The Pharma Innovation Journal 2020; 9(4): 147-150

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2020; 9(4): 147-150

www.thepharmajournal.com
Received: 08-02-2020
Accepted: 10-03-2020

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

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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 number of pods plant^{-1}, test weight, seed yield, haulm yield and harvest index 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 7.5tha^{-1} targeted yield recommendation along with FYM (T_5 and T_{10}) and RDF with FYM (T_6). 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_2) and 7.5 t ha^{-1} targeted yield fertilizer recommendation with FYM (T_{10}) compared to the rest of the treatments.

Keywords: Rice- blackgram, TYFR, yield, 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) [7]. 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 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-5204 in a Randomized Block Design with ten treatments and three replications. The treatments comprised of, Recommended Dose of Fertilizer (T_1), Soil test based fertilizer recommendation(T_2); Targeted yield fertilizer recommendations for 5.5 tons ha^{-1} (T_3), 6.5 t ha^{-1} (T_4) and 7.5 t ha^{-1} (T_5) ; Treatment T_1 + FYM @ 10 t ha^{-1} (T_6); Treatment T_2 + FYM @ 10 t ha^{-1} (T_7); Treatment T_3 + FYM @ 10 t ha^{-1} (T_8); Treatment T_4 + FYM @ 10 t ha^{-1} (T_9); and Treatment T_5 + FYM @ 10 t ha^{-1} (T_{10}). 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 formulae Targeted yield (qha^{-1}) equation for *kharif*- Rice: (Anon., 2007) [3].

*FN= 2.30 x T 0.32 x SN	SN= Soil Nitrogen
*FP_2O_5=1.91 x T - 1.90 x SP	SP= Soil Phosphorous
*FK=2.27 x T - 0.27 x SK	SK= Soil Potassium

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

Treatments	2017-18 N-P-K (kg ha^{-1})	2018-19 N-P-K (kg ha^{-1})
T_1	120-60-40	120-60-40
T_2	156-42-28	156-42-28
T_3	80-30-30	70-30-28
T_4	102-30-52	98-30-50
T_5	125-30-75	123-30-73
T_6	T_1+FYM@10 t ha^{-1}	T_1+FYM@10 t ha^{-1}
T_7	T_2+FYM@10 t ha^{-1}	T_2+FYM@10 t ha^{-1}
T_8	T_3+FYM@10 t ha^{-1}	T_3+FYM@10 t ha^{-1}
T_9	T_4+FYM@10 t ha^{-1}	T_4+FYM@10 t ha^{-1}
T_{10}	T_5+FYM@10 t ha^{-1}	T_5+FYM@10 t ha^{-1}

Results and discussion

Data pertaining to number pods per plant (Table 1) Indicated that residual effect of STFR application with 10 t FYM (T_7) produced significantly higher number of pods per plant and was on par with STFR application alone (T_2) compared to the rest of the treatments during 2018-2019.

Whereas, differences among the treatments T_7, T_2, T_{10} and T_5 were not significant in producing number of pods per plant. These treatments produced significantly higher number of pods per plant over the remaining treatments during the year 2018. The lower number of pods per plant produced in the treatments T_3 followed by T_8 and T_4 compared to other treatments during both the years and pooled data.

Per cent number of pods plant^{-1} increase with soil test recommendation with FYM (T_7) and without FYM (T_2) was 29.9%, 22.6%, 20.9% and 24.1% & 26.0%, 18.4%, 16.6% and 19.9% higher compared to the treatments T_3, T_4, T_9, and T_8 respectively in pooled data.

Number of pods plant^{-1} of blackgram increased corresponding to the residual effect of incremental dose of fertilizer levels applied to the previous rice crop. Addition of FYM to the treatments showed a significant influence in increasing pods per plant. Similar findings with residual effect of soil test-based fertilizer management along with organics of rice on succeeding blackgram was reported by Subramani *et al.* (2008) [12] Senthivelu *et al.* (2009) [10] and Ombir Singh *et al.* (2012) [6]

Data pertaining to test weight (Table 2) indicated that test weight recorded with STFR application with FYM (T_7), STFR application alone (T_2) and targeted yield (7.5 t ha^{-1}) fertilizer recommendation with FYM (T_{10}) were significantly higher compared with remaining treatments during 2018, 2019 and pooled data. However, differences between these treatments targeted yield (7.5 t ha^{-1}) fertilizer recommendation alone (T_5) were not significant during the year 2018. The lower test weight recorded with the treatment (T_3) was found on par with all other treatments except T_7 and T_2.

Though test weight is a genetic character, good management practices can increase the test weight of the blackgram. Residual effect of inorganic fertilizers and organic manures on growth and yield attributes of succeeding pulse crops was also noticed by Reddy and Reddy (2005) [8] and Davari *et al.* (2012).

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 (T_7) to rice and was significantly superior to other treatments. Whereas, the differences in yield obtained among the treatments T_7, T_2, T_{10}, T_5 and T_6 were not significant during 2018 and 2019.

The lowest seed yield of blackgram observed with targeted yield (5.5 t ha^{-1}) fertilizer recommendation (T_3) was significantly inferior compared to the treatments T_7, T_2, T_{10} and T_5 during both the years of study and pooled data.

Seed yield increase with soil test recommendation with FYM (T_7) and without FYM (T_2) 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_3, T_4, T_9, and T_8 respectively.

Seed yields of blackgram after rice increased significantly with the increasing level of nutrient (156-30-28 kg ha^{-1} NPK) application in T_7 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 confirmity with the observations of Aruna and Shaik Mohammad (2005) [1], Bhoite (2005) [5] and Ombir Singh *et al.* (2012) [6].

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) [11] and Saha and Moharana (2008) [9].

Data pertaining to haulm yield in (table 3) indicated that the higher haulm yield recorded with treatment T_7, T_2 and T_{10} was significantly superior to the remaining treatments during the year 2019 and pooled data. However, during 2018 the differences in haulm yield among the treatments T_7, T_2, T_{10} and T_5 were not significant. The haulm yield produced with T_3 was significantly lower compared with T_7, T_2, T_{10} and T_5. The differences among the rest of the treatments were not significant in producing haulm yield during both the years and pooled data.

Per cent haulm yield increase with soil test recommendation with FYM (T_7) and without FYM (T_2) was 23.2%, 17.5%, 16.5% and 21.4% & 19.8%, 13.8%, 12.8% and 17.9%, higher compared to the treatments T_3, T_4, T_9, and T_8 respectively (pooled data).

STFR might have affected more on fertility attributes of soil for residual crops. This might be the reason it reflected in the yield by maintaining higher plant population and this inturn could have led to higher drymatter accumulation and resulted in more haulm yield. Similar results were obtained by Amanullah *et al.* (2006) [2]. The study results are in conformity with those of Subramani and Solaimalai (2000) [13] and Sudhakar and Kuppuswamy (2007) [14].

Data pertaining to harvest index (Table 3) indicated that harvest index of blackgram was not significantly influenced by residual effect of STFR and target yield recommendations given to rice during both the years of study and in pooled data.

Interestingly, higher values of harvest index were noticed in treatments (T_5) with 7.5 t ha^{-1} target yield recommendation (39.50, 40.59 and 40.04%), and (T_{10}) along with FYM (39.39, 38.64 and 39.01%) in comparison with other treatments which will describe the fact of effective allocation of biomass into reproductive parts in these treatments. Similar results were observed by Pushpendra Singh *et al*. (2012) [7] and Sujathamma *et al.* (2014) [15].

Table 1: Number of pods plant^{-1} 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
T_1- Recommended dose of fertilizer (RDF) 120-60-40 kg ha^{-1}	17.63	18.12	17.88
T_2- Soil test based fertilizer recommendation (STFR)	20.33	22.13	21.23
T_3- Targeted yield fertilizer recommendation for 5.5 t ha^{-1} (TYFR)	15.67	15.87	15.77
T_4- Targeted yield fertilizer recommendation for 6.5 t ha^{-1} (TYFR)	17.00	17.63	17.32
T_5- Targeted yield fertilizer recommendation for 7.5 t ha^{-1} (TYFR)	19.00	20.00	19.50
T_6- T_1+FYM @ 10 t ha^{-1}	18.00	18.25	18.13
T_7- T_2+FYM @ 10 t ha^{-1}	22.00	22.78	22.39
T_8- T_3+FYM @ 10 t ha^{-1}	16.50	17.50	17.00
T_9- T_4+FYM @ 10 t ha^{-1}	17.50	17.90	17.70
T_{10}- T_5+FYM @ 10t ha^{-1}	19.83	20.33	20.08
SEm±	1.22	0.58	0.78
CD (p = 0.05)	3.62	1.72	2.33
CV (%)	11.50	5.26	7.25

Table 2: Test weight (g/1000 grains) 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
T_1- Recommended dose of fertilizer (RDF) 120-60-40 kg ha^{-1}	35.48	36.07	35.77
T_2- Soil test-based fertilizer recommendation (STFR)	39.76	40.33	40.05
T_3- Targeted yield fertilizer recommendation for 5.5 t ha^{-1} (TYFR)	33.13	34.67	33.90
T_4- Targeted yield fertilizer recommendation for 6.5 t ha^{-1} (TYFR)	34.67	35.00	34.83
T_5- Targeted yield fertilizer recommendation for 7.5 t ha^{-1} (TYFR)	36.16	37.05	36.61
T_6- T_1+FYM @ 10 t ha^{-1}	35.67	36.28	35.98
T_7- T_2+FYM @ 10 t ha^{-1}	40.17	42.67	41.42
T_8- T_3+FYM @ 10 t ha^{-1}	34.62	35.33	34.98
T_9- T_4+FYM @ 10 t ha^{-1}	35.00	35.23	35.12
T_{10}- T_5+FYM @ 10t ha^{-1}	37.33	38.67	38.00
SEm±	1.19	1.44	1.09
CD (p = 0.05)	3.54	4.29	3.23
CV (%)	5.71	6.73	5.13

Table 3: Seed yield (kg ha^{-1}), haulm yield (kg ha^{-1}) and harvest index (%) 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		
	Seed yield	Haulm yield	Harvest index	Seed yield	Haulm yield	Harvest index	Seed yield	Haulm yield	Harvest index
T_1- Recommended dose of fertilizer (RDF) 120-60-40 kg ha^{-1}	755	1196	38.44	765	1268	37.37	760	1232	37.90
T_2- Soil test based fertilizer recommendation (STFR)	857	1332	38.99	884	1412	37.87	871	1372	38.43
T_3- Targeted yield fertilizer recommendation for 5.5 t ha^{-1} (TYFR)	642	1067	37.71	681	1134	37.38	661	1100	37.55
T_4- Targeted yield fertilizer recommendation for 6.5 t ha^{-1} (TYFR)	734	1159	38.32	746	1204	38.38	740	1182	38.35
T_5- Targeted yield fertilizer recommendation for 7.5 t ha^{-1} (TYFR)	794	1241	39.50	882	1303	40.59	838	1272	40.04
T_6- T_1+FYM @ 10 t ha^{-1}	760	1204	38.88	784	1279	38.16	772	1242	38.52
T_7- T_2+FYM @ 10 t ha^{-1}	876	1391	38.80	905	1474	38.23	891	1433	38.51
T_8- T_3+FYM @ 10 t ha^{-1}	697	1092	38.79	719	1161	38.45	708	1126	38.62
T_9- T_4+FYM @ 10 t ha^{-1}	746	1161	39.18	755	1231	37.88	750	1196	38.53
T_{10}- T_5+FYM @ 10t ha^{-1}	831	1281	39.39	855	1361	38.64	843	1321	39.01
SEm±	40.89	53.19	1.59	44.87	48.51	1.53	31.64	46.91	1.23
CD (p = 0.05)	121.48	158.02	NS	133.31	144.14	NS	94.02	139.88	NS
CV (%)	9.2	7.6	7.0	9.7	6.5	6.9	7.0	6.5	5.5

Conclusions

Thus based on the number of pods plant^{-1}, test weight, seed yield, haulm yield and harvest index 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_{10}) and RDF with FYM (T_6). Whereas targeted yield recommendation 5.5 and 6.5 t ha^{-1} (T_3 and T_4) found with significantly lower number of pods $plant^{-1}$, test weight, seed yield, haulm yield and harvest index compared to the rest of treatments during both the years of study.

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