Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; SP2: 377-380

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Progressive alliance of organic manures in ensuring promising productivity in rice

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Abstract
Rice is the major staple food of Asia. Self-sufficiency in rice has been a major goal of agricultural research and development in most Asian countries. In 2025 A.D, the global demand for rice would increase by 70 per cent, requiring a production of 800 metric tonnes of unmilled rice against the present production of 600 metric tonnes. It has been repeatedly emphasized that in order to meet the demand, the yield potential of irrigated rice has to be increased from the present yield potential of 4.5 t ha^{-1} to 8 t ha^{-1}.
To realize the full yield potential of rice field experiment was conducted at Annamalai University Experimental Farm, Department of Agronomy, Annamalai University, Annamalainagar (Tamil Nadu), India during the cropping year 2017–2018 to find out the effect of progressive alliance of recommended dose of inorganic fertilizers in combination with organic manures *viz*., pressmud compost and bone sludge on the growth and yield of rice in the tail-end Cauvery deltaic region. The experiments conducted with four inorganic fertilizers levels (100%, 75%, 50% and 0% RDF) in combination with organic manure sources (FYM 12.5 t ha^{-1}, pressmud compost 5 t ha^{-1} with and without bone sludge 3 and 6 t ha^{-1}). The experiment was laid out in split plot design and replicated thrice. The results revealed that integrated application of industrial wastes *viz*., pressmud compost @ 5t ha and bone sludge @ 6 t ha^{-1} along with 100 per cent recommended dose of fertilizers (M_1S_3) gave significantly higher promising grain yield of 6209 kg ha^{-1} compared to other treatments.

Keywords: Progressive alliance, organic manures, agricultural research

Introduction
Globally rice is cultivated over an area of 154 million hectares with an annual production of around 600 million tonnes with an average productivity of 3.9 tonnes ha^{-1}. In India, rice is cultivated in an area of 45.54 million hectares with a production of 99.18 million tonnes and an average productivity of 2.18 tonnes ha^{-1} (Directorate of Economics and Statistics, 2012) [4]. Rice requires high quantity of nutrients to harness their potential yield. Rice based cropping systems removed about 630 - 840 kg of primary nutrients ha^{-1} (Khanda *et al*., 2005) [5].
Sustainable production could be achieved only when factors leading to continued maintenance of soil health are taken care of. Hence, the complimentary role of organics as supplements to chemical fertilizers is important for keeping the soil health in order to harness the potential yield in rice based cropping systems (Lency, 2001) [6]. Under these circumstances, more emphasis is now being given on integration of inorganic and organics including crop residues, agro - based industrial wastes and by-products to improve the soil productivity (Chettri and Bandhopadhaya, 2005) [3].
Lency (2001) [6] found that bone sludge improved the growth and yield of rice crop when used in combination with inorganic fertilizers, providing balanced supply of nutrients as required by the crop. Pressmud compost is sugarcane based industrial waste having greater potential to supply nutrients the production and productivity of rice can be increased by the combined application of Pressmud compost along with inorganic fertilizers (Aravind, 2012) [2]. Pressmud compost is one of the major by- products of sugar industry containing major as well as minor nutrients and is being used as a source of N and P to improve the nutrient status of soil and availability of micro nutrients in a cropping system.
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. Thus, the present investigation was undertaken to study the effect of industrial wastes in augmenting rice productivity.
In this context, the present investigation was undertaken to study the progressive alliance of organic manures in ensuring promising productivity in rice.

The investigation was undertaken with the following objectives.

1. To study the effect of graded levels of inorganic fertilizers in combination with organic manure sources on the growth and yield of rice.
2. To evaluate the impact of integrated use of organic nutrient sources and inorganic fertilizers in augmenting the productivity of rice
3. To optimize the dose of bone sludge and pressmud compost for rice production

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 N (215.35 kg ha^{-1}), low in available P_2O_5 (19.85 kg ha^{-1}) and high in available K_2O (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 M_4 -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_5 - FYM @ 12.5 t ha^{-1} and bone sludge @ 3 t ha^{-1} and S_6 - FYM @ 12.5 t ha^{-1} and bone sludge @ 6 t ha^{-1}. Rice variety Co. 43 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, Tamil Nadu. 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 -1 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 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 139.15 cm and dry matter production of 12184 kg ha at harvest. It was followed by 100% recommended dose of NPK fertilizers along with pressmud compost @ 5 t $ha^{-1}$and bone sludge @ 3 t ha (M_1 S_2), 100% recommended dose of NPK fertilizers along with FYM @ 12.5 t ha^{-1} and bone sludge @ 6 t ha^{-1} (M_1 S_6) and 75 % recommended dose of NPK fertilizers along with pressmud compost @ 5 t ha^{-1} and bone sludge @ 6 t ha^{-1} (M_2S_3)which were on par among themselves. Shorter plants and lower dry matter production were recorded in the application of FYM @12.5 t ha^{-1} under absolute control treatment (M_4 S_4). The combined application of inorganic and organic manures could have helped in steady and balanced availability of nutrients at all stages causing improved uptake of nutrients which ultimately has led to more vegetative growth of plants and dry matter production.

Table 1: Effect of integrated nutrient management on the growth characters of rice at harvest stage

	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**
S1	120.35	115.21	110.88	99.88	111.58	10292	9590	9190	8338	9352
S2	133.70	126.92	118.99	106.08	121.42	11606	11074	10002	8791	10368
S3	139.15	131.11	122.85	115.00	127.03	12184	11551	10543	9394	10918
S4	120.15	115.01	108.98	94.18	109.58	10234	9447	9182	7056	8980
S5	123.44	119.99	111.18	99.28	113.47	10663	10197	9229	8257	9587
S6	133.00	127.22	119.89	105.78	121.47	11722	11089	10112	8748	10418
Mean	128.30	122.58	115.46	103.37	117.43	11117	10491	9710	8430	9937
	S.Ed			CD (p=0.05)		S.Ed			CD (p=0.05)	
M	1.03			2.52		118.61			290.23	
S	1.32			2.67		99.64			201.37	
M x S	2.63			5.48		217.16			466.49	
S x M	2.65			5.35		199.27			402.75	

Higher dry matter production was perhaps due to the higher leaf dry weight and stem dry weight recorded at different stages. This has provided more photosynthetically active leaf area resulting in higher dry matter production. Apart from that, nitrogen might have involved in various physiological activities like increased photosynthetic activity and better light interception which in turn resulted in higher dry matter accumulation. Similar findings of higher growth indices in rice due to application of organic and inorganic were reported by Sangeetha *et al.* (2013) [7].

Yield attributes

The yield attributes of rice *viz.*, number of productive tillers m-2 and number of filled grains panicle-1 were favorably influenced by the integrated nutrient management (Table 2). Among the different integrated use of inorganic and organic sources of plant nutrient tested, combined application of 100 % Recommended dose of NPK fertilizers along with

pressmud compost @ 5 t ha $^{-1}$ and bone sludge @ 6 t ha $^{-1}$ (M_1 S_3) significantly registered the highest productive tiller number of 363.95 m^{-2} and filled grain number of 106.45 panicle^{-1}. It was followed by 100% recommended dose of NPK fertilizers along with FYM @ 12.5 t ha $^{-1}$ and bone sludge @ 6 t ha^{-1} (M_1S_6), 100% recommended dose of NPK fertilizers along with pressmud compost @ 5 t ha $^{-1}$ and bone sludge @ 3 t ha $^{-1}$ (M_1S_2) and 75 % recommended dose of NPK fertilizers along with pressmud compost @ 5 t ha $^{-1}$ and bone sludge @ 6 t ha (M_2 S_3) which were on par with each other. Application of FYM @12.5 t ha $^{-1}$ without inorganic fertilizers (M_4S_4) registered the minimum tiller number of 197.03 m^{-2} and filled grains number of 63.52 panicle^{-1}. Higher availability of nutrients because of favorable effect of organic sources might have improved the physiological and metabolic functions inside the plant body which in turn laid down the foundation for higher yield in rice (Lency, 2001) [6]. The combined application of inorganic fertilizers and organic manures could have helped in balanced availability of nutrients at all the growth stages of rice. Further, this might have improved the macro and micro nutrient availability and enhanced soil microbial activity resulting in higher uptake of nutrients which ultimately led to more vegetative growth of plant and consequently improved the productive tiller m^{-2} and number of filled grains panicle^{-1}. These findings are in conformity with the earlier reports of Siddaram *et al.* (2011) [8] in rice.

Table 2: Effect of integrated nutrient management on the yield attributes of rice

	Number of productive tillers m-2					Number of filled grains panicle-1				
	M_1	**M_2**	**M_3**	**M_4**	**Mean**	**M_1**	**M_2**	**M_3**	**M_4**	**Mean**
S1	283.79	259.28	251.03	221.41	253.88	92.41	87.16	85.58	72.86	84.50
S2	330.79	317.27	280.27	228.96	289.32	98.72	96.73	91.94	80.63	92.01
S3	363.95	330.79	295.46	255.52	311.43	106.45	97.69	96.52	86.71	96.84
S4	281.15	256.96	250.90	197.03	246.51	92.36	86.83	85.24	63.52	81.99
S5	295.46	281.15	251.87	219.35	261.96	96.53	92.33	86.47	71.67	86.75
S6	332.36	317.30	281.15	226.88	289.42	100.87	97.44	92.23	78.95	92.37
Mean	314.58	293.79	268.45	224.86	275.42	97.89	93.03	89.66	75.72	89.08
	S.Ed			CD (p=0.05)		S.Ed			CD (p=0.05)	
M	3.33			8.14		1.06			2.59	
S	2.75			5.55		0.89			1.81	
M x S	6.02			12.95		1.95			4.18	
S x M	5.50			11.11		1.79			3.62	

Yield

Integrated use of inorganic and organic sources of nutrients significantly influenced the grain yield and straw yield of rice (Table 3). Application of 100 % recommended dose of NPK fertilizers along with pressmud compost @ 5 t ha-1 and bone sludge @ 6 t ha $^{-1}$ (M_1S_3) significantly registered the highest grain yield of 6209 kg ha and straw yield of 7637 kg ha $^{-1}$. It was followed by 100% recommended dose of NPK fertilizers along with FYM @ 12.5 t ha $^{-1}$ and bone sludge @ 6 t ha $^{-1}$ (M_1S_6), 100% recommended dose of NPK fertilizers along with pressmud compost @ 5 t ha $^{-1}$ and bone sludge @ 3 t ha $^{-1}$ (M_1S_2), and 75 % recommended dose of NPK fertilizers along with pressmud compost @ 5 t ha $^{-1}$ and bone sludge @ 6 t ha $^{-1}$ (M_2 S_3) which were on par with each others. Application of FYM @ 12.5 t ha $^{-1}$ without inorganic fertilizers (M_4S_4) registered the minimum grain yield of 3565 kg ha^{-1} and straw yield of 5875 kg^{-1} ha^{-1}. The increase in grain yield might be due to superior yield attributing characters under integrated nutrient management treatment which received the essential nutrient at balanced proportion for better growth of rice (Adhikari and Mishra, 2002) [1]. Higher availability of nutrients because of favorable effect of organic and inorganic sources might have improved the physiological and metabolic functions inside the plant body which in turn laid down the foundation for higher yield in rice. The present findings are in agreement with the earlier reports of Virdia and Mehta. 2010 [9].

Table 3: Effect of integrated nutrient management on the yields (kg ha-1) of rice.

	Grain yield (kg ha-1)					Straw yield (kg ha-1)				
	M_1	**M_2**	**M_3**	**M_4**	**Mean**	**M_1**	**M_2**	**M_3**	**M_4**	**Mean**
S1	4559	4008	3691	2930	3797	7137	6789	6718	6545	6797
S2	5713	5318	4454	3355	4710	7406	7153	7001	6700	7065
S3	6209	5691	4836	3922	5164	7637	7395	7144	6753	7232
S4	4500	3953	3663	2143	3565	7129	6782	6715	5875	6625
S5	4968	4503	3748	2852	4018	7149	7104	6740	6531	6881
S6	5797	5416	4485	3228	4731	7424	7185	7100	6699	7102
Mean	5291	4815	4146	3072	4331	7314	7068	6903	6517	6950
	S.Ed			CD (p=0.05)		S.Ed			CD (p=0.05)	
M	35.64			87.21		55.20			135.08	
S	36.56			73.89		58.46			118.15	
M x S	75.67			160.08		120.16			253.67	
S x M	73.12			147.79		116.92			236.31	

Conclusion

Based on the results of the present investigation, it could be concluded that integrated application of 100% recommended dose of NPK fertilizers along with industrial wastes *viz*., pressmud compost @ 5 t ha $^{-1}$ and bone sludge @ 6 t ha $^{-1}$ holds promise in enhancing crop yields in rice, which is a felt

need of the present day agriculture. Further, the integrated nutrient management system with organic industrial wastes *viz*., pressmud compost and bone sludge not only reduces the cost of cultivation of rice but also enhances the soil health, a concept called sustainable agriculture which is agronomically sound economically viable and socially acceptable.

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