 100 % RDF + Neem cake	17000	45218	28218	2.65
T_6- 100 % RDF + RHL + PSF	17765	50186	32421	2.82
T_7- 100 % RDF + EFYM + RHL + PSF	18615	56166	37551	3.01
T_8- 100 % RDF + Neem cake + RHL + PSF	18123	54188	36065	2.99

T_9- 100 % RDF + EFYM + Neem cake + RHL + PSF	18766	59156	40390	3.15

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