Residual effect of fertilizer recommendations and organic manures imposed in kharif rice on succeeding rabi blackgram

D Mounika, M Martin Luther, K Chandra Sekhar, G Kishore Babu and K Jaya Lalitha

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Abstract
A field experiment was conducted at the Agricultural College farm, Bapatla, during kharif and rabi 2017-18 and 2018-19. The experiment was conducted with variety BPT-5204 in a Randomized Block Design with ten treatments and three replications. The maximum plant height and drymatter production and seed yield were recorded with soil test based fertilizer recommendation with 10 t ha$^{-1}$ FYM application which was at par with soil test based fertilizer recommendation alone and 7.5 t ha$^{-1}$ targeted yield recommendation along with FYM (T$_8$) and RDF with FYM (T$_9$). Seed yield of blackgram was significantly higher with soil test based fertilizer recommendation with 10 t ha$^{-1}$ FYM application which was statistically at par with soil test based fertilizer recommendation alone (T$_5$) and 7.5 t ha$^{-1}$ targeted yield fertilizer recommendation with FYM (T$_{10}$) compared to the rest of the treatments.

Keywords: Blackgram, targeted yield fertilizer recommendation, yield and growth parameters, STFR

Introduction
Rice is a staple food crop not only in India but also in entire South Asia. Of the total rice (Oryza sativa L.) production in the world, more than 90% is in Asia. Rice is cultivated in 111 countries of all continents, except Antarctica. India and China are the leading producers as well as consumers of rice. In India, it is grown in an area of 43.9 m ha with a production of 99.24 m t and productivity of 2494 kg ha$^{-1}$. In Andhra Pradesh, it is grown in an area of 2.152 m ha with a production of 8.05 m t and productivity of 3741 kg ha$^{-1}$. (Anon., 2018) [3]. Blackgram (Vigna mungo L. Hepper) is one of the most important pulse crops among the various grain legumes. It is a rich protein food, contains about 26% protein, 1.2% fat and 56.6% carbohydrates on dry weight basis. It fits well in rice based cropping sequence in coastal Andhra Pradesh. India with largest area under pulses in the world (190.4 lakh ha.) produce about 124.0 lakh tonnes with an average yield of 651.2 kg ha$^{-1}$. Among the pluses, blackgram (Urdbean) contributes 16.28% of the total area and 11.48% of the total production. Among the pluses, blackgram (Urdbean) contributes 16.28% of the total area and 11.48% of the total production with an average productivity of 451.6 kg ha$^{-1}$. Nutrient management is an important aspect in increasing the productivity of pulses. It is closely related to availability of nutrients to plants. Integrated nutrient management, which entails the maintenance / adjustment of soil fertility to an optimum level for crop productivity to obtain the maximum benefit from all possible sources of plant nutrients. To get more and more yield, farmers inclined to the excess use of chemical fertilizer, but the decision on fertilizer use requires knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrient needs, supply of nutrients from indigenous sources, and the short and long term fate of fertilizer applied. Application of fertilizers by the farmers in the fields without information on soil fertility status and nutrient requirement by the crop causes adverse effects in soil and crop regarding both nutrient toxicity and deficiency either by over use or inadequate use.

Rice–blackgram (cereal–legume) sequence is an age old and the best cropping sequence followed in the Krishna Agro-climatic Zone of Andhra Pradesh, India. The potential for increasing the productivity of both of these crops i.e, rice and blackgram in sequence with sustainable nutrient management practices. Farmers in this region grow blackgram crop only on residual soil fertility.
Hence, maintaining higher residual fertility through the credible use of chemical fertilizers and organic manures in previous rice crop is very important in enhancing the productivity of rice – blackgram sequence.

Materials and Methods
A field experiment was conducted at the Agricultural College farm, Bapatla, during kharif and rabi 2017-18 and 2018-19. The experiment was conducted with variety BPT 2680 in a Randomized Block Design with ten treatments and three replications. The treatments comprised of, Recommended Dose of Fertilizer (T1), Soil test based fertilizer recommendation (T2); Targeted yield fertilizer recommendations for 5.5 tons ha⁻¹ (T3), 6.5 t ha⁻¹ (T4) and 7.5 t ha⁻¹ (T5); Treatment T1 + FYM @ 10 t ha⁻¹ (T6); Treatment T2 + FYM @ 10 t ha⁻¹ (T7); Treatment T3 + FYM @ 10 t ha⁻¹ (T8); Treatment T4 + FYM @ 10 t ha⁻¹ (T9); and Treatment T5 + FYM @ 10 t ha⁻¹ (T10). The experimental soil was clay loam in texture, slightly alkaline in reaction, non saline, low in available nitrogen, low in organic carbon, high available phosphorus and potassium. The application of nutrients was done following the soil test based fertilizer recommendations as per the treatment. Target yield fertilizer recommendations were based on using the target yield equations developed for Krishna Godavari agro ecological region.

By using formulæ Targeted yield (qha⁻¹) equation for kharif: Rice:

(Anon., 2007) [3]

\[ *FN* = 2.30 \times T \times 0.52 \times S N \]

\[ *FP* = 0.91 \times T \times T - 1.90 \times S P \]

\[ *FK* = 2.27 \times T - 0.27 \times S K \]

\[ S N = \text{Soil Nitrogen} \]

\[ S P = \text{Soil Phosphorous} \]

\[ S K = \text{Soil Potassium} \]

Fertilizer schedule during kharif rice- during 2017and 2018 (As Per Initial soil analysis data).

| Treatments | 2017-18 | 2018-19 |
|------------|---------|---------|
| N-P-K      | (kg ha⁻¹) | N-P-K  | (kg ha⁻¹) |
| T1         | 120-60-40 | 120-60-40 | |
| T2         | 156-42-28 | 156-42-28 | |
| T3         | 80-30-30  | 70-30-28  | |
| T4         | 102-30-52 | 98-30-50  | |
| T5         | 125-30-75 | 123-30-73 | |
| T6         | T1+FYM@10 t ha⁻¹ | T1+FYM@10 t ha⁻¹ | |
| T7         | T2+FYM@10 t ha⁻¹ | T2+FYM@10 t ha⁻¹ | |
| T8         | T3+FYM@10 t ha⁻¹ | T3+FYM@10 t ha⁻¹ | |
| T9         | T4+FYM@10 t ha⁻¹ | T4+FYM@10 t ha⁻¹ | |
| T10        | T5+FYM@10 t ha⁻¹ | T5+FYM@10 t ha⁻¹ | |

Results and Discussion
Plant height of blackgram at different growth stages viz., at 30, 60 days after sowing and at maturity (Table 1) was affected significantly by residual effect of fertilizer recommendations imposed in rice. Soil test fertilizer recommendation along with 10 FYM (T3) followed by T5, T10, T6 treatments significantly influenced the plant height of blackgram compared to other treatments. Similarly 5.5 t targeted yield fertilizer recommendation to rice observed with significantly lower height plant height over other treatments and it was found to be on par with the treatments T8, T1 and T9. Application of organics like FYM in combination of other treatments to rice increased plant height significantly compared with the treatments without FYM.

Almost similar trend was observed during 2019 also where, application of FYM along with STFR application and 7.5 t targeted yield fertilizer recommendation to rice produced significantly taller plants along with the treatments T2 and T3 over other treatments given to rice. A significant decrease in plant height of blackgram with 5.5 t targeted yield fertilizer recommendation followed by T3 and T1 compared with other treatments at all the growth stages of blackgram during the year 2019.

Per cent plant height increase with soil test recommendation with FYM (T1) and without FYM (T2) was 38.0%, 27.5%, 23.3%, 31.2% and 17.42%., 35.3%, 24.4%, 20.0% higher compared to the treatments T3, T4, T6, and T8 respectively (pooled data).

In a cropping sequence the effect of nutrients applied to the preceding crops is beneficially influencing the productivity of succeeding crop. The carryover effect of organic sources is more than inorganic sources. The residual effect of inorganic sources is more pronounced in T1 among treatments without FYM and T3 among the treatments with FYM. Similar views are reflected from the observations of Senthilvalavan and Ravichandran (2016) [9] and Saha and Moharana (2008) [8].

Drymatter accumulation is one of the important factors influencing the partitioning of assimilates among different plant parts. Drymatter accumulation of blackgram at different growth stages viz., at 30, 60 days after sowing and at maturity presented in (Table 2).

Drymatter production of blackgram was significantly the highest with application of 10 t FYM along with STFR application (T1) to preceding rice compared to rest of the treatments at 30, 60, 90 DAS and pooled data. However, it was found on par with STFR application alone (T2) and targeted yield (7.5 t ha⁻¹) fertilizer recommendation (T10). The lowest drymatter production observed with targeted yield (5.5 t ha⁻¹) fertilizer recommendation (T1) over all other treatments and it was on par with treatments T3 and T4 at 30 DAS and T9 and T1 as well at 60 and 90 DAS during year 2018 and 2019. Similar trend as that of 2018 was also observed in 2019 also where, treatments T7 followed by T2, T10 and T6 were observed with higher drymatter production over that of the remaining treatments. Similarly, the treatments T3 followed by T1 and T4 produced lower drymatter at 30 DAS. However, the differences among the treatments T3, T4, T9 and T8 were not significant at 90, 60 DAS and in pooled data and in the year 2019.

Drymatter production increase with soil test recommendation with FYM (T1) and without FYM (T2) was 15.0%, 12.9%, 11.9% and 13.5% & 13%, 10.8%, 9.8% and 11.4% higher compared to the treatments T3, T4, T6, and T8 respectively (pooled data).

The superiority of residual effect of organic manures treatments was attributed to its slow decomposition, that might have released the nutrients slowly as compared to that of without FYM. Increased dry matter accumulation with increased fertilizer doses and with organic manures was reported by many researchers (Alagappan and Venkitasawamy, 2016; Senthilvalavan and Ravichandran, 2016; Anu Lavanya and Ganapathy, 2010) [1, 9, 4].

Data pertaining to seed yield presented in (table 3) indicated that the highest seed yield of blackgram was recorded with STFR application with 10 t FYM (T4) to rice and was significantly superior to other treatments. Whereas, the differences in yield obtained among the treatments T1, T2, T6, T10 and T4 were not significant during 2018 and 2019.

The lowest seed yield of blackgram observed with targeted yield (5.5 t ha⁻¹) fertilizer recommendation (T1) was significantly inferior compared to the treatments T6, T2, T10 and T4 during both the years of study and pooled data.

Seed yield increase with soil test recommendation with FYM (T1) and without FYM (T2) was 25.8%, 16.9%, 15.8% and
20.5% & 14.4%, 4.1%, 2.8% and 8.3%, higher compared to the treatments \( T_1, T_6, T_7, \) and \( T_8 \) respectively. Seed yields of blackgram after rice increased significantly with the increasing level of nutrient (156-42-28 kg ha\(^{-1}\) NPK) application in \( T_8 \) along with FYM compared with other treatments in the rice-blackgram sequence. Similarly, addition of FYM to rice crop showed significant residual effect on the seed yield of blackgram. These results are in conformity with the observations of Aruna and Shaik Mohammad (2005) \(^5\), Bhote (2005) \(^6\) and Ombrir Singh et al. (2012) \(^7\).

Residual effect of STFR based integrated plant nutrient management along with FYM and biofertilizers imposed by preceding rice crop on blackgram seed yield was reported by Senthilvalavan and Ravichandran (2016) \(^8\) and Saha and Moharan (2008) \(^9\).

**Table 1:** Plant height (cm) at different stages on residual effect of rabi blackgram as influenced by site - specific nutrient management in rice-blackgram sequence during rabi 2017-18, 2018-19 and pooled data

| Treatments | 2017-18 | 2018-19 | Pooled data |
|------------|---------|---------|-------------|
|            | 30 DAS  | 60 DAS  | Maturity    | 30 DAS  | 60 DAS  | Maturity    | 30 DAS  | 60 DAS  | Maturity    |
| \( T_2 \)  | 18.48   | 41.67   | 82.43       | 21.30   | 42.33   | 88.96       | 19.89   | 42.00   | 85.65       |
| \( T_3 \)  | 21.95   | 48.30   | 86.72       | 23.51   | 51.67   | 87.16       | 22.70   | 49.98   | 85.39       |
| \( T_4 \)  | 25.54   | 54.67   | 86.11       | 29.14   | 57.91   | 82.09       | 27.34   | 56.29   | 86.80       |
| \( T_5 \)  | 25.29   | 53.54   | 87.40       | 25.67   | 56.64   | 86.38       | 24.98   | 55.09   | 86.39       |
| \( T_6 \)  | 30.19   | 57.91   | 86.70       | 32.14   | 63.27   | 77.43       | 31.17   | 60.59   | 75.56       |
| \( T_7 \)  | 20.44   | 43.67   | 87.17       | 22.46   | 45.67   | 85.33       | 21.45   | 44.67   | 85.60       |
| \( T_8 \)  | 24.11   | 53.67   | 88.82       | 24.41   | 52.67   | 80.65       | 23.51   | 51.08   | 86.46       |
| SE_{\pm}  | 1.58    | 3.08    | 4.1        | 1.95    | 2.30    | 5.07        | 1.27    | 2.46    | 3.57        |
| CD (p = 0.05) | 4.70  | 9.16    | 12.31       | 5.80    | 6.83    | 15.06       | 4.07    | 7.30    | 10.61       |
| CV (%)    | 11.33   | 10.47   | 12.65       | 12.79   | 7.34    | 13.45       | 9.36    | 8.09    | 10.14       |

**Table 2:** Drymmatter production (kg ha\(^{-1}\)) at different stages on residual effect of rabi blackgram as influenced by site - specific nutrient management in rice-blackgram sequence during rabi 2017-18, 2018-19 and pooled data

| Treatments | 2017-18 | 2018-19 | Pooled data |
|------------|---------|---------|-------------|
|            | 30 DAS  | 60 DAS  | Maturity    | 30 DAS  | 60 DAS  | Maturity    | 30 DAS  | 60 DAS  | Maturity    |
| \( T_2 \)  | 5.73    | 1223    | 2188       | 5.58    | 1274    | 2240       | 5.78    | 1249    | 2214       |
| \( T_3 \)  | 6.48    | 1348    | 2426       | 6.62    | 1425    | 2437       | 6.55    | 1366    | 2431       |
| \( T_4 \)  | 4.03    | 1104    | 2096       | 427    | 1223    | 2112       | 415    | 1164    | 2114       |
| \( T_5 \)  | 4.91    | 1199    | 2113       | 495    | 1244    | 2273       | 493    | 1222    | 2168       |
| \( T_6 \)  | 5.94    | 1287    | 2269       | 609    | 1364    | 2375       | 602    | 1326    | 2322       |
| \( T_7 \)  | 5.86    | 1245    | 2215       | 596    | 1359    | 2246       | 591    | 1302    | 2231       |
| \( T_8 \)  | 6.58    | 1360    | 2493       | 676    | 1424    | 2493       | 676    | 1401    | 2488       |
| SE_{\pm}  | 18.61   | 36.58   | 70.07       | 17.50   | 40.01   | 67.63       | 12.93   | 32.40   | 46.49       |
| CD (p = 0.05) | 55.30 | 108.68  | 208.18      | 51.98   | 118.89  | 200.93      | 38.42   | 96.27   | 138.13      |
| CV (%)    | 5.80    | 5.0     | 5.41        | 5.29    | 5.20    | 5.10        | 3.97    | 4.37    | 3.55        |

**Table 3:** Seed yield (kg ha\(^{-1}\)) of rabi blackgram as influenced by site - specific nutrient management in rice-blackgram sequence during rabi 2017-18, 2018-19 and pooled data

| Treatments | 2017-18 | 2018-19 | Pooled data |
|------------|---------|---------|-------------|
|            | 755     | 765     | 760         |
| \( T_2 \)  | 857     | 884     | 871         |
| \( T_3 \)  | 642     | 681     | 661         |
| \( T_4 \)  | 734     | 746     | 740         |
| \( T_5 \)  | 794     | 882     | 838         |
| \( T_6 \)  | 760     | 784     | 772         |
| \( T_7 \)  | 876     | 905     | 891         |
| \( T_8 \)  | 697     | 719     | 708         |
| \( T_9 \)  | 746     | 755     | 750         |
| \( T_{10} \) | 831   | 855     | 843         |
| SE_{\pm}  | 40.89   | 44.87   | 31.64       |
| CD (p = 0.05) | 121.48 | 133.31  | 94.02       |
| CV (%)    | 9.2     | 9.7     | 7.0         |

**Conclusions**

Thus based on the plant height and drymatter production and seed yield it can be recommended to go for up to soil test based fertilizer recommendation with 10 t ha\(^{-1}\) FYM application (156-42-28 kg NPK ha\(^{-1}\)), applied. Among the treatments with soil test based fertilizer recommendation with 10 t ha\(^{-1}\) FYM application which was at par with soil test based fertilizer recommendation alone and 7.5 t ha\(^{-1}\) targeted yield recommendation along with FYM (\( T_5 \) and \( T_6 \)) and RDF with FYM (\( T_8 \)). Whereas targeted yield recommendation 5.5 and 6.5 t ha\(^{-1}\) (\( T_3 \) and \( T_4 \)) found with significantly lower plant height and drymatter production and seed yield compared to the rest of treatments during both the years of study.

\( \sim 2681 \)
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