

Original Research Article

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Effect of Integrated Nitrogen Management on Macronutrient Content and Uptake of Rice Fallow *Rabi* Blackgram

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ABSTRACT

A field experiment was conducted on the residual effect of integrated nitrogen management on rice and rice fallow blackgram crop. The major nutrient content (N, P & K) and uptake by blackgram crop was studied during *rabi* season. The experiment was conducted at College Farm, Agricultural College, Bapatla during the *kharif* and *rabi* seasons of two years 2015 and 2016. The treatments consists of M₁(100% RDN) and M₂ includes 50% RDN + 25% N through FYM + 25% N through neem cake + recommended dose of microbial consortium (Azospirillum + PSB @ 2.5kg ha⁻¹). The main treatments were imposed during *kharif* seasons of both the years and their residual effect was studied during *rabi* season with blackgram *rabi* crop. During the immediate *kharif*, the experiment was laid out in a split plot design without disturbing the soil for succeeding *rabi* crops with the two treatments given to *kharif* rice as main plot treatments and each of these divided into five sub-plots. Popular cultivars of rice (BPT 5204) and blackgram (PU 31) were used for this study. The highest nitrogen content was obtained in seed of blackgram (3.12 %) during 2015-16 and 3.25% during 2016-17 year. The highest nitrogen uptake was noticed in seed 95.03 kg ha⁻¹ during 2015-16 and 104.81 kg ha⁻¹ of blackgram during 2016-17 year. The overall highest phosphorus content was obtained in seed of 1.34% during 2015-16 and 1.25% during 2016-17 year. The overall highest phosphorus uptake was noticed in seed of 40.81 kg ha⁻¹ during 2015-16 and 40.31 kg ha⁻¹ in seed of blackgram during 2016-17 year while the highest potassium content was obtained at harvest stage of haulm of 0.52%, 0.60% during first and second years. The overall 20.78 kg ha⁻¹ and 20.67 kg ha⁻¹ of potassium uptakes were noticed in haulms of blackgram crop observed during 2015-16 and 2016-17 years respectively.

Keywords

INM, Yield of blackgram, Nutrient content, Nutrient, Uptake by rice fallow *rabi* blackgram

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Introduction

In recent years there has been adverse effect of continuous and indiscriminate use of inorganic fertilizers on deterioration of soil structure, soil health and environment. Intensive cultivation, mono cropping, use of imbalanced fertilization accompanied by

restricted use of organic manures and bio-fertilizers have made the soils not only deficient in the nutrients but also deteriorated the soil health resulting in decline of crop response to the recommended dose of fertilizers. The high cost of fertilizers and unstable crop production call for substituting part of the inorganic fertilizers by locally

available organic sources like farmyard manure, neem cake in an integrated manner for sustainable production and to maintain soil health. Integrated nitrogen management involving conjunctive use of organic, inorganic and crop residues may improve the soil productivity and system productivity become sustainable. Boosting yield, reducing production cost and improving soil health are three interlinked components of the sustainability triangle. Therefore, combined use of chemical fertilizers, organic manures and bio fertilizers is essential.

Hence, the present experiment is formulated to find out the residual effect of integrated nitrogen management on rice and rice fallow *rabi* blackgram crop and influence on nutrient contents of blackgram.

Materials and Methods

A field experiment was conducted for two consecutive years (2015-16 & 2016-17) on clayloam soils of Agricultural College Farm, Bapatla. The experiment was laid out in a two sample t-test for rice in *kharif* season with 2 treatments and replicated thrice. The treatments consists of M₁ 100% RDN, M₂ (50% RDN + 25% N through FYM + 25% N Through neem cake + Azospirillum + PSB @ 2.5 kg ha⁻¹ (INM). During the immediate *kharif*, the experiment was laid out in a split plot design without disturbing the soil for succeeding *rabi* crops with the two treatments given to *kharif* rice as main plot treatments and each of these divided into five sub-plots. The experiment was repeated in another field during *kharif* and *rabi* seasons. Popular cultivars of rice (BPT 5204) and blackgram (PU 31) were used for this study.

The soil was vertisol with bulk density (1.42 & 1.43), porosity (43.50 and 43.80%) and water holding capacity (45.10 & 45.80%), slightly alkaline in reaction, (pH 7.70 and 7.50), two fields were non-saline in nature, cation exchange capacity (35.4 & 37.2),

medium range of organic carbon (0.55 and 0.50%). Low nitrogen content (266 and 250 kg ha⁻¹), available phosphorus was (59 and 53 kg ha⁻¹) and available potassium (630 and 668 kg ha⁻¹).The initial soil analysis data is presented in table 1.The present investigation was undertaken during 2015-16 and 2016-17 of consecutive years.

The nutrients were applied through the fertilizers like urea, single super phosphate, muriate of potash. The farm yard manure and neem cake was applied at seven days before transplanting of rice on dry weight basis as per the treatment. The bacterial inoculants applied at the time of sowing as per recommended dosage (Azospirillum + PSB @ 5.0 kg ha⁻¹).

The recommended fertilizer doses were applied as 120-40-40, 20-50-0 kg N, P₂O₅ and K₂O ha⁻¹ to rice and blackgram crops. The soil samples were analysed as per standard procedures for soil physical and physico-chemical properties. Soil texture by Piper, 1966, bulk density by Dastane, 1967, water holding capacity by Sankaram, 1966, soil reaction and EC by Jackson, 1973, CEC by Bower *et al.*, 1952 and organic carbon by Walkley and Black, 1934. The data obtained during *kharif* 2015-16 and 2016-17 were analysed statistically using two sample t-test analysis of variance (Panse and Sukhatme, 2000). The t-test value calculated for 12 replications and t-test value was 2.07. If the t-test value was >2.07, it was significant, while <2.07 includes non-significant. Whereas the data obtained during *rabi* 2015-16 and 2016-17 were analyzed statistically by following split plot design as suggested by Gomez and Gomez (1984). Wherever, the treatment differences were found significant, critical differences were worked out at five per cent probability level and furnished along with mean values of the parameter concerned in tables. Non-significant treatment differences were

denoted by “NS”.

Collection and processing of plant samples

Blackgram plant samples were collected from five random sites in each treatment at different growth stages and sent for laboratory for further analysis. The samples were first dried in shade and then in hot air oven at 65°C. The plant samples were ground in willey mill and stored in labeled brown paper bags for analysis. The grain samples were also processed and stored in similar fashion.

Nitrogen

Nitrogen content in plant samples was determined by micro Kjeldahl method (Piper, 1966).

Preparation of di-acid mixture

Di-acid extract was prepared as per the method outlined by Jackson (1973). It was carried out using a 9:4 mixture of HNO₃: HClO₄. The pre-digestion of sample was done by using 10ml of HNO₃ g⁻¹ sample. This di-acid extract was used to determine P and K contents in the plant and grain samples.

Phosphorus

It was determined spectrophotometrically by vanadomolybdate phosphoric acid yellow color method as described by Jackson (1973) from di-acid extract.

Potassium

It was estimated from di-acid extract by using flame photometer (Jackson, 1973).

Nutrient uptake

From the chemical analytical data, uptake of the each nutrient was calculated as shown

below.

Nutrient uptake (kg ha⁻¹) =

Nutrient content (%) x dry matter in kg ha⁻¹

100

Results and Discussion

Seed yield of Blackgram

Seed yields of blackgram were presented in table 2 and depicted in figure 1. Significantly highest seed yield was obtained in residual effect of M₂ treatment with values of 1118 and 1210 kg ha⁻¹ in the year 2015-16 and 2016-17, respectively. These yields were higher by 21.9% and 10.40% over M₁ during first and second years, respectively, which indicated the residual effect of INM treatment (M₂) imposed in rice during *khari*.

Similar results were obtained by Gajendrasingh *et al.* (2016) who reported that residual effect of INM had showed the highest seed yield in blackgram compared to inorganics alone. Shashikumar *et al.* (2013) had also stated that highest yields were obtained with organics in conjunction with inorganics. Growth regulators combinedly affect the grain yield of blackgram crop. Geetha and Velayutham, (2016) also supported that the fertilizer application methods followed in the preceding rice crop did exert significant variation in the grain yield of succeeding blackgram crop and the percent of yield increase due to fertilizer application to blackgram was 12% over application of the recommended dose of fertilizer to preceding rice crop. The increase in yield might be due to enhancement in growth and yield parameters as well as uptake of nutrients by crop. Obviously, the cumulative effects of these parameters might have contributed to increased grain yield

potential of the crop. Anulavanya and Ganapathy, (2010) stated that the maximum seed yield was recorded with 2% DAP + bio-fertilizers. The *rhizobium* inoculation formed good nodulation and increased blackgram showing effective symbiosis which might have left appreciable amount of N to increase yield. Phosphobacteria application made the insoluble phosphates present in the soil into soluble forms by secreting organic acids resulting in effective solubilization and utilization of phosphorus.

Devaraju and Senthivel (2018) concluded that the grain yield was increased with application of pulse wonder @ 5kg/ha (organics) gave significantly highest grain yield than other treatments. The increase in yield might be due to enhanced yield attributes like number of pods plant⁻¹, number of seed pod⁻¹ and increased uptake of nutrients by blackgram by effective translocation of nutrients from sink to reproductive area of crop. Selvakumar *et al.* (2009) stated that the yield of blackgram increased with biofertilizers (dual inoculation of *rhizobium* with *phosphobacteria*). It was evident that INM treatment increased plant height, leaf number and leaf area contributing to increased yield. Senthivalavan and Ravichandran (2016) reported that residual effect of integrated plant nutrient supply NPK ha⁻¹ along with 12.5 t ha⁻¹ FYM and biofertilizers viz., *Azospirillum* and *PSB* as soil treatment obtained increased seed yields. This might be due to better availability of P to blackgram during *rabi* season when applied to preceding rice crop in *kharif* season.

Haulm yield of blackgram

To evaluate the residual effect of INM practice imposed in *kharif* rice, the *rabi* yields of blackgram haulm yield were recorded in table 2 and depicted in figure 1. The haulm yields of INM (M₂) treatment were higher by 91(6.33%) and 113kg ha⁻¹(7.52%) over M₁ (only inorganics). The residual effect of INM

treatment was confirmed with the above significant increase in haulm yield.

The application of organics along with 50% RDN showed the increments in yield of haulm yields. Similar type of results were found with Gajendrasingh *et al.* (2016) and the increase of yield in organic manure treatment was due to the higher photosynthetic activity in blackgram plant leading to the better supply of carbohydrates resulting in more number of branches and dry matter. Increase in straw yield might be due to the cumulative influence of improvement in vegetative growth of crop through the atmospherically nitrogen fixed in the root nodules Ghosh and Joseph (2008).

Senthivalavan and Ravichandran (2016) reported that integrated plant nutrient supply NPK along with FYM and biofertilizers viz., *Azospirillum* and *PSB* as soil treatment obtained increased seed and haulm yields. This might be due to better availability of phosphorus to blackgram during *rabi* season when applied to preceding rice crop in *kharif* season. The superiority of residual effect of FYM and biofertilizers through efficient utilization of mineralized N and Zn from FYM along with atmospheric N fixed by the crop itself (by increasing the activity of nodule bacteria would have increased the availability of N throughout the growth period and thereby increased the assimilation of photosynthates which in turn better source and sink relationship led to better performance of rice fallow blackgram crop.

Harvest index

Significantly higher harvest index was obtained with residual effect of INM treatment in both the years. The conversion of biomass into reproductive organs of yield attributing character was revealed in INM treatment. Harvest index value was recorded in M₁ (39.85%) over than that of M₂ (42.25%)

during 2015-16 year and 42.18 to 42.83% during the year 2016-17.

Nutrient content and uptake

Nitrogen

The experimental results pertaining to nitrogen content at different growth stages of blackgram crop are presented in table 3. Data indicated that there was significant residual effect of M₂ (INM) treatment over 100% RDN on nitrogen content of blackgram. At all the growth stages of blackgram the N content was significantly higher with M₂ treatment than M₁ during both the years of study.

The nitrogen content was gradually decreased with the age of the crop *i.e* from vegetative stage to flowering stage. The highest nitrogen content was obtained within seed of 3.12 % during 2015-16 and 3.25% during 2016-17 year. This was coincided with the results of Gajendrasingh *et al.*, (2016) and due to the increased root development and more nutrient availability, resulting in better absorption and utilization of all plant nutrients, thus resulting in more nitrogen content in seed. *Rhizobium* inoculation increased the root nodulation through better root development and more nutrient availability, resulting in better absorption and utilization of all plant nutrients, thus resulting in more nitrogen content in seed. Similar type of results was reported by Singh and Pareek, (2003).

The experimental results pertaining to nitrogen uptake at different growth stages of crop are presented in table 4. Data indicated that there was significant influence of the residual effect of M₂ treatment over 100% RDN (M₁). The significant increase was noticed in nutrient uptake during two years of study.

The nitrogen uptake was also increased from vegetative stage to flowering stage. The highest nitrogen uptake was noticed in seed 95.03 kg ha⁻¹ during 2015-16 and 104.81 kg ha⁻¹ of blackgram during 2016-17 year. Similar type of range of nitrogen uptakes by blackgram crop was happened with Gajendrasingh *et al.* (2016) and Senthilvalavan and Ravichandran, (2016).

Phosphorus

The experimental results pertaining to phosphorus content at different growth stages of blackgram are presented in table 3. Data indicated that there was significant influence of the residual effect of M₂ treatment over 100% RDN at all the growth stages in both years of study. Mir *et al.* (2013) stated that phosphorus solubilizers increased the availability thereby improved phosphorus and plant and uptake of nutrient manifested in increased concentration.

The phosphorus content was gradually decreased with the age of the crop *i.e* from vegetative stage to flowering stage. The overall highest phosphorus content was obtained in seed of 1.34% during 2015-16 and 1.25% during 2016-17 year. This was coincided with those of Gajendrasingh *et al.* (2016).

The higher phosphorus content in seed was due to increased better root development and more nutrient availability, resulting in better absorption and utilization of all plant nutrients, thus resulting in more phosphorus content in seed.

The experimental results pertaining to phosphorus uptake at different growth stages of crop are presented in table 4.

Table.1 Initial properties of the experimental soil

Particulars	2015-16	2016-17	Class/ Group
I. Physical properties			
Mechanical composition			
1. Sand (%)	42	40	
2. Silt (%)	20	21	
3. Clay (%)	38	39	
Textural class	Clay loam	Clay loam	Clay loam
Bulk density (Mg m ⁻³)	1.44	1.43	Normal
Porosity(%)	43.50	43.80	Normal
Water holding capacity (%)	45.10	45.80	Normal
II. Physico-chemical properties			
pH (1:2.5)	7.70	7.50	Neutral to slightly alkaline in nature
EC (dS m ⁻¹)	0.26	0.31	Non-saline
Cation exchange capacity (cmol (p+) kg ⁻¹)	35.4	37.2	Normal
Organic carbon (%)	0.55	0.50	medium
III. Available nutrients			
N (kg ha ⁻¹)	266	250	Low
P ₂ O ₅ (kg ha ⁻¹)	59	53	High
K ₂ O (kg ha ⁻¹)	630	668	Very high
Particulars	2015-16	2016-17	Class/ Group
IV. Secondary nutrients			
Exchangeable Ca (cmol (p+) kg ⁻¹)	23.39	24.07	Normal
Exchangeable Mg (cmol (p+) kg ⁻¹)	5.80	5.70	Normal
SO ₄ ⁻² - Sulphur (mg kg ⁻¹)	15.00	15.50	Normal
V. Available micro nutrients (mg kg⁻¹)			
Iron	27.50	25.00	Sufficient
Manganese	5.50	4.90	Sufficient
Zinc	2.55	2.65	Sufficient
Copper	0.59	0.65	Sufficient
VI. Biological properties			
Dehydrogenase activity (µg TPF g ⁻¹ 24h ⁻¹)	49.14	39.15	Normal
Microbial populations			
Bacteria count (10 ⁵ x cfu g ⁻¹ soil)	20.0	25.0	Normal
Fungi (10 ³ x cfu g ⁻¹ soil)	10.0	8.0	Normal
Actinomycetes (10 ³ x cfu g ⁻¹ soil)	15.0	15.0	Normal

Table.2 Effect of Integrated Nitrogen Management on yield attributes and yield of rice fallow *rabi* blackgram

Treatment	2015-16				2016-17			
	100 seed weight(g)	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Harvest Index (%)	100 seed weight(g)	Seed yield (kg ha ⁻¹)	Haulm yield (kg ha ⁻¹)	Harvest Index (%)
M₁ : 100 % RDN	3.98	917	1437	38.95	4.55	1096	1502	42.18
M₂ : 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	4.17	1118	1528	42.25	4.91	1210	1615	42.83
t-value	9.76	14.10	5.15	2.15	8.11	4.75	12.85	2.07

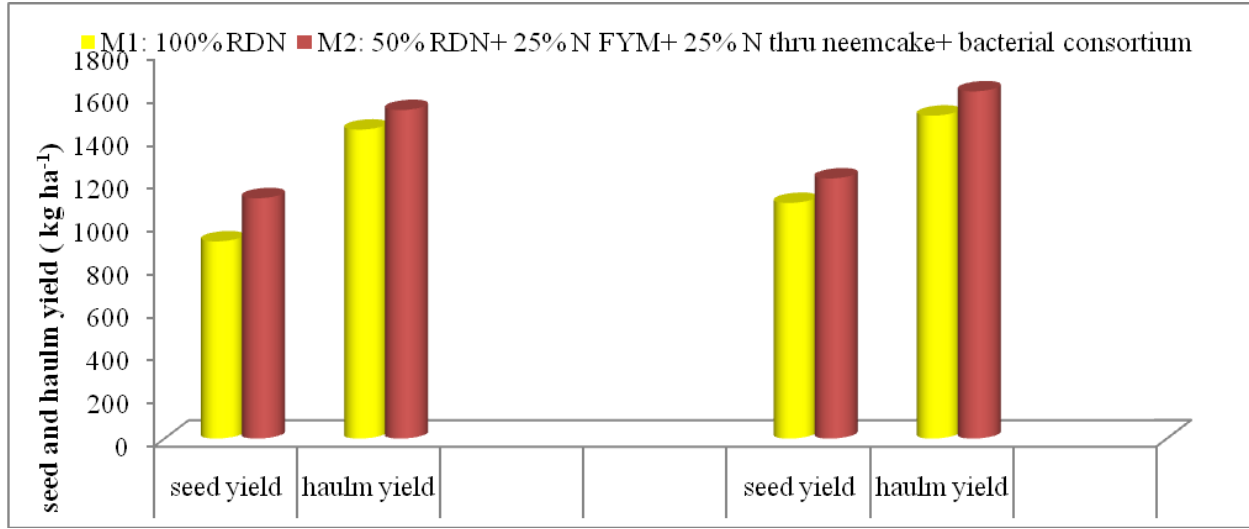
Table.3 Effect of Integrated Nitrogen Management on N, P and K contents in rice fallow *rabi* blackgram

Treatment	2015-16				2016-17			
	Vegetative	Flowering	Haulm	Seed	Vegetative	Flowering	Haulm	Seed
Nitrogen(%)								
M₁: 100 % RDN	1.56	1.36	0.44	3.05	1.58	1.48	0.54	3.11
M₂: 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	1.63	1.46	0.62	3.12	1.86	1.59	0.66	3.25
t - value	3.60	2.51	4.56	5.92	3.69	2.11	2.15	2.11
Phosphorus (%)								
M₁: 100 % RDN	0.33	0.30	0.28	1.08	0.45	0.40	0.32	0.99
M₂: 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	0.38	0.35	0.33	1.34	0.64	0.60	0.43	1.25
t - value	2.34	2.19	2.42	2.52	4.79	3.77	2.27	2.16
Potassium(%)								
M₁: 100 % RDN	1.24	1.18	1.04	0.41	1.36	1.26	1.02	0.55
M₂: 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	1.39	1.29	1.36	0.52	1.48	1.37	1.28	0.60
t - value	2.25	2.17	3.34	2.13	2.56	2.20	2.17	2.17

Table.4 Effect of Integrated Nitrogen Management on macronutrient uptake by rice fallow *rabi* blackgram

Treatment	2015-16				2016-17			
	Vegetative	Flowering	Haulm	Seed	Vegetative	Flowering	Haulm	Seed
Nitrogen (kg ha⁻¹)								
M₁: 100 % RDN	1.43	11.68	6.32	27.9	1.40	12.81	8.11	34.85
M₂: 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	2.44	13.72	4.27	34.8	3.06	16.02	10.65	39.32
t - value	2.15	7.07	6.26	18.14	2.35	2.93	3.47	3.77
Phosphorus (kg ha⁻¹)								
M₁: 100 % RDN	0.30	2.57	4.02	9.90	0.40	3.46	4.80	10.85
M₂: 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	0.57	3.29	5.04	14.98	1.05	3.65	6.94	15.12
t - value	2.17	11.63	3.30	4.41	2.92	9.47	2.93	3.06
Potassium (kg ha⁻¹)								
M₁: 100 % RDN	1.14	10.13	14.9	3.75	1.21	12.64	15.32	4.82
M₂: 50% RDN+25% N - FYM+ 25% N - neem cake + bacterial consortium	2.08	12.12	20.78	5.81	2.44	16.09	20.67	6.77
t - value	2.45	3.53	4.54	5.17	2.79	9.43	3.45	3.34

Fig.1 Effect of Integrated Nitrogen Management on yield of rice fallow *rabi* blackgram



The phosphorus uptake also increased from vegetative stage to flowering stage. Data indicated that there was significant increase of the residual effect of M₂ treatment over 100% RDN had given the significantly higher phosphorus uptake. The significant increase was noticed in nutrient uptake during two years of study. The overall highest phosphorus uptake was noticed in seed of 40.81 kg ha⁻¹ during 2015-16 and 40.31 kg ha⁻¹ in seed of blackgram during 2016-17 year. Similar type of range of phosphorus uptake observed by blackgram crop was noticed with Harishkumarmehta *et al* (2015).

Potassium

Potassium content at different growth stages of crop were presented in table 3. Potassium content was gradually decreased with the age of the crop *i.e* from vegetative stage to flowering stage. The highest potassium content was obtained at harvest stage of haulm of 0.52% during first and 0.60% during second year (Mir *et al.*, 2013).

There was significant residual effect of M₂ treatment over 100% RDN. Irrespective of growth stage the highest potassium content

was obtained with residual effect of M₂ over M₁ (only inorganics). Similar type of results was quoted by Harishkumarmehta *et al.*, (2015). There was residual effect of M₂ treatment over 100% RDN. Similar type of potassium uptakes were stated by Gajendrasingh *et al.* (2016).

The potassium uptake was also increased from vegetative stage to flowering stage as it is a product of content and dry matter. The significant increase was noticed in nutrient uptake during two years of study. The overall highest nutrient potassium uptake was noticed in haulm of 20.78 kg ha⁻¹ during 2015-16 and 20.67 kg ha⁻¹ in haulm of blackgram during 2016-17 year.

The highest nutrient uptakes of blackgram were obtained due to higher dry matter production and increased availability of nutrients from the INM might have enhanced the K uptake. These results were in conformity with the findings of Geetha and Velayutham (2016).

In conclusion, application of integrated nitrogen management improved the macronutrient content and uptake of rice fallow *rabi* blackgram with the implication of

M₂ {50% RDN + 25% N through FYM + 25% N through neem cake + recommended dose of microbial consortium (Azospirillum + PSB @ 2.5kg ha⁻¹) during *kharif* season. Nitrogen, Phosphorus and potassium uptakes in seed were increased 24.7%, 51% and 69% respectively during first year and in second year 13.9%, 48% and 40% increments were noticed in seed uptakes of N, P and K respectively. This conclusion was based on two years study the evaluation and assessment need long-term experimentation on different agro-climatic conditions and locations.

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