

Residual Effect of Organics and Fertilizer Nitrogen on Growth, Yield Attributes and Yield of Rice-Blackgram Cropping Sequence in Typic Ustifluvents Soil

R. Manivannan^{*1}, M. V. Sriramachandrasekharan², P. Senthilvalavan³ and C. Ravikumar⁴

Received: 17 Jan 2021 | Revised accepted: 16 Mar 2021 | Published online: 23 Mar 2021

© CARAS (Centre for Advanced Research in Agricultural Sciences) 2021

ABSTRACT

Field experiments were conducted at farmer's field kuttalam during rabi and summer season of 2012-13 and 2013-14 to study the residual effect of organics and fertilizer nitrogen on growth, yield attributes and yield in rice-black gram cropping sequence in sandy clay loam soil. The treatments consisted of the residual effect of organics viz., composted coir pith (CCP), green manures (GM), sugarcane trash compost (STC), vermicompost (VC), poultry manure (PM) and FYM applied (100% N) and combination of above residual organics with urea @ 50% N besides 100% RDN as urea and control in rice crop. Residual effect of organics and fertilizer nitrogen were studied in rice fallow blackgram in two years. The pooled data of results revealed that application of residual organics alone or fertilizer nitrogen alone or both significantly increased the growth and yield of rice and black gram. The highest growth parameters viz., plant height (93.4cm), no. of tillers/hill (12.33), LAI (4.21), chlorophyll content (2.86 mg 100 g⁻¹), and yield attributes viz., number of panicles m² (213.3), number of grains/panicle (107.7) and panicle length (20.0 cm) were recorded in residual poultry manure + fertilizer N (100%) in rice. The highest grain (4637.0 kg ha⁻¹) and straw yield (5871.0 kg ha⁻¹) were registered in residual poultry manure + fertilizer N (100%) in rice in both years. The highest yield attributes viz., number of clusters/plant (7.69), number of pods/plant (30.00), number of seeds/pod (5.57) were recorded in residual poultry manure and fertilizer N in rice fallow black gram in both years. Application of residual poultry manure and fertilizer N were registered highest grain (311.2 kg ha⁻¹) and haulm yield (1743.6 kg ha⁻¹) in rice fallow blackgram in two years.

Key words: Rice, Blackgram, Cropping sequence, Residual organics, Fertilizer nitrogen, Poultry manure, Yield

Rice (*Oryza sativa* L.) is one of the most important food crops of India in terms of production and consumers choice. India produces rice of about 111.01 million tonnes in 2017-18 accounting for 22.81% of production in that year. Rice is an important staple food crop which provides 60-70% of body calories intake of the consumers [1]. Nitrogen is commonly the most limiting nutrient for crop production in the major world's agricultural areas and therefore adoption of good N management strategies often results in large economic benefits to farmers. Rice-pulse is the predominant cropping system of major rice growing areas of Tamil Nadu. The cropping sequence of rice-pulse is practically feasible, economical and water saving approach for sustaining soil fertility and rice productivity. Increased use of organic fertilizers in crop production deteriorate soil health and causes

health hazard in humans [2]. Organic manures leaves behind sufficient residual effect for the sequence [3]. Currently the emphasis has been shifted from individual crop to cropping system as a whole the response of the component crop in the cropping system are influenced by the previous crops [4]. The available nutrients in organic manures are not fully accessible to the crops in the current season [5]. Organic manures besides providing nutrients to the existing crop usually leaves a considerable residual nutrient on the subsequent crops in the cropping system. Awareness about crop quality and soil health increased attention of people towards organic farming [6]. Integrated nutrient management practice helps to increase efficiency of applied and native nutrients improve soil health economize the fertilizer use and decrease nutrient loss [7]. Keeping this view, the current investigation was carried out to study relative profitability of rice and black gram with different residual effect of organics and fertilizer nitrogen on growth, yield attributes and yield in rice-black gram cropping sequence in sandy clay loam soil.

*R. Manivannan

rengamanivannan@gmail.com

¹⁻³Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture, Annamalai University, Annamalaiagar - 608 002, Tamil Nadu, India

⁴Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalaiagar - 608 002, Tamil Nadu, India

MATERIALS AND METHODS

Field experiments were conducted in farmers field at Kuttalam for two years (2012-13) and 2013-14) to study the residual effect of organics and fertilizer N on growth, yield

attributes and yield in rice-pulse cropping system. The texture of the soil was sandy clay loam (Padugai series-Typic Ustifluvents). The trials were conducted during rabi season (2012 & 2013) and summer rice fallow black gram (2013 & 2014). The experiments were laid out in randomized block design with fourteen treatments replicated thrice. The test rice variety was ADT 38. The treatment structure was T₁- Absolute control, T₂- composted coir pith (CCP-100%N), Green manure (GM-100% N), T₄- Sugarcane trash compost (STC-100%N), T₅- Vermicompost (VC-100% N), T₆- Poultry manure (100% N), T₇- farm yard manure (FYM-100% N), T₈- CCP (50% N) + Urea (100% N), T₉- GM (50% N) + Urea (100% N), T₁₀- STC (50% N) + Urea (100% N), T₁₁- VC (50% N) + Urea (100% N), T₁₂- PM (50% N) + Urea (100% N), T₁₃- FYM (50% N) + Urea (100% N), T₁₄- RDF (150:50:50 N, P₂O₅, K₂O kg ha⁻¹). In rabi rice all the treatments received recommended dose of 50 kg P₂O₅ ha⁻¹ and 50 kg K₂O ha⁻¹ except control. In rabi rice no organics were applied to study the residual effect but 100%N (RDF) were applied from T₈-T₁₄. The experimental soil was sandy clay loam in texture, pH- 6.80, 6.79, EC- (0.32, 0.31) dSm⁻¹, CaCO₃- (1.56, 1.54%), organic carbon (6.09, 6.10 g kg⁻¹), available nitrogen (224.1, 226.2 kg ha⁻¹), available P (14.3, 14.1 kg ha⁻¹), available K (341.5, 345.7 kg ha⁻¹). The chemical properties of soil viz., Organic carbon by [8], Available nitrogen [9], Available P [10] were estimated by using

standard procedures. After harvesting of first rice crop the field was prepared with fine tilth with spade without disturbing individual plots. The growth parameters viz., plant height, no. of tillers/hill, LAI (leaf area index) chlorophyll content, yield attributes viz., number of panicles m², number of grains/panicle, panicle length were recorded. The grain and straw yield were registered for two years in rabi rice.

Residual effect of organics and fertilizer N were studied in rice fallow Black gram (ADT 3) with available soil moisture in soil without disturbing layout for two years (2013 & 2014). Foliar spray of 2% DAP was applied to all treatments except control at 45 DAS. The yield components viz., number of clusters/plant, number of pods/plant, number of seeds/pod were recorded for two years. Seed and haulm yield were recorded for two years in sandy clay loam soil. All the data were pooled for two years and given in results and tables.

RESULTS AND DISCUSSION

Residual effect of organics and direct effect of fertilizer nitrogen in rabi rice

Growth parameters and yield attributes

Application of residual organics alone or fertilizer N alone or both significantly improved the growth parameters, yield attributes in rabi rice (Table 1-2).

Table 1 Residual effect of organics and direct effect of fertilizer N on growth parameters in rabi rice in sandy clay loam soil (Pooled data for two years)

Treatments	Plant height (cm)	No. of tillers/hill	LAI	Chlorophyll content (mg 100 g ⁻¹)
T ₁ : Absolute control	72.1	6.22	3.23	2.19
T ₂ : CCP- 100% N	75.8	6.92	3.76	2.29
T ₃ : GM- 100% N	74.0	6.61	3.71	2.26
T ₄ : CCT- 100% N	76.6	7.59	3.79	2.33
T ₅ : VC- 100% N	79.5	8.32	3.86	2.41
T ₆ : PM- 100% N	81.1	8.73	3.91	2.43
T ₇ : FYM- 100% N	78.0	7.98	3.82	2.38
T ₈ : CCP (50%) + Urea (100% N)	86.0	9.89	4.00	2.53
T ₉ : GM (50%) + Urea (100% N)	83.6	8.87	3.95	2.46
T ₁₀ : CST (50%) + Urea (100% N)	89.4	10.31	4.04	2.60
T ₁₁ : VC (50%) + Urea (100% N)	93.0	11.90	4.16	2.75
T ₁₂ : PM (50%) + Urea (100% N)	93.4	12.33	4.21	2.86
T ₁₃ : FYM- (50%) + Urea (100% N)	90.5	11.54	4.11	2.38
T ₁₄ : RDF (120:38:38kg ha ⁻¹)	91.6	10.77	4.08	2.64
C.D @ 5%	0.43	0.05	0.04	0.05

The highest growth parameters, yield attributes were recorded in combined treatments than in organics alone or fertilizer N alone. The highest growth parameters viz., plant height (93.4cm), no. of tillers/hill (12.33), LAI (4.21), chlorophyll content (2.86 mg 100 g⁻¹), and yield attributes viz., number of panicles m² (213.3), number of grains / panicle (107.7) and panicle length (20.0 cm) were recorded in residual poultry manure + fertilizer N (T₁₂) in sandy clay loam soil. Lower number of tillers and LAI was observed in control plot. Increase in the growth of rice by application of residual PM might be due to the presence of uric acids that hastens the release of nutrients from poultry manure which could have attributed to steadier and greater root development greater response of the crop to available nutrients and rapid conversion of synthesized photosynthates into protein to form more protoplasm thus increasing the number and size of the cell which might have increased the number of tillers and the leaf area index [11]. This may be due to the improved soil

physical properties viz., bulk density, infiltration rate, hydraulic conductivity by the poultry manure there by the soil health favoured the better growth attributes [12]. This may be due to higher concentration of macro and micronutrients, their slow decomposition, results in more carry over effect in subsequent rice crop [13]. Among the organic alone the highest growth parameters viz., plant height (81.1cm), number of tillers/hill (8.73), LAI (3.91), chlorophyll content (2.43 mg 100 g⁻¹) and yield attributes viz., number of panicles m² (189.2), number of grains/panicle (94.0) and panicle length (16.6 cm) were recorded in residual poultry manure (T₆) which was followed by residual vermicompost alone in rabi rice. This may be ascribed to presence of large amounts of nutrients in soluble form for a quite longer period by not allowing the entire soluble form into solution to come in contact with soil and other inorganic constituents thereby minimizing fixation and resulted in higher growth and yield attributes in subsequent rice crop [14].

Rice yield

Application of residual organics alone or fertilizer N alone or both significantly increased the grain and straw yield over control in rabi rice (Table 2). The highest grain (4637.0 kg ha⁻¹) and straw yield (5871.0 kg ha⁻¹) were recorded in residual poultry manure + fertilizer N (T₁₂) in sandy clay loam soil [15]. This was probably due to higher N availability caused by greater mineralization of N from residual poultry

manure. This might increase the N uptake and therefore increased the photosynthesis rate and subsequently photosynthetic partitioning towards the developing grain which resulted in increased grain yield [16]. Among the organics the highest grain (4035.5 kg ha⁻¹) and straw yield (4934.0 kg ha⁻¹) were recorded in residual poultry manure alone which was followed by residual vermicompost alone in sandy clay loam soil.

Table 2 Residual effect of organics and direct effect of fertilizer N on yield attributes and yield in rabi rice (Pooled data for two years)

Treatments	No. of panicle m ²	No. of grains /panicle	Panicle length (cm)	Grain yield (kg ha ⁻¹)	% increase over control	Straw yield (kg ha ⁻¹)	% increase over control
T ₁ :	167.5	41.4	13.0	2959.5	-	4000.5	-
T ₂ :	177.8	57.7	14.4	3791.5	28.0	4555.5	13.8
T ₃ :	173.8	55.6	14.0	3652.5	23.4	4501.0	12.4
T ₄ :	180.0	59.8	14.8	3869.0	30.7	4669.0	16.6
T ₅ :	186.0	93.2	16.0	4024.0	35.9	4848.0	21.1
T ₆ :	189.2	94.0	16.6	4035.5	36.3	4934.0	23.3
T ₇ :	183.5	82.4	15.2	3928.0	32.7	4734.0	18.3
T ₈ :	193.1	98.1	17.2	4119.5	39.1	5213.5	30.2
T ₉ :	191.0	95.3	16.9	4098.0	38.4	5074.5	26.8
T ₁₀ :	197.4	100.9	17.9	4205.5	42.1	5401.5	35.0
T ₁₁ :	211.5	106.0	19.4	4422.0	49.3	5777.5	44.3
T ₁₂ :	213.3	107.7	20.0	4637.0	56.6	5871.0	46.7
T ₁₃ :	209.6	102.9	18.9	4352.5	46.9	5703.0	42.5
T ₁₄ :	208.7	102.7	18.5	4295.5	45.9	5610.5	40.2
C.D @ 5%	0.91	1.58	0.42	16.7	-	19.8	-

Table 3 Residual effect of organics and fertilizer N on yield attributes and yield (kg ha⁻¹) of rice fallow black gram in sandy clay loam soil

Treatments	Sandy clay loam soil						
	No. of clusters/plant	No. of pods/plant	No. of seeds/pod	Grain yield (kg/ha)	% increase over control	Haulm yield (kg/ha)	% increase over control
T ₁ :	2.77	15.56	2.77	161.4	-	987.5	-
T ₂ :	5.35	24.02	4.67	264.7	64.0	1199.1	21.4
T ₃ :	5.13	23.12	4.56	220.6	36.6	1189.0	20.4
T ₄ :	5.62	24.41	4.65	287.2	77.9	1247.5	26.3
T ₅ :	6.02	25.32	4.76	290.2	80.2	1298.1	31.4
T ₆ :	6.15	25.75	4.88	292.9	81.4	1314.6	33.1
T ₇ :	5.83	24.91	4.68	288.9	78.9	1273.5	28.9
T ₈ :	6.92	26.99	5.31	302.0	87.1	1502.6	52.1
T ₉ :	6.71	26.11	5.22	298.7	85.0	1494.1	51.3
T ₁₀ :	7.15	27.42	5.32	304.1	88.4	1572.1	59.2
T ₁₁ :	7.42	28.71	5.46	308.5	91.1	1639.1	65.9
T ₁₂ :	7.69	30.00	5.57	311.2	92.8	1743.6	76.5
T ₁₃ :	7.27	28.10	5.31	306.9	90.1	1615.6	63.6
T ₁₄ :	6.46	26.06	4.98	294.5	82.4	1407.6	42.5
C.D @ 5%	0.03	0.10	0.03	6.42	-	13.91	-

Residual effect of organics and fertilizer nitrogen in rice fallow black gram

Application of residual organics alone or fertilizer N alone or both significantly increased the yield parameters, grain and haulm yield over control in rice fallow black gram in sandy clay loam soil (Table 3). The highest yield parameters viz., number of clusters/plant (7.69), number of pods/plant (30.00), number of seeds/pod (5.57), grain yield (311.2 kg ha⁻¹) and haulm yield (1743.6 kg ha⁻¹) were recorded in residual poultry manure + fertilizer nitrogen (T₁₂) over other treatments in 2013 and 2014 respectively.

Integrated use of organic sources and chemical fertilizers often leave a substantial residual effect on succeeding crop in the system [17]. The percent increase in grain yield due to residual poultry manure + fertilizer N was (92.8) and in haulm yield (76.5) in 2013 and 2014 in sandy clay loam soil [18]. The part of nutrient requirement unutilized by main crop is expected to help growth and development of succeeding crop and consequently accumulated nitrogen and other nutrients are mineralized and utilized by the crop [19]. Among the residual organics alone, the highest yield parameters viz., number of clusters/plant (6.15), number of pods/plant (25.75), number of

seeds/pod (4.88), grain yield (292.9 kg ha⁻¹) and haulm yield (1314.6 kg ha⁻¹) were recorded in residual poultry manure (T₅) over other treatments [20-21]. The efficient utilization of mineralized N from the organic manures and fertilizer N 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 higher yield attributes of rice fallow black gram [22-23]. Similar findings on the improvement of yield attributes in the fallow crops due to the residual effect of

organic manures and inorganic fertilizer N.

CONCLUSIONS

It may be concluded that from this experiment that combined residual application of poultry manure + fertilizer N (100) recommended for rabi rice and residual poultry manure + fertilizer N for rice fallow blackgram is the viable nutrient management package for getting higher income through higher yield in rice-pulse cropping sequence.

LITERATURE CITED

- Barah BC, Pandey S. 2005. Rainfed rice production systems in Eastern India, An on-farm diagnosis and policy alternatives. *Indian Journal of Agricultural Economics* 60(1): 110-136.
- Sangeetha SP, Balakrishnan A, Devasenapathy P. 2013. Influence of organic manures on yield and quality of rice (*Oryza sativa* L.) and Black gram (*Vigna mungo* L.) in rice-black gram cropping sequence. *American Journal of Plant Sciences* 4: 1151-1157.
- Eghball B, Ginting D, Gilley JE. 2004. Residual effects of manure and compost applications on corn production and soil properties. *Agronomy Journal* 96: 442-447.
- Silva J, de Oliveria FHT, de Sousa AKF, Duda GP. 2006. Residual effect of cattle manure application on green ear yield and corn grain yield. *Horticultura Brasileira* 24(2): 166-169.
- Rosen CJ, Bierman PM. 2005. Using manure and compost as nutrient sources for fruit and vegetable crops. In: U.O.M. Extension (Eds.) Commercial fruit and vegetable production, Minnesota.
- Sharma M, Pandey CS, Mahaptra BS. 2008. Effect of biofertilizers on yield and nutrient uptake by rice and wheat in rice-wheat cropping system under organic mode of cultivation. *Journal of Ecofriendly Agriculture* 3(1): 19-23.
- Panda D. 2005. Integrated nutrient management in rice. In: Rice-in-Indian-perspective. (Eds) Sharma S. D. and Nayak B. C. (Part 1 and 2). Published in Current Trends in Life Science Vol. 25 by Today and Tomorrow's Printers and Publishers, New Delhi, India. pp 709-717.
- Walkley A, Black IA. 1934. An examination of the Degtjareff method for determination of organic matter and proposed modification of the chromic acid titration method. *Soil Science* 37: 29-38.
- Subbiah BV, Asija GL. 1956. A rapid procedure for estimation of available nitrogen in soils. *Current Science* 25: 259-260.
- Wattanabe I, Olsen SR. 1965. Tests of an ascorbic acid method for determining phosphorus in water and NaHCO₃ extracts from the soil. *Soil Sci. Soc. Am. Proc.* 29: 677-678.
- Syed AHH, Vijayageetha V, Naliah D. 2019. Influence of different organic manures integrated with nitrogenous fertilizer on the growth and yield of rice. *The Pharma Innovation Journal* 8(3): 336-339.
- Maragatham N, Martin GJ, Poongodi T. 2010. Effect of nitrogen sources on aerobic rice production under various soil ecosystems. 19th World Congress of Soil Science. Soil Solutions for a changing world 1-16 Aug, Brisbane, Australia.
- Devegowda G. 1997. Poultry manure excreta and other wastes as a source of organic manures. In: Training course on organic farming, UAS, GKVK, Bangalore. pp 7-11.
- Mohandas S, Paramasivam V, Sakthivel N. 2008. Phosphorus and zinc enriched organics for enhancing the yield of transplanted rice in New Cauvery delta, Tamil Nadu. *Journal of Ecobiology* 23(3): 73-76.
- Mishra A, Behera B, Pal AK, Mohanty SK, Rath BS, Subudhi CR, Nayak SC, Sahoo N. 2012. Performance of rice and blackgram with different nutrient management practices in rainfed upland. *Oryza* 49(4): 273-279.
- Almaz MG, Martini MY. 2020. Effects of residual organic manure and supplemental inorganic fertilizers on performance of subsequent maize crop and soil chemical properties. *International Journal of Research Studies in Agricultural Sciences* 6(1): 1-9.
- Pradhan BK, Mondal SS. 1997. Integrated nutrient management for sustaining productivity and fertility building of soil under rice based cropping system. *Indian Journal of Agronomy* 40: 4-13.
- Behera B, Maruthi Sankar GR, Mohanty SK, Mishra A, Rabindra CG. 2009. Sustainable and effective fertilizer management for rice + Pigeonpea intercropping under subhumid alfisols. *e- Planet* 7(1): 20-25.
- Bisht PS, Pandey PC, Singh DK. 2006. Effect of different sources of nutrients on rice (*Oryza sativa*) yield and soil nutrient status in rice-wheat cropping. In: National symposium on conservation agriculture and environment, Varnasi (India), Banaras Hindu University. pp 45-46.
- Rao DLN. 2014. Recent advances in biological nitrogen fixation in agricultural systems. *Proc. Ind. National. Sci. Academy* (80): 359-378.
- Calderón FJ, McCartney GW, Reeves JB. 2005. Analysis of manure and soil nitrogen mineralization during incubation. *Biol. Fertil. Soils* 41: 328-336.
- Balasubramanian A, Stalin P, Saravanaperumal M, Vinothkumar SR. 2016. Residual effect of integrated nutrient management practices on growth and yield of rice fallow blackgram (*Vigna mungo* L.). *Journal of Emerging Technologies and Innovative Research* 3(5): 597-605.
- Gutser R, Ebertseder T, Weber A, Schraml M, Schmidhalter U. 2005. Short-term and residual availability of nitrogen after long-term application of organic fertilizers on arable land. *Jr. Plant Nutr. Soil Sci.* 168: 439-446.