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Growth, yield and yield attributes of rice (*Oryza sativa* L.) influenced by inorganic and organic source of nutrients in rice-wheat cropping system

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Abstract
A field experiment was carried out at Experimental Research Farm Janta Mahavidiyalaya Ajitmal, Auraiya during 2014 - 15 and 2015 - 16 to investigate the impact of FYM, green manures, poultry manures and wool based manures with 75, 50, 25 per cent nitrogen from fertilizers and 100 per cent above organic sources on growth, yield and yield attributes of rice *Oryza sativa* L., wheat (*Triticum aestivum* L.) cropping system. Growth, yield and yield attributes showed better performance in treatment combination with T_{14} (25% N, from wool based 75% fertilizers). The residuals effects of these fertilizers treatment combination (T_{14} - T_{17}) showed better results. While lowest Growth, yield and yield attributes was showed under (T_1) control.

Keywords: Rice, wheat organic, inorganic sources, cropping system

Introduction
Rice (*Oryza sativa* L. wheat (*Triticum aestivum* L. Cropping system plays a significant role in food security, contributing 76% of total food grain production in India. About 33% of India's rice and 42% of wheat is grown in this rotation. This system is the principal cropping system occupying 24 m ha of cultivated land in the Asian subtropics. In south Asian countries, this system is prevalent in 13.5 m ha in the Indo-Gangetic plain of which 10 m ha lies in India (FAO 2008) [2]. Application of imbalanced chemical fertilizers has led to decline of nutrient use efficiency, poor purchasing capacity of farmers, ill soil health and creating environment pollution. All these factors led to search for alternative sources of plant nutrients. Integrated nutrients management gave a better tools i.e. Use of optimum chemical fertilizers and organic manures has been found promising in arresting the declining trend in soil-health and crop productivity, micro-nutrients, growth of micro-flora and fauna and physical, chemical and biological properties of soil (Ullasa *et al.*, 2018) [9]. Thus, keeping in view the above consideration the study was formulated on long term effect of combination of organic sources and inorganic fertilizer on growth parameters, yield and economics under rice-wheat cropping system.

Methods and Materials
Field experiment was conducted at Experimental Research Farm Janta Mahavidiyalaya Ajitmal, Auraiya during 2014-15 and 2015-16 to investigate the impact of integrated nutrient management on growth, yield and yield attributes of rice wheat cropping system. The soil of the experimental field was sandy loam having pH 7.1, organic carbon 0.52%, available nitrogen 162.7 kg N ha^{-1}, available phosphorus 18.5 kg P_2O_5 ha^{-1}, available potassium 200.3 kg K ha^{-1}.The experiment consisted of seven treatments *viz.*,

T_1 - Control,
T_2 - 25% N (FYM) + 75% N (fertilizers),
T_3 - 50% N (FYM) + 50% N (fertilizers),
T_4 - 75% N (FYM) + 25% (fertilizers N),
T_5 - 100% N (FYM),
T_6 - 25% (green Manures) + 75% (fertilizer N),
T_7 - 50% (green Manure) + 50% (fertilizer N),
T_8 - 75% (green Manure) + 25% (fertilizer N),
T_9 - 100% N (green Manure),
T_{10} - 25% N (Poultry manure) + 75% (fertilizer N),
T_{11} - 50% N (Poultry manure) + 50% (fertilizer N),

T_{12} - 75% N (Poultry manure) + 25% (fertilizer N)
T_{13} - 100% (Poultry manure)
T_{14} - 25% N (Wool based) + 75% (fertilizer N)
T_{15} - 50% N (Wool based) + 50% (fertilizer N)
T_{16} - 75% N (Wool based) + 25% (fertilizer N)
T_{17} - 100% N (Wool based)
T_{18} - 100% (fertilizer N)

Were laid out in randomized block design with three replications. The inorganic fertilizers were supplied through urea, diammonium phosphate, muriate of potash and gypsum. The rice variety Pant-10 was transplanted in rows 20x10 cm. The FYM was applied in 15 days before sowing as per treatment. Full dose of phosphorus, potassium, half of nitrogen (as per treatment) applied at the time of sowing. Remaining $^1/_4$ of nitrogen was applied after 30 DAT and ¼ of Nitrogen at 65 DAT. The crop was harvested in the month of December. Recording of data of different character *viz*. plant height, number tillers plant^{-1} and number of penicles hill^{-1}, grain yield ha^{-1}, straw yield ha^{-1} and test weight per schedule. Statistical analysis was based on the method analysis of variance as suggested by Panse and Sukhatme (1967) [7] and the standard error difference was computed by at 5% and 1% level of significance.

Results and Discussion

The results revealed that growth parameters of rice *viz.* plant height, number of tiller plant^{-1}, number of panicles hill^{-1} increased with the under inorganic and organic source of nutrients in rice-wheat cropping system (Table 1). Maximum plant height was measured in T_{18} (100% inorganic fertilizers and lowest at control at all the stages of growth during both the year of experimentation. A significant enhancement was noticed at various stages in number of tillers plant^{-1} in treatment combination T_{14} to T_{17} closely followed by T_{10} to T_{13} (poultry manure), green manures (T_6-T_9) and FYM (T_2-T_5). With decreasing in fertilizers ratio in each organic sources declining trend was noticed in during both the year. Number of panicle hill^{-1} was significantly influenced by different treatments in comparison to control. With increasing in fertilizers ratio with each sources of organic combination number of panicles showed declining trends. The maximum number of panicles hill^{-1} was noticed in treatments T_{18} (100% inorganic fertilizers) and lowest in control. The statistical analysis of data showed significant differences among different treatments for grain yield ha^{-1}. The maximum grain yield (46.00 and 44.00 qha^{-1}) was recorded in T_{18} (100% inorganic fertilizers). However, lowest grain yield was recorded in control (T_1) during both the year. Decrease in fertilizers and increase in organic resources of nutrients grain yield showed declining trends. Wool waste fertilizers showed better results in comparison to other organic sources. A significant enhancement was reported in straw yield with various treatments combination. The highest straw yield (80.00 and 76.85 q ha^{-1}) was recorded in treatment T_{18}, while lowest was noticed in (33.21 and 32.65 q ha^{-1}) in control during both the years. A significant reduction was noticed in test weight with increase in fertilizers ratio in each organic sources of nutrient. The highest test weight (29.00 and 28.50 g) in T18 and lowest test weight (18.10 and 18.15 g) was recorded in control. It may be due to organic sources of nutrients releases many macro, micro nutrient as well as growth promoting substances which enhances the cell division and cell enlargement and also increases water/nutrients absorption, translocation of solute resulting more accumulation of photosynthete which was translocate from source to sink. Similar results were also reported by earlier Kumawat *et al*., (2014), Kumar *et al.* (2018), Kumar *et al.* (2019), Kumar *et al.* (2019) [4, 3, 5, 6].

Table 1: Growth, yield and yield attributes in rice (*Oryza sativa* L.) under inorganic and organic source of nutrients in rice-wheat cropping system

Treatments	Plant height (cm) (DAT)						Number of Tillers hill^{-1} (DAT)						Number of Panicles hill^{-1}		Grain yield (q ha^{-1})		Straw yield (q ha-^{1})		Test weight (g)	
	2015			2016			2015			2016										
	30	60	90	30	60	90	30	60	90	30	60	90	2015	2016	2015	2016	2016	2015	2016	2015
T_1	44.20	72.86	79.23	43.10	71.00	77.00	5.00	7.00	8.00	5.00	6.33	7.66	6.00	5.66	20.91	20.22	33.21	32.65	18.10	18.15
T_2	54.96	80.28	92.10	54.50	79.25	90.00	7.00	9.60	10.33	7.00	9.33	10.00	9.33	9.00	39.50	39.05	58.20	56.90	23.70	23.60
T_3	54.20	79.52	91.72	54.00	78.70	89.50	6.60	9.00	9.60	6.60	8.66	9.33	8.33	8.00	38.20	38.02	57.30	55.70	23.10	23.05
T_4	53.52	78.24	90.50	53.20	77.95	89.20	6.00	8.60	9.33	6.00	8.33	9.00	7.66	7.66	37.75	37.70	56.90	53.67	22.90	22.95
T_5	49.50	74.96	85.20	49.40	74.9	85.20	5.60	8.00	9.00	5.60	8.00	8.66	7.00	7.00	32.10	32.00	53.00	52.85	20.20	20.30
T_6	61.10	83.20	93.82	60.00	82.50	92.02	8.00	11.00	12.00	8.00	10.33	11.66	9.66	9.33	40.50	39.50	59.68	57.92	23.50	23.35
T_7	62.25	82.20	92.10	59.75	52.00	91.07	7.60	10.33	11.33	7.60	10.00	11.00	9.00	9.00	39.75	39.12	58.30	57.05	23.20	23.15
T_8	59.12	81.90	91.82	59.25	81.20	90.90	7.30	9.60	10.66	7.00	9.60	10.33	8.66	8.33	38.95	38.75	57.20	56.95	22.96	23.00
T_9	50.25	76.20	88.00	50.30	76.50	87.95	6.30	9.00	10.00	6.00	8.66	9.66	8.00	8.00	35.25	35.15	54.25	53.85	21.00	21.00
T_{10}	62.98	85.05	96.12	61.00	84.20	94.10	9.60	13.00	14.00	9.30	12.00	13.66	11.00	10.66	42.75	41.90	73.20	71.15	28.10	28.05
T_{11}	62.00	84.00	95.00	61.70	83.20	93.45	8.67	12.00	13.00	8.33	11.66	13.00	10.66	10.00	41.35	41.05	71.05	70.82	27.02	27.00
T_{12}	60.25	83.10	93.96	60.20	82.00	93.70	8.33	11.33	12.33	8.00	11.33	12.00	10.33	9.66	40.60	40.30	70.10	70.02	26.95	26.98
T_{13}	58.20	78.25	90.10	58.10	78.30	90.00	8.00	10.60	11.00	7.66	9.66	10.66	9.00	9.33	39.10	39.00	58.30	58.06	25.00	25.20
T_{14}	65.60	88.00	103.20	64.75	86.25	101.05	10.66	14.33	15.33	10.00	14.00	14.66	12.33	12.00	45.95	43.90	78.00	76.12	28.90	28.70
T_{15}	64.05	85.25	100.66	64.00	83.20	100.00	9.33	13.66	14.66	9.00	13.00	14.33	11.66	11.33	44.90	42.05	76.75	75.37	28.20	28.10
T_{16}	62.90	84.20	99.65	63.05	83.00	99.50	9.00	13.00	14.00	8.66	12.66	14.00	11.00	11.00	43.00	41.80	73.85	73.12	27.95	28.00
T_{17}	60.75	81.25	91.12	61.00	81.30	94.32	8.66	11.00	12.20	8.00	11.33	12.33	10.33	10.66	41.26	41.15	71.05	70.90	27.10	27.20
T_{18}	66.60	88.25	103.10	65.00	86.50	101.20	11.00	14.00	15.66	11.000	14.00	15.00	13.00	12.33	46.00	44.00	80.00	76.85	29.00	28.50
SE (DIFF)	2.55	3.73	3.72	2.52	2.80	3.53	0.607	0.608	0.801	0.561	0.657	0.870	0.492	0.810	1.93	1.72	2.83	3.009	1.28	1.38
CD (0.05%)	5.19	7.59	7.56	5.12	5.71	7.18	1.23	1.23	1.62	1.14	1.33	1.77	1.41	1.64	3.93	3.50	5.762	6.12	2.61	2.80

The residual response of different treatments combination added during kharif in rice crops their residual effect on wheat crop was noticed and results indicated in Table 2. A significant enhancement was noticed in growth parameters of wheat *viz.* plant height, number of tiller plant^{-1}, number of panicles hill^{-1} increased with the under inorganic and organic

source of nutrients in rice-wheat cropping system. The residuals effect of different organic nutrients showed significant effect on plant height during both the year. The treatment combination wool waste (T_{14} to T_{18}) observed maximum plant height followed by poultry manures, green manure and FYM. Green manures and poultry manures were statistically at par. The residuals effect of organic manures showed maximum plant height in wheat in comparison to inorganic fertilizers. The wool waste recorded maximum number of tillers followed by poultry manures, green manures and FYM. Wool waste, poultry manures and green manures recorded higher number of tiller hill^{-1} in comparison with inorganic nitrogen whereas FYM produced lowest number of tillers hill-1. Increase the proportion of inorganic nitrogen the of tiller hill^{-1} increased in linear order. The maximum number of tillers was recorded with 100 percent application of organic manures. Number of spikelets hill^{-1} was maximum reported in wool waste followed by poultry manures, green manures, FYM. In Organic manures noticed maximum number of spikelets hill^{-1} in comparison to inorganic fertilizers. The different organic manures significantly enhanced the test weight. Wool waste recorded highest test weight in comparison to other organic manures. The test weight in green manures and poultry manures were statistically at par. The wool manures, green manures, poultry manures and FYM recorded higher test weight in comparison to inorganic fertilizers. The grain yield of wheat as influenced by residual amount of different treatments. The application of wool waste produced maximum grain yield (33.38 and 33.87 q ha-1) in wheat followed by poultry manures, green manures and FYM. The lowest grain yield (22.02 and 22.00 q ha^{-1}) was reported in control. The residual effect of different organic manures was found significant. The wool waste produced highest straw yield (45.50 and 45.37 q ha-1) of wheat followed by poultry manures, green manures and FYM. The lowest straw yield (35.12 and 34.77 q ha-1) was recorded in control. The organic manures showed higher residual effect in comparison to inorganic fertilizers. It may be due to organic sources of nutrients slowly releases many macro, micro nutrient as well as growth promoting substances which enhances the cell division and cell enlargement and also increases water/nutrients absorption, translocation of solute resulting more accumulation of photosynthete which was translocate from source to sink. This finding also corroborated with the results of Abdul *et al.*, (2008), Kumar *et al.* (2019) [1, 5]. While inorganic fertilizers are highly solubilising nature resulting fast release of nutrients in soil solution some of them are utilised by crop plant. But if soils are saline/ water logged/high temperature condition nitrogenous fertilizers are denitrified or leeched out, phosphatic fertilizers are converted in chelating compound and fixed on soil collides resulting unavailability of nutrients to crop plant.

Conclusion

Application of 100 percent inorganic nutrient established its superiority over organic sources of nutrients i.e. wool waste, poultry manure, green manure, FYM in different ratio in respect to direct effect on rice crop. Wool waste was found comparatively better sources of nutrients in respect to all organic sources. The residual effect on wheat crop organic sources of nutrients showed better results as compared to 100 percent inorganic sources of nutrients. So on the basis of our finding we are advised to farmers to adopt this fertilization programme for getting better yield from rice wheat cropping system and also minimise environmental pollution and improve soil health.

Table 2: Effect of different treatments on growth, yield and yield attributes of wheat in rice wheat cropping sequence

Treatments	Plant height (cm) (DAS)		Number of Tillers hill^{-1} (DAS)		Number of spikelets hill^{-1}		Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Test weight (g)	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
	90	90	90	90								
T_1	78.20	78.35	3.70	3.65	2.00	2.00	22.02	22.00	35.12	34.77	38.60	38.20
T_2	92.15	91.00	4.00	3.90	2.33	2.33	28.00	27.89	41.22	41.18	42.92	42.68
T_3	93.02	93.00	4.33	4.20	2.66	2.66	29.75	29.20	42.01	42.00	43.11	43.00
T_4	93.80	93.81	4.60	4.52	3.00	3.00	31.22	31.20	42.96	42.65	43.18	43.15
T_5	94.22	94.20	5.00	5.00	3.33	3.33	32.15	32.16	43.72	43.02	43.98	43.97
T_6	96.92	96.52	4.66	4.50	2.66	2.33	29.20	29.00	42.72	42.12	44.02	44.00
T_7	97.10	96.99	5.22	5.02	3.00	2.66	30.16	30.12	42.95	42.99	44.35	44.30
T_8	98.28	98.20	5.66	5.60	3.33	3.00	32.18	32.17	43.07	42.98	44.98	44.96
T_9	98.80	98.82	5.85	5.80	3.66	3.66	33.50	33.40	44.99	44.92	45.08	45.06
T_{10}	97.22	97.00	5.53	5.23	3.00	3.00	30.20	30.00	43.66	43.02	45.22	45.06
T_{11}	98.06	98.00	5.88	5.80	3.66	3.33	31.15	31.13	43.98	43.45	45.99	45.76
T_{12}	98.46	98.20	6.20	6.16	4.00	3.66	33.00	32.98	44.02	44.00	45.72	43.70
T_{13}	98.92	98.90	6.49	6.42	4.33	4.00	34.62	34.61	45.87	45.85	46.27	46.26
T_{14}	98.15	98.00	5.52	5.46	4.00	3.66	32.30	32.11	44.15	44.00	45.20	45.02
T_{15}	98.92	98.12	5.90	5.72	4.33	4.00	33.96	33.22	44.88	44.60	45.98	45.90
T_{16}	99.56	99.42	6.20	6.05	4.66	4.66	34.12	34.00	46.12	46.08	46.13	46.10
T_{17}	100.05	99.98	6.66	6.60	5.00	5.00	33.17	35.02	46.85	46.82	46.99	46.98
T_{18}	99.17	95.40	6.50	6.43	3.66	3.33	30.72	30.02	43.12	43.05	42.20	41.66
SE (DIFF)	1.432	1.08	0.133	0.101	0.112	0.984	1.085	0.990	1.05	0.890	1.087	0.859
CD (0.05%)	2.911	2.207	0.270	0.205	0.228	0.200	2.206	2.012	2.13	1.80	2.090	1.746

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