Plant Archives Volume 20 No. 1, 2020 pp. 2525-2528 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

RESIDUAL EFFECT OF INDUSTRIAL WASTES IN TAPPING THE PRODUCTION POTENTIAL OF RICE FALLOW BLACKGRAM

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Abstract

Field experiment was conducted at Annamalai University Experimental Farm, Department of Agronomy, Annamalai University, Annamalainagar during the cropping year 2013 – 2014 to find out the effect of graded levels of recommended dose of inorganic fertilizers in combination with industrial wastes *viz.*, pressmud compost and bone sludge (organic manures) on the growth and yield of rice fallow blackgram in the tail-end Cauvery deltaic region. The results revealed that integrated application of industrial wastes *viz.*, pressmud compost @ 5t ha^{-1} and bone sludge @ 6 t ha^{-1} along with 100 per cent recommended dose of fertilizers given to the first crop rice gave significantly higher rice fallow blackgram yield of 953 kg ha^{-1} when compared to other treatments.

Key words : Bone sludge, Pressmud compost, Augment, Sustainable agriculture.

Introduction

In Cauvery delta farmers cultivate blackgram crop as rice fallow crop for efficient utilization of residual moisture and nutrients added to the preceding rice crop. The yield potential of blackgram grown as relay crop is not exploited fully, and it records only very low yields, due to improper nutrient management. If proper integrated nutrient management practices by adding organics are followed for the preceding rice crop definitely, it will increase the residual soil nutrient status as well as the growth and yield of succeeding rice fallow blackgram under relay cropping. Industrial wastes originating from agriculture and non- agriculture related fields are finding acceptance for recycling in agriculture because they have soil ameliorative properties, acting as a source of plant nutrients, capable of improving the fertilizer use efficiency and help the indigenously available resources by acting as a low cost input in agriculture. The exponential increase in industrialization is producing large amounts of industrial wastes. This uncontrolled disposal of the industrial waste is hazardous to mankind as well as soil health on which the whole plant kingdom thrives on. Therefore avenues are being searched to recycle these wastes effectively and economically. Wastes originating from sugar industry, biogas plants, papers and pulp mills, chemical industries and food processing industries are finding their acceptance in today's agriculture. The challenge is to properly incorporate these wastes in a controlled management programme so that the applied wastes do not contribute to the problem of pollution.

The bone sludge is suspended bone particles in the bone washings which are filtered and sun -dried. This bone sludge contains sizeable quantity of macro and micro nutrients and hence has a great scope for being used as manure for agricultural crops. Lency (2001) found that bone sludge improved the growth and yield of rice crop when used in combination with inorganic fertilizers, providing balanced supply of all nutrients as required by the crop. Anu lavanya (2005) reported that integrated nutrient management system involving bone sludge, NPK fertilizers and bio- fertilizers significantly influenced the growth components in maize and blackgram. Pressmud compost is sugarcane based industrial waste having greater potential to supply nutrients (Aravind, 2012). The production and productivity of rice can be increased by the combined application of pressmud compost along with inorganic fertilizers.

The increased rice production which is an absolute necessary for the 21st century is likely to come from the adoption of high yielding varieties and intensive cropping. These approaches need heavy fertilization, but the chemical fertilizers are expensive and with the escalating

costs, they are beyond the reach of our Indian farmers. Integrated nutrient management practices with locally available cheaper organic nutrient sources receive worldwide attention since it reduces the dependence of costly inorganic fertilizers while sustaining soil and environmental health. In this juncture, nutrient management with industrial wastes holds a great promise in maintaining yield stability. Hence, the present investigation was carried out to develop a system based nutrient management practice for rice – blackgram under relay cropping system.

Materials and Methods

The experiment was conducted in the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai Varsity, Annamalainagar. The geographical location of Annamalai Nagar is 11º24' N latitude and 79º44' E longitude at an altitude of + 5.79 m above mean sea level. The soil of the experimental field is classified as *Udic chromustert* (clay) according to FAO / UNESCO (1974). The initial analysis of the experimental soil revealed that heavy clay with neutral in reaction (pH = 7.5), with low soluble salts (EC = 0.33 dSm^{-1}), medium in available nitrogen (215.35 kg ha^{-1}), low in available Phosphorus (19.85 kg ha^{-1}) and high in available potassium (368.90 kg ha^{-1}). The experiment was laid out in split plot design with three replications. The experiment comprised of four main treatments *viz.*, M_1-100% recommended dose of NPK fertilizers, M_2 – 75 % recommended dose of NPK fertilizers, M_3 - 50 % recommended dose of NPK fertilizers, and M2- 0 % recommended dose of NPK fertilizers and six sub - treatments *viz.*, S_1 - pressmud compost @ 5 t ha^{-1}, S_2 - pressmud compost @ 5 t ha-1 and bone sludge @ 3 t ha^{-1}, S_3 pressmud compost @ 5 t ha-1 and bone sludge @ 6 t ha-1, S_4 - FYM @ 12.5 t ha^{-1}, S - FYM @ 12.5 t ha^{-1} and bone sludge @ 3 t ha^{-1} and S - FYM @ 12.5 t ha^{-1} and bone sludge @ 6 t ha^{-1}. Rice fallow blackgramvariety ADT -5 was chosen as test crop for the investigation. Bone sludge, obtained from M/S Pioneer Miyagi Chemicals Ltd., Cuddalore, Tamilnadu was applied 10 days before sowing evenly over the respective plots as per the treatment schedule. The pressmud compost used in the study was obtained from MRK Co-operative Sugar Factory, Sethiathope, Tamilnadu. The nutrient content of industrial wastes *viz.*, pressmud compost and bone sludge are N-3.73% and 2%, P- 3.64% and 9.92% and K- 2.36% and 0.36% respectively. The recommended package of practices was followed and the crop was harvested. For the estimation of dry matter production, five plants were removed randomly at harvest stage. These samples were first air dried in shade and then oven dried at 80 ± 5°C till a constant weight was obtained and the weight was recorded. The mean dry weight was expressed in kg ha^{-1}. The yields and economic analysis of each treatment were recorded separately and analyzed statistically with Analysis of Variance.

Results and Discussion

Growth characters

The growth components of rice fallow blackgram *viz.*, plant height and dry matter production were significantly influenced by the integrated application of nutrients (Table 1). Among the different treatments studied, integrated use of inorganic fertilizers @100 % recommended dose of NPK along with industrial wastes *viz.*, pressmud compost @ 5 t ha^{-1} and bone sludge @ 6 t ha^{-1} (M_1 S_3) significantly registered the highest plant height of 50.11 cm and dry matter production of 2914 kg ha $^{-1}$ at harvest. This treatment was on par with the application of 75% RDF along with pressmud compost 5 t ha-1 and bone sludge 6 t ha^{-1} (M_2S_3), application of 100% RDF along with FYM 12.5 t ha-1 and bone sludge 6 t ha^{-1}(M_1S_6) and application of 75 % RDF along with FYM 12.5 t ha-1 and bone sludge 6 t ha^{-1} (M_2S_6). The lowest plant height of 26.25 cm and the lowest dry matter production of 1443 kg ha $^{-1}$ at harvesting stages were recorded in the treatment with FYM 12.5 t ha^{-1} alone (M_4S_4).

This could be due to the interaction effects between the levels of inorganic fertilizers and decomposition of pressmud compost along with bone sludge in lowland rice soils releasing NH_4^+ -N into rice –rhizosphere system and thereby resulting in higher residual uptake of N by the rice fallow blackgram plant. This form of N transferred from pressmud compost and bone sludge fulfills the nutrient requirement at all the stages of plant growth that facilitated better crop growth. Application of mineral fertilizers along with organic manures increased plant height significantly due to the stronger role of N in cell division, cell expansion and enlargement which ultimately accelerated the vegetative growth of rice. This is in concomitance with the findings of Satish *et al*., (2010) and Ramesh *et al*., (2011).

The combined application of inorganic fertilizers and organic manure sources could have helped in steady and balanced availability of both native and applied nutrients which might have enabled the leaf area duration to extend, thereby providing an opportunity for the plants to increase the photosynthetic rate which in turn resulted in higher accumulation of drymatter. As a consequent, improved physiological activities like increased photosynthetic activity and better light interception in turn resulted in

Table 1: Effect of INM on the growth characters of rice fallow blackgram at harvest.

Treatment	Plant height (cm) at harvest					Dry matter production (kg ha^{-1})				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
S_1	38.25	36.40	32.84	28.96	34.11	3317	2473	2027	1611	2357
S_2	45.28	44.73	36.81	29.12	38.99	3606	3532	2593	1780	2878
S_3	50.11	49.68	41.36	36.11	44.32	3874	3851	3362	2118	3301
S_4	38.12	36.31	32.19	26.25	33.22	3128	2451	1882	1443	2226
S_5	41.52	37.69	32.97	28.72	35.23	3381	2960	2057	1597	2499
S_6	49.51	48.96	37.62	29.04	41.28	3800	3768	2613	1697	2969
Mean	43.80	42.29	35.63	29.70	37.86	3518	3172	2423	1708	2705
	SEd			CD(p=0.05)		SEd			CD(p=0.05)	
M	0.22			0.54		25.88			63.33	
S	0.67			1.35		36.50			73.78	
M x S	1.23			2.51		71.49			148.48	
S x M	1.33			2.69		73.00			147.55	

Table 2 : Effect of INM on the yield attributes of rice fallow blackgram at harvest.

Treatment	Number of pods plant^{-1}					Number of seeds pod^{-1}				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
S_1	9.00	8.36	7.79	6.42	7.89	5.86	5.83	5.69	5.54	5.73
S_2	11.26	11.21	8.54	6.51	9.38	6.04	6.03	5.85	5.58	5.88
S_3	12.52	12.48	10.02	8.00	10.76	6.84	6.81	5.86	5.71	6.31
S_4	8.89	8.06	7.63	4.96	7.39	5.86	5.80	5.59	5.05	5.58
S_5	10.06	8.86	7.87	6.18	8.24	6.03	5.86	5.71	5.52	5.78
S_6	12.40	12.38	8.61	6.50	9.97	6.76	6.66	5.86	5.56	6.21
Mean	10.69	10.23	8.41	6.43	8.94	6.23	6.17	5.76	5.49	5.91
	SEd			CD(p=0.05)		SEd			CD(p=0.05)	
M	0.08			0.20		0.05			0.13	
S	0.13			0.25		0.09			0.17	
M x S	0.24			0.49		0.17			0.34	
S x M	0.25			0.50		0.17			0.34	

more vegetative growth of plants and also dry matter. Similar findings were reported by Siddaram *et al*. (2011).

Yield attributes

The yield attributes of rice fallow blackgram *viz.*, number of pods plant^{-1} and number seeds pod^{-1} were observed in the plots which received 100% RDF along with pressmud compost 5 t ha^{-1}and bone sludge 6 t ha^{-1} during the preceding rice crop. The reason for increase yield attributes might be due to microbial stimulation effect of organic manures and supply of essential plant nutrients through gradual mineralization in long term manner which provided enough nutrients to match the uptake pattern of succeeding crop throughout the growth period and thereby increased the assimilation of photosynthates which in turn helped better source and sink relationship and ultimately led to higher yield attributes of blackgram grown under rice fallow condition. Similar findings on higher yield attributes of rice fallow blackgram due to the residual effects were well documented by Yadav *et al*. (2013).

Yield

Integrated use of inorganic and organic sources of nutrients significantly influenced the grain yield and straw yield of rice fallow blackgram (Table 3). Application of 100% RDF along with pressmud compost 5 t ha^{-1} and bone sludge 6 t ha^{-1} (M_1S_3) registered the highest blackgram seed yield of 953 kg ha^{-1} and haulm yield of 2312 kg ha^{-1}. This was on par with the application of 75% RDF along with pressmud compost 5 t ha^{-1} and bone sludge 6 t ha^{-1} (M_2S_3), application of 100% RDF along with FYM 12.5 t ha^{-1} and bone sludge 6t ha^{-1}(M_1S_6) and application of 75 % RDF along with FYM 12.5 t ha^{-1} and bone sludge 6 t ha^{-1} (M_2S_6). The lowest seed yield of 362 kg ha^{-1} and haulm yield of 1190 kg ha^{-1} were recorded in the treatment with FYM 12.5 t ha^{-1} alone (M_4S_4).

These beneficial effects might be due to the formation of mettalo-organic complex with organic ligands which

Table 3: Effect of INM on the yields of rice fallow blackgram.

Treatment	Grain yield (kg ha^{-1})					Haulm yield (kg ha^{-1})				
	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
S_1	730	568	498	405	550	1917	1561	1455	1309	1560
S_2	853	837	638	431	690	2118	2118	1792	1414	1860
S_3	953	949	746	548	799	2312	2305	1985	1579	2045
S_4	683	552	485	362	521	1871	1505	1428	1190	1499
S_5	778	673	510	399	590	2015	1864	1455	1309	1661
S_6	923	906	649	413	723	2257	2223	1803	1312	1899
Mean	820	747	588	426	645	2082	1929	1653	1352	1754
	SEd			CD(p=0.05)		SEd			CD(p=0.05)	
M	6.17			15.11		15.83			38.75	
S	8.87			17.92		24.85			50.22	
M x S	17.32			35.95		48.05			99.34	
S x M	17.73			35.84		49.70			100.45	

led to increased nitrogen and offered better soil- plant nutrient environment also to the succeeding crop. In addition, the cumulative and synergetic effect of INM after harvest, more quanta of available nutrients were possible even after harvest of rice crop. Further, various organic acids were produced by pressmud compost and bone sludge during decomposition which solubilize phosphate and other phosphate bearing minerals and lowers the phosphate fixation and increased the availability of several macro and micro nutrients. As all the essential elements are realized in series of nutrient transformation this form of nutrients transferred from INM followed in preceding rice crop might have benefited the succeeding rice fallow blackgram. As a consequent, improved uptake of nutrients has led to higher yields and harvest Index. These results were in consonance with the findings of Sangeetha *et al*., (2013).

Conclusion

Considering the above results of the present investigations, it can be concluded that integrated application of 100% RDF along with pressmud compost 5 t ha^{-1} and bone sludge 6 t ha-^{1} (M_1S_3) imposed to preceding rice appears to be more promising in enhancing the yields of succeeding blackgram and this treatment combination would also reduce the cost of farming in addition of maintaining soil productivity, improve the eco system and ultimately resulting in healthier soil – plant – health in a sustainable agriculture eco system. Therefore, this nutrient management practice can be recommended for adoption by the farmers in the Cauvery deltaic region of Tamilnadu.

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