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Cumulative and Residual Effects of Integrated Nutrient Management Practices of *Kharif* Rice on Soil Fertility after *Rabi* Black Gram

K. Shanthi

Dept., of Agri., Science, Loyola Academy (Degree &P.G College), Alwal, Secunderabad – 500 010, India

ABSTRACT

A field experiment was conducted during 2014-15 with rice in Kharif, black gram in *Rabi* season, at farmer's field, Devaryamjal village, near Hakimpet, Rangareddy district, Telangana. The experiment was laid out in randomized block design (RBD) with 11 treatments, each replicated 3 times. The treatments consisted of control (T_1), 100% RDFN (T_2), 75% RDFN + 25% N through VC, PM and FYM (T_3, T_6, T_9), 50% RDFN + 50% N through VC, PM and FYM (T_4, T_7, T_{10}), 100% RDN through VC, PM and FYM (T_5, T_8, T_{11}). Rice (BPT 5204) was test crop grown during *Kharif* season with RDF applied as N : P_2O_5: K_2O @ 120 : 60 : 40 kg ha^{-1}. A uniform dose of 60 kg ha^{-1}P_2O_5 and 40 kg ha^{-1}K_2O was applied as basal to all the plots. In the *Rabi* season black gram (LBG-20) was taken up in same plots. Each treatmental plot of *Kharif* crop was divided into two equal halves. In one half recommended dose of fertilizers to black gram @ 30 : 60 : 40 kg ha^{-1}(N : P_2O_5 : K_2O) were applied to study the cumulative effects. In the other half no fertilizers were applied to study the residual effects. The results revealed that different Integrated Nutrient Management (INM) treatments had significant effect on organic carbon, soil available nitrogen, available phosphorus and available potassium. Maximum available N, P_2O_5 and K_2O contents were recorded with treatment T_5, the values being 262.1, 32.5 and 337.2 kg ha^{-1} under cumulative effects and 244.2, 22.3 and 296.8 kg ha^{-1} respectively under residual effects. Treatment T_1 (control) recorded lowest values both under cumulative and residual effects.

Keywords: Black gram, INM, Organic Carbon, Available Nitrogen, Phosphorus, Potassium

INTRODUCTION

Black gram (*Vigna mungo L.*) is one of the most important leguminous crops among the various grain legumes. It contains about 26% protein, 1.5% fats and 56.6% carbo hydrates on dry weight basis and it is the rich source of calcium and iron. Black gram has the ability to fix about 22.10 kg of atmospheric nitrogen per hectare through its' root nodules. In addition, it is shade tolerant and therefore compatible as an inter crop with maize, sorghum, sugar cane and cotton (FAOSTAT 2012). Factors attributed for low yields of pulses in India as compared to world productivity are nonavailability of quality seeds of improved varieties, cultivation of pulses under marginal and low fertile soils, unscientific post harvest practices and storage under unfavorable conditions. Hence there is a scope for improving the production potential by the use of inorganic fertilizers and organic manures. Chemical fertilizers play a crucial role to meet the nutrient requirement of crops. But imbalance and continuous use of chemical fertilizers have adverse effect on physical, chemical and biological properties of soil there by effecting sustainability of crop production, human health and environmental pollution. Therefore there is an urgent need to reduce the usage of chemical fertilizers and increase the use of organic manures to check the quality and quantity of yield levels and maintain soil fertility status (Sutaria et al., 2010, Bhikane et al., 2007). Therefore aforesaid consequences have paved the way to cultivate leguminous crops using inorganic fertilizers along with organic manures. Thus integrated nutrient management envisages use of inorganic fertilizers, organic manures, green manures and biofertilizers taking into account the fertility status of soils. The basic concept of integrated nutrient management is supply of required plant nutrients for sustaining the desired crop productivity with minimum deleterious effect on soil health environment. Therefore the present study has been taken up to evaluate the fertility status of the soil under cumulative and residual effects after harvest of *Rabi* black gram.

MATERIALS & METHODS

A field experiment entitled "Cumulative and Residual Effects of Integrated Nutrient Management Practices of *Kharif* Rice on Soil Fertility after *Rabi* Black Gram" was conducted during 2014-15 with rice in Kharif, black gram in *Rabi* season, at farmer's field, Devaryamjal village, near Hakimpet, Rangareddy district, Telangana. It is situated at an altitude of 536 m above mean sea level, $17^0 23'$ N latitude and $78^0 28'$ E longitude. It is classified as Southern Telangana agro-climatic zone of Telangana State.*Kharif* rice was laid out in randomized block design (RBD) with 11 treatments, each replicated 3 times. The treatments consisted of control (T_1), 100% RDFN (T_2), 75% RDFN + 25% N through VC, PM and FYM (T_3, T_6, T_9), 50% RDFN + 50% N through VC, PM and FYM (T_4, T_7, T_{10}), 100% RDN through VC, PM and FYM (T_5, T_8, T_{11}). Soil of the experimental field is a sandy clay loam (ultisol), slightly alkaline in reaction (pH : 7.60), non saline (EC : 0.39 dS m^{-1}), medium in organic carbon (0.51%), low in available N (235 kg ha^{-1}), medium in available P_2O_5 (23 kg ha^{-1}) and high in available K_2O (304 kg ha^{-1}). Rice (BPT 5204) was test crop grown during *Kharif* season with RDF applied as N : P_2O_5: K_2O @ 120 : 60 : 40 kg ha^{-1}. A uniform dose of 60 kg $ha^{-1}P_2O_5$ and 40 kg $ha^{-1}K_2O$ was applied as basal to all the plots. In the *Rabi* season black gram (LBG-20) was taken up in same plots. Each treatmental plot of *Kharif* crop was divided into two equal halves. In one half recommended dose of fertilizers to black gram @ 30 : 60 : 40 kg ha^{-1}(N : P_2O_5 : K_2O) were applied to study the cumulative effects. In the other half no fertilizers were applied to study the residual effects. The soil samples were collected from each plot treatment wise after harvest of black gram. The soil samples were analysed by following standard procedures. Organic carbon (%) was analysed by wet digestion method (Walkley and Black, 1934), available nitrogen (kg N ha^{-1}) by alkaline potassium permanganate method (Subbiah and Asija, 1956), available phosphorus (kg $P_2O_5ha^{-1}$) by Olsen's method (Olsen et al., 1954), available potassium (kg K_2O ha^{-1}) by Neutral normal Ammonium acetate method (Jackson, 1973)

RESULTS AND DISCUSSION

The data on contents of organic carbon, available N, P, and K after harvest of Black gram are presented in Table 1.

Organic Carbon (%)

Irrespective of the treatments, all the cumulative effects recorded higher organic carbon contents than their corresponding residual treatments.The difference in the mean organic carbon contents between cumulative and residual effects was 0.10%. Among the cumulative treatments, organic carbon contents after Black gram harvest ranged from 0.50 to 0.66% with a mean value of 0.59%. The treatment T_5 (100% RDN through VC to rice and 100% RDF to Black gram crops) recorded maximum organic carbon content which was on par with treatments T_4, T_7, T_8, T_{10} and T_{11} and significantly superior with the treatments T_2, T_3, T_6 and T_9. Minimum organic carbon content was recorded with treatment T_1 (control) where no fertilizer was applied to rice crop, but received 100% RDF to Black gram. Among the residual treatments the mean organic carbon content recorded was 0.49%. The treatment T_5 (100% RDN – VC) to rice crop recorded maximum organic carbon content of 0.56% which was on par with treatments T_4, T_7, T_8, T_{10} and T_{11} and significantly superior with the treatments T_2, T_3, T_6 and T_9. Minimum organic carbon content was recorded with treatment T_1 (0.40) where no fertilizer was applied to both rice and Black gram crops.

Available Nitrogen (kg ha^{-1})

All the treatments meant for cumulative effects recorded higher available nitrogen contents than their corresponding residual treatments.The difference in mean available nitrogen contents between cumulative and residual effects was 14.3 kg ha^{-1}. Among the cumulative treatments the mean available nitrogen content after harvest of Black gram was 248.4 kg ha^{-1}. The minimum and maximum contents of available nitrogen were recorded with treatments T_1 (227.6 kg ha^{-1}) and T_5 (262.1 kg ha^{-1}). The available nitrogen content recorded with the later treatment was on par with other organic manure alone and 50% RDF + 50% organic manure applied treatments i.e., T_8, T_{11} and T_4, T_7 and T_{10}. However this treatment was superior to the contents recorded in the treatments T_1, T_2, T_3, T_6 and T_9. Among residual treatments the available nitrogen contents ranged from 212.1 to 244.2 kg ha^{-1} with a mean value of 234.1 kg ha^{-1}. The treatment T_5, which received 100% RDN through VC during preceding rice crop, recorded maximum available nitrogen content of 244.2 kg ha^{-1} which was on par with the treatments T_3, T_4, T_7, T_8, T_{10} and T_{11}, but was superior to the treatments T_2, T_6 and T_9.

Available Phosphorus (kg ha^{-1})

Irrespective of the treatments, the available phosphorus contents observed under cumulative effects were higher than their corresponding residual treatments. The difference in mean available phosphorus contents between cumulative and residual effects was 8.7 kg ha^{-1}. Among the cumulative treatments available phosphorus contents after Black gram harvest ranged from 22.2 to 32.5 kg ha^{-1} with a mean value of 29.6 kg ha^{-1}. The available phosphorus content recorded with treatment T_1 (control) was significantly lower than rest of all the treatments. The treatment T_2 (100% RDFN) to rice and 100% RDF to *Rabi* Black gram recorded available phosphorus content of 27.6 kg ha^{-1} which was inferior to all the organic manure alone and combined treatments T_5, T_8, T_{11} and T_3, T_4, T_6, T_7, T_9 and T_{10}, but was superior to T_1 (control). Among the residual treatments mean available phosphorus content after harvest of Black gram was 20.4 kg ha^{-1}. Minimum and maximum contents of available phosphorus were recorded with treatments T_1 (17.3 kg ha^{-1}) and T_5 (22.3 kg ha^{-1}). The available phosphorus content recorded with treatment T_5 was on par with treatments T_4,T_8, T_{11} and superior to rest of all the treatments.

Available Potassium (kg ha^{-1})

Among the cumulative treatments the mean available potassium content after harvest of Black gram was 315.6 kg ha^{-1}. The available potassium content recorded with treatment T_1 (289.5kg ha^{-1}) was lower than the contents observed in rest of all the treatments. Treatment T_5 which received 100% RDN-VC to *Kharif* rice and 100% RDF to *Rabi* Black gram recorded maximum available potassium content of 337.2 kg ha^{-1} which was on par with the treatments T_4, T_8 and T_{11} and superior to rest of all the other treatments. Among the residual treatments available potassium content ranged from 258.4 (T_1) to 296.8 kg ha^{-1}(T_5)with a mean value of 278.1 kg ha^{-1}. The available potassium content recorded with treatment T_5 was on par with treatments T_4, T_8 and T_{11} and superior to rest of all the treatments. Among residual treatments, the increase in OC, available N, P_2O_5&K_2O contents in T_2 (100% RDFN applied to rice) was 7.5, 4.5, 12.1, 3.4 percent respectively when compared to T_1 (control).

The lower values of available N, P_2O_5&K_2O in this treatment (T_2) after harvest of Black gram as compared to INM treatments (T_3 to T_{11}) may be due to maximum utilization of applied nutrients by both the crops in the sequence. Apparently higher available N, P_2O_5&K_2O contents under INM treatments may be due to the reason that even after the harvest of rice, certain quantities of VC, PM and FYM continue to mineralize releasing N, P and K which would add to the available pool. This is a further testimony to the fact that the treatments with 100% level of organic N maintained more available N, P_2O_5&K_2O contents than with lower levels (50% & 25%) of organic N. This was attributed to the differences in time required for mineralization process and release of nutrients. Availability of nutrients at initial stage of crop growth as well as at later stages after a lapse of time may be better as by which period the mineralization process of 25% of organic part would have been completed earlier when compared with 50% & 100% of organic substitution. The increase in mean OC, available N, P_2O_5&K_2O contents after harvest of Black gram due to cumulative effects was by 20.4, 6.1, 45.1 and 13.5 percent over residual effects respectively. The cumulative effects of treatments (residual effects of treatments applied to first crop of rice coupled with direct effects of 100% RDF applied to Black gram) on second crop of Black gram grown in sequence with rice indicated that it should be fertilized with recommended fertilizer dose to maintain the required nutrient status in the soil. The results are well supported by the findings of (Ramesh et al., 2006, Sutaria et al., 2010, Bhikane et al, 2007, Datta and Singh, 2010, Baik and Sharma, 2008, Upendra Rao et al., 2009, Peda Babu et al., 2008).

CONCLUSION

From the above discussion, it can be inferred that application of organic manures significantly increase the available N, P and K status of soil when compared to application of N solely through chemical fertilizer. Among the different manures used in the study vermicompost showed superiority over poultry manure and farm yard manure. This indicates that application of vermicompost improves the availability of nutrients though it could not increase the total amount of nutrients in the soil.

Table 1 Cumulative and residual effects of integrated nutrient management treatments of *Kharif* rice on soil available nutrient status after *Rabi* blackgram.

Treatments given to *Kharif* rice			Organic Carbon (%)		Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})	
			CUM.	RES.	CUM.	RES.	CUM.	RES.	CUM.	RES.
T_1	-	Control (No RDFN)	0.50	0.40	227.6	212.1	22.2	17.3	289.5	258.4
T_2	-	100% RDFN	0.53	0.43	237.3	221.6	27.6	19.4	303.6	267.2
T_3	-	75% RDFN + 25% N-VC	0.55	0.47	244.6	233.5	29.4	20.1	311.1	273.8
T_4	-	50% RDFN + 50% N-VC	0.62	0.52	253.5	241.8	31.2	21.1	323.2	284.5
T_5	-	100% RDN-VC	0.66	0.56	262.1	244.2	32.5	22.3	337.2	296.8
T_6	-	75% RDFN + 25% N-PM	0.55	0.47	242.7	230.2	28.7	19.8	308.4	271.4
T_7	-	50% RDFN + 50% N-PM	0.62	0.52	252.4	239.7	30.8	20.7	318.6	280.4
T_8	-	100% RDN-PM	0.66	0.56	261.2	243.6	32.2	21.9	332.0	292.2
T_9	-	75% RDFN + 25% N-FYM	0.54	0.46	239.9	228.7	28.2	19.7	306.5	269.8
T_{10}	-	50% RDFN + 50% N-FYM	0.61	0.51	250.8	237.8	30.5	20.3	313.8	276.2
T_{11}	-	100% RDN-FYM	0.65	0.54	260.3	242.3	31.9	21.5	327.3	288.1
SEm±			0.03	0.02	4.56	4.31	0.69	0.48	5.58	4.91
CD (P=0.05)			**0.08**	**0.05**	**13.45**	**12.73**	**2.05**	**1.42**	**16.46**	**14.51**
CV (%)			7.59	5.67	3.18	3.19	4.07	4.09	3.06	3.06
Mean			**0.59**	**0.49**	**248.4**	**234.1**	**29.6**	**20.4**	**315.6**	**278.1**

CUM - Cumulative effects - 100% RDF (N,P_2O_5 and K_2O @ 30:60:40 kg ha^{-1}, respectively)

RES - Residual effects - 0 RDF

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