

Influence of Crop Residue, Inorganic Fertilizers and Vermicompost on the Growth, Yield and Yield attributes of Blackgram under Rice-Blackgram System

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ABSTRACT: Rice – Blackgram was the major adopted cropping system of Tamil Nadu. Increasing the productivity of blackgram by reducing the usage inorganic fertilizer, in view of improving soil fertility without affecting the productivity of the crop with a proper residue management practice was the main objective of this research. The field experiment was conducted in blackgram Vamban (VBN 8) during January – June, 2020, to study the influence of crop residue, inorganic fertilizers and vermicompost on the growth, yield and yield attributes of blackgram under rice - blackgram cropping system. Blackgram with and without incorporating preceding rice crop residue were taken as vertical factors V1 – blackgram with incorporation of rice residue, V2 – blackgram without incorporation. Different fertilizer recommended doses in combination with vermicompost as an integrated approach were taken as horizontal factors H1- 100 per cent recommended dose of fertilizer alone, H2- 75 per cent recommended dose of fertilizer alone, H3- 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost, H4- 50 per cent recommended dose of fertilizer alone and H5- 50 per cent recommended dose of fertilizer with 25 per cent of vermicompost. With three replication and laid out in strip plot design. The growth and yield attributes were recorded in all the stages of crop growth. From the first-year study it was observed that plant height (52.67 cm), leaf area index (3.12), dry matter production (1831 kg ha⁻¹), number of pods per plant (38.87), number of seeds per pod (8.36), grain (823 kg ha⁻¹) and haulm yield (1891 kg ha⁻¹) of blackgram recorded were higher in blackgram without rice residue incorporation along with 100 per cent recommended doses of fertilizer. This was found on par in blackgram without incorporation of rice residue with 75 per cent of recommended dose of fertilizer plus 25 per cent of vermicompost. The incorporation of residue with 100 per cent recommended dose of fertilizer was also found at par. The least attributes were recorded in blackgram with crop residue incorporation and 50 per cent recommended dose of fertilizer alone. Hence, this study is to find out a way for rice residue management, also to know effect of rice residue incorporation with reduced fertilizer usage on blackgram in rice – blackgram cropping system, to improve soil health and also to establish a suitable cropping system with best management practice for the region. The major challenge in conducting the research was raising crop on time sequentially one after other as the research is based on cropping system.

Keywords: Blackgram, fertilizer, rice residue, vermicompost, yield.

INTRODUCTION

India has made inspiring progress in achieving self-sufficiency in food grain production and achieved a sufficient growth rate to meet the demands of an expanding population. However, pulse production has been stable in recent decades, ranging between 13 and 15 million metric tonnes. Pulses are the primary source

of quality protein and essential amino acids in India, which is predominantly vegetarian. Due to low and unstable production, as well as increasing population pressure, per capita availability of pulse has decreased from 69g in 1961 to approximately 47.2g per capita per day in 2014 (MFED 2014-15) and in 2020 it was 48g reported counter to the minimum requirement of 80g per capita per day (Statista, 2021).

Blackgram (*Vigna mungo* L. Hepper.) is one of the highly prized vegetarian diets in India. Being a leguminous crop, it has a beneficial effect on improving soil fertility through fixation of atmospheric nitrogen. India is the world's largest producer and consumer of pulses, accounting for 33.6 percent of global area and 24 percent of global pulse production (Pramanik, 2009). In Tamil Nadu, the area under blackgram fluctuated between 3.19 and 4.26 lakh ha, so did production, which fluctuated from 1.27 to 3.01 lakh tonnes. The productivity ranged from 398 kg/ha to 707 kg/ha. Tamil Nadu is not self-sufficient in pulses requirement. Therefore, there is an burning need to increase the production of blackgram, the major pulse crop of the state. Blackgram's low productivity is due to its cultivation in marginal and sub-marginal lands with poor management practices. . The use of improved crop management packages can invariably increase productivity by 50-100 %. In addition to other management practices such as irrigation and plant protection, blackgram respond markedly to précised application of plant nutrients in combination with foliar nutrition especially when applied in balanced amount and at appropriate time (Swaminathan *et al.*, 2021). Rice-black gram is one of the main cropping systems adopted in Tamil Nadu, India. Farmers are adopting this technology in greater numbers because to its higher economic returns. Growing high-yielding varieties, fertilizer-responsive hybrids, and intensive cultivation resulted in a significant volume of crop wastes such as leaves, twigs, and stubbles in our agricultural land. Their disposal is a significant issue. However, because to low nutrient content, bulkiness, and difficulties in straight application, their usefulness in agriculture is limited. The crop residues can be used effectively by proper degradation and also with appropriate bioagents (Bhudhar and Palaniappan, 1994). Increasing production solely through the use of inorganic fertilizers will result in environmental pollution as well as soil health degradation. . As a result, combining organics, crop residues, bio agents, and chemical fertilizer will sustain productivity and soil health. An integrated plant nutrient management approach will achieve sustainable productivity. The main aim of the study was to establish a suitable cropping system with best residue management practice and also to improve soil health by reducing fertilizer requirement.

MATERIALS AND METHODS

In strip plot design with three replication, the experiment was carried out at D Block, Central Farm, Agricultural College and Research Institute, Madurai during Jan – June, 2020. The field was prepared after incorporating previous season (Aug – Dec, 2019) rice residue using mulcher and NCOF waste decomposer was sprayed uniformly with 60 percent moisture to all the plots and left 30 days undisturbed to enhance in-situ decomposition. The field was prepared with tilth as needed for the crop. The blackgram variety Vamban VBN (8) were sown in flat bed system with between rows 30 cm and 10 cm between plants in a sandy clay

loam soil with a size of the plot 5.4 m × 4.2 m. The experimental treatments included V1 – blackgram with incorporation of rice residue, V2 – blackgram without incorporation of rice residue as vertical factors and H1- 100 per cent recommended dose of fertilizer alone, H2- 75 per cent recommended dose of fertilizer alone, H3- 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost, H4- 50 per cent recommended dose of fertilizer alone and H5- 50 per cent recommended dose of fertilizer with 25 per cent of vermicompost. A full dose of fertilizer schedule (25: 50: 25 kg ha⁻¹ of NPK) was applied as per treatment in basal and 25 per cent of vermicompost for the recommended treatment was applied based on nitrogen equivalent basis. All the parameters of growth [plant height (cm), leaf area index, dry matter production (kg ha⁻¹), yield grain (kg ha⁻¹) and haulm yield (kg ha⁻¹) and yield attributes (number of pods per plant, number of seeds per pod) were recorded at all the growth stages of the crop.

Statistical analysis

All collected data were analysed using the analysis of variance (ANOVA) technique with IBM-SPSS (Version 22.0) statistical software at a 5% level of significance.

RESULTS AND DISCUSSION

A. Growth attributes

Among the vertical treatment, the growth attributes of blackgram *viz.*, plant height, leaf area index and dry matter production at 40 days after sowing were recorded higher in no residue incorporation and followed with rice residue incorporation treatment (Table 1). More leaf area with high photosynthetic efficiency increased dry matter production, A greater number of seeds per pod and higher uptake of nutrients could be contributed to increased seed production as this was attributed by nutrient availability and mobility. A decrease in nitrogen during the early stages of growth may reduce the rate of photosynthesis, which could lead to a reduction in growth rate (Beniwal and Tomer, 2019). In present study, with the horizontal treatment, 75 per cent recommended dose of fertilizer along with 25 per cent vermicompost supplement recorded higher in plant height and leaf area index. This was found on par with 100 per cent recommended dose of fertilizer. With the dry matter production, 100 per cent recommended dose of fertilizer was found on par with 75 per cent recommended dose of fertilizer along with 25 per cent vermicompost at the same day of crop growth (Table 1). The least growth was recorded with 50 per cent recommended dose of fertilizer alone. Gayathri *et al.* (2013) reported the effect of chemical fertiliser and leaf extracts on black gramme seed germination. And noticed higher germination percentage with the integrated nutrient management. The growth and yield parameters were also increased when inorganic fertilizers and herbal extracts were combined. The plant height consistently increased to a maximum in plants treated with vermicompost 50 per cent, which increased 1.25 cm more over the control.

Table 1: Effect of the treatments on growth attributes of blackgram under rice – blackgram system at 40 DAS.

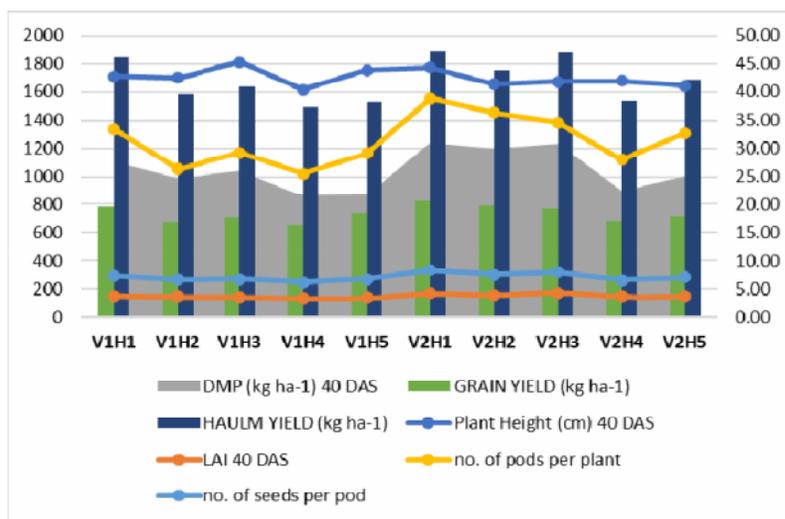
| Treatments | Plant height (cm) | Leaf Area Index | Dry Matter Production (kg ha ⁻¹) |
|--|-------------------|-----------------|--|
| Vertical factor: cropping system under crop residue incorporation | | | |
| V1 | 42.98 | 3.62 | 976 |
| V2 | 42.13 | 4.01 | 1115 |
| SEd | 0.18 | 0.06 | 15.65 |
| C. D. (p=0.05) | 0.76 | 0.24 | 67.33 |
| Horizontal factor: nutrient management | | | |
| H1 | 43.57 | 4.01 | 1178 |
| H2 | 41.93 | 3.82 | 1090 |
| H3 | 43.60 | 4.03 | 1137 |
| H4 | 41.14 | 3.59 | 884 |
| H5 | 42.53 | 3.63 | 938 |
| SEd | 0.53 | 0.13 | 34.32 |
| C. D. (p=0.05) | 1.22 | 0.29 | 79.14 |

Vertical factors: V1 – blackgram with incorporation of rice residue, V2 – blackgram without incorporation of rice residue **Horizontal factors:** H1- 100 per cent recommended dose of fertilizer alone, H2- 75 per cent recommended dose of fertilizer alone, H3- 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost, H4- 50 per cent recommended dose of fertilizer alone and H5- 50 per cent recommended dose of fertilizer with 25 per cent of vermicompost.

The same was also recorded in the growth and yield characters of blackgram as stated by Rekha *et al.* (2013). The application of manure and vermicompost @ 17 t ha⁻¹, its growth was 90.50 % higher over control. This indicates that the black gram grows well for the treatment as stated by Haridha *et al.* (2020).

From this experiment, the interaction of the treatments, raising of blackgram without the incorporation of rice residue during the first year of the study and the application of 100 per cent recommended dose of fertilizer alone recorded the highest growth attributes. And this was found at par with no rice residue

incorporation with 75 per cent recommended dose of fertilizer along 25 per cent vermicompost (Fig. 1). A sufficient amount of nutrients from inorganic fertilisers and some from organic sources improves the plant's cell activities, cell multiplication, and luxuriant growth, which could explain the crop's increased plant height (Fashina *et al.*, 2002). The beneficial nutritional status of the soil, which results in increased biomass production of the crop, is attributed to the significant interactive effect of biofertilizers, vermicompost, and fertiliser application (Shekhawat *et al.*, 2017).



V1H1- blackgram with incorporation of rice residue with 100 per cent recommended dose of fertilizer alone, V1H2- blackgram with incorporation of rice residue with 75 per cent recommended dose of fertilizer alone, V1H3- blackgram with incorporation of rice residue with 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost, V1H4- blackgram with incorporation of rice residue with 50 per cent recommended dose of fertilizer alone and V1H5- blackgram with incorporation of rice residue with 50 per cent recommended dose of fertilizer with 25 per cent of vermicompost. V2H1 – blackgram without incorporation of rice residue with 100 per cent recommended dose of fertilizer alone, V2H2- blackgram without incorporation of rice residue with 75 per cent recommended dose of fertilizer alone, V2H3- blackgram without incorporation of rice residue with 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost, V2H4- blackgram without incorporation of rice residue with 50 per cent recommended dose of fertilizer alone and V2H5- blackgram without incorporation of rice residue with 50 per cent recommended dose of fertilizer with 25 per cent of vermicompost.

Fig. 1. Represents the interaction effect of rice residue with chemical fertilizer and vermicompost on the growth, yield and yield attributes of blackgram.

Chaudharya *et al.* (2020) reported that in the case of height, treatment 100% RDF plus 5t vermicompost ha⁻¹ results in higher plant height in both 30DAS and 60DAS recording 26.40 cm and 28.46 cm height, respectively.

B. Yield attributes

Higher yield attributes were recorded in blackgram with no residue incorporation. It was followed by incorporating rice residue on number of pods per plant and number of seeds per pod (Table 2). The incorporation of residue increases microbial colonies to enhance decomposition by degrading the larger compounds to simpler one and thus drastically decreasing the crop's nutrient availability. As the microbes accompanied in this process take some amount of nutrients for its metabolic activities, that may be the reason for the reduction in the growth of the crop which indirectly lags yield and yield attributing characters of the crop. In terms of nutrient management, 100 per cent recommended dose of fertilizer application alone recorded highest yield attributes. It was followed by 75 per cent recommended dose of fertilizer and 25 per cent of vermicompost on the number of pods per plant (Table 2). As the same treatments were found at par with each other on number of seeds per pod. Fifty per cent recommended dose of fertilizer alone recorded least in the above attributes. Based on the study of Shekhawat *et al.* (2017), the results showed that optimum fertilizer application in The number of pods plant⁻¹, number of seeds pod⁻¹, test weight, seed yield, straw yield, biological yield, and harvest index were maximised in a mungbean crop involving various nutrient combinations with vermicompost and biofertilizers. Noor-E-Zannat *et al.* (2020) states that yield contributing characters like, 1000-seed weight, seed yield and biological yield and harvest index were

greatly influenced by vermicompost with RDF combinations.

From the study, the interaction of the treatments (Fig. 1), without rice residue incorporation in blackgram supplied with 100 per cent recommended dose of fertilizer alone recorded higher yield attributes. This was found at par with no residue incorporation and 75 per cent of the recommended dose of fertilizer alone with the number of pods per plant. On number of seeds per pod, the same treatment (without residue and 100 per cent recommended dose of fertilizer) was found on par with no residue incorporation and 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost. With incorporation of crop residue and application of 50 per cent recommended dose of fertilizer alone was the least among all the treatments on yield attributes of blackgram. Gururajan and Subramanian (2001) revealed that higher quantities of inorganic fertilizer applied to the rice crop had a significant residual influence on black gram growth and yield parameters and seed yield was increased with 125 per cent of the recommended dose of fertilizer applied to crop as compared with control (50 per cent of the recommended dose) and it was at par with application of 100 per cent of the recommended dose of inorganic fertilizer. This increase in seed yield could be attributed to increased N, P, and K availability and organic carbon after the harvest of rice. According to Babou *et al.* (2009), the yield attributes (number of pods per plant, number of seeds per pod) of black gram was markedly increased due to the residual effect of incorporation of residue with or without bio-inoculants, in the previous season that increased the available nutrient level in soil to the succeeding crops contributed to the yield.

Table 2: Effect of the treatments on yield and yield attributes of blackgram under rice – blackgram system at harvest.

| Treatments | Number of pods per plant | Number of seeds per pod | Grain yield (kg ha ⁻¹) | Haulm yield (kg ha ⁻¹) |
|--|--------------------------|-------------------------|------------------------------------|------------------------------------|
| Vertical factor: cropping system under crop residue incorporation | | | | |
| V1 | 28.73 | 6.75 | 710 | 1618 |
| V2 | 34.32 | 7.49 | 756 | 1750 |
| SEd | 0.45 | 0.10 | 10.25 | 24.79 |
| C. D. (p=0.05) | 1.92 | 0.44 | 44.10 | 106.68 |
| Horizontal factor: nutrient management | | | | |
| H1 | 36.17 | 7.86 | 802 | 1872 |
| H2 | 31.37 | 7.06 | 732 | 1668 |
| H3 | 32.40 | 7.38 | 739 | 1759 |
| H4 | 26.77 | 6.38 | 670 | 1515 |
| H5 | 30.93 | 6.89 | 723 | 1608 |
| SEd | 1.05 | 0.23 | 28.60 | 55.78 |
| C. D. (p=0.05) | 2.41 | 0.54 | 65.94 | 128.62 |

Vertical factors: V1 – blackgram with incorporation of rice residue, V2 – blackgram without incorporation of rice residue **Horizontal factors:** H1- 100 per cent recommended dose of fertilizer alone, H2- 75 per cent recommended dose of fertilizer alone, H3- 75 per cent recommended dose of fertilizer with 25 per cent of vermicompost, H4- 50 per cent recommended dose of fertilizer alone and H5- 50 per cent recommended dose of fertilizer with 25 per cent of vermicompost.

C. Yield

With no rice residue incorporation in blackgram higher grain and haulm yield was recorded followed by incorporation treatment (Table 2). Among the nutrient management practices, higher yield was obtained with 100 per cent recommended dose of fertilizer treatment Suvain *et al.*,

alone, which was found on par with 75 per cent recommended dose of fertilizer applied with 25 per cent of vermicompost. Recommended dose of 50 per cent fertilizer recorded the least of seed and haulm yield (Table 2). Manurial application along with chemical fertilizer was found to be most effective followed by

the same dose of manure with reduced fertilizer dosage (Mishra *et al.*, 2012; Shankar *et al.*, 2021). Based on this experimental result the interaction The highest grain yield was obtained as a result of the treatments in blackgram with no rice residue incorporation and 100 per cent recommended dose of fertilizer alone. This was found on par with 75 per cent recommended dose of fertilizer alone treatment without incorporation of residue. For haulm yield, the highest yield was recorded with the same treatment (no residue incorporation with 100 per cent recommended dose of fertilizer). This found at par with no rice residue incorporation treatment in addition to 75 per cent recommended dose of fertilizer with 25 per cent vermicompost. And the rice residue incorporation treatment applied with 100 per cent recommended dose of fertilizer was also found on par with both the grain and haulm yield of blackgram with the above said treatments (Fig. 1). According to Davari *et al.*, (2012), in a rice-based cropping system, a combination of farm yard manure, crop residue, and vermicompost was cost-effective for mung bean nutrient needs . FYM has no significant effect on grain yield of blackgram whereas in combination with crop residue and the residue with vermicompost has the best result over control. It has been discovered that the use of biofertilizer, organic manure, and inorganic fertilizers in combination can be beneficial to provide higher productivity than that reported by Kokani *et al.*, (2015); Mohammad *et al.*, (2017). From the research, the insitu incorporation of preceding crop residue (rice) with blackgram in rice - blackgram cropping system along with reduced fertilizer management increased the yield attributes of the crop.

CONCLUSION

The study concluded that without incorporation of rice residue and the application of 100 per cent recommended dose of fertilizer alone (V₂H₁) recorded higher growth and yield of blackgram Vamban (VBN 8). This was found on par with no rice residue incorporation and 75 per cent recommended dose of fertilizer plus 25 per cent application of vermicompost (V₂H₃) and blackgram without rice residue incorporation with 75 per cent recommended dose of fertilizer alone (V₂H₂). Incorporation of rice residue with the application of 100 per cent recommended dose of fertilizer alone (V₁H₁) was also found on par with the same trend. And least of all the attributes (plant height, leaf area index, dry matter production, number of pods per plant, number of seeds per pod, grain and haulm yield) were recorded in blackgram with rice residue incorporation treatment along with 50 per cent recommended dose of fertilizer alone (V₁H₄).

FUTURE SCOPE

The future scope of this research area is to quantify crop residue, decomposition and nutrient releasing pattern to be recorded on weekly interval. Analysing the uptake and partitioning of nutrients in the subsequent crop. Microbial population and the species involved in the trial also to be examined.

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Conflict of Interest. None.

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