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RESEARCH PAPER

Conjunctive use of organic and inorganic nutrient management on economics and quality of hybrid rice (*Oryza sativa* L.)

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Abstract : Field investigation was carried out during kharif 2002 and 2003 at research farm, IGAU, Raipur (C.G.). The experiment aimed at comparing performance of different levels of inorganic fertilizer and its conjunction with different organic fertilizers. Results showed that application of 100:60:40 kg NPK ha^{-1} in conjunction with PM gave the highest value of KLAC, ER and amylose content, which was comparable to inorganic fertilizer level of 100:60:40 kg NPK ha^{-1} applied along with FYM or blending of N with cow dung. The hulling and milling percent was also increased under these combinations. The highest input cost, net profit and per rupee investment was found under 150:80:60 kg NPK ha^{-1} followed by application of 100:60:40 kg NPK ha^{-1} along with PM.

Key Words ::- FYM, Poultry manure, Cow-dung urine mixture, Blue green algae, Phosphorus solubilizing bacteria, Hybrid rice

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INTRODUCTION

Rice is one of the most important food crop and primary food source for more than one-third of world's population (Prasad *et al.,* 2010). India has the largest area under rice cultivation (44.3 million ha), amounting for 29.40% of the global rice area. But the productivity of rice in India is lower (2.04 tonnes/ha) as compared to Japan (6.25 tonnes/ha), China (6.24 tonnes/ha) and Indonesia (4.25 tonnes/ha). Limited availability of scarce resources along with declining factor productivity of rice crop is one of the major concerns of feeding a population which has been increasing globally by about 80 million people per year (Fischer Heilig, 1998). Agricultural sustainability depends to a large extent on improvements in soil properties those are controlled by many factors, of which the mineral nutrition is by and large most important. The steady decline in soli organic matter levels due to continuous cropping without recycling enough crop or animal residues, coupled with nutrient imbalances due to insufficient application of nutrient has led to negative nutrient balance in agriculture, impaired soil health and decline factor productivity. Declining trend in productivity

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due to continuous use of chemical fertilizers alone has been observed in several long-term experiments all over India (Nambiar,1994), while integration of organic sources sustains the productivity. It is however, difficult to meet the crop-nutrient requirements with bulky organic manure alone and there is a need for integrated application of different sources of nutrients including biofertilizers like Blue Green Algae, Phosphorus Solubilizing Bacteria (PSB) etc. for sustaining the desired crop productivity (Gogoi *et al*., 2010). Since sustainability of production system depends on the sustainable use of soil-resources, it is necessary to develop and adopt soil-management technologies that increase soil organic matter contents and biological activities and improves soil physical conditions to keep land productive on the sustainable basis (Ali *et al*., 2012). Soil productivity is closely linked with soil organic matter status. Organic amendments play an important role in the improvement of soil structure and soil organic matter content (Meelu *et al*.,1994). Farmyard manure (FYM)/compost, Cow-dung Urine Mixture (CDU), Poultry Manure (PM) and crop stubbles are important sources of organic matter in case of rice crop. Among the technological options, hybrid rice as the commercially viable technology with 15 – 20 per cent yield advantage over the best inbred (Virmani,1996) varieties seems to be an important step towards augmentation of rice yield. Hybrids as a rule, due to their higher yield need more nutrients than a variety and further information on the response of hybrid rice to integrated nutrient management practices is lacking in the state. Considering the importance, the details of a study on assessment of the conjunctive use of organic and inorganic nutrient management on economics and quality of hybrid rice (*Oryza sativa* L.) in terms of soil-fertility and yield stability using data generated from a two years experiment are described here.

MATERIAL AND METHODS

The field trial was conducted to two consecutive years during *Kharif* 2002 and 2003 on hybrid rice (*Oryza sativa* L.) under irrigated condition at Research farm, Indira Gandhi Krishi Vishwavidyalaya,, Raipur, Chhattisgarh. Experiment was comprised of different levels of inorganic fertilizer and its conjunction with different organic fertilizers. In all 12 treatments, comprising of different N, P and K levels and its conjunction with organic fertilizers were laid out in Randomized Block Design with 3 replications). The soil of experiments was clay-loam in texture (*Vertisols*), neutral in reaction (pH 7.4), medium in organic carbon (0.52%) low in available N (216 kg/ha), medium in available P (18.35 kg/ha) and high in available K (325 kg/ha). Rice hybrid cultivar *'Sahyadri'* was used as the test crop. The treatments were 150:80:60 kg NPK ha^{-1} (T_1); 100:60:40 kg NPK ha^{-1} (T_2); 50:30:20 kg NPK ha^{-1} (T_3); T_3 + FYM 10 t ha^{-1} (T_4); T_3 + BL of N with CDU (T_5); T_3 + PM 3t ha^{-1} (T_6); T_3 + SRN (NC treated N) (T7); T_2 + FYM 3t ha^{-1} (T_8); T_2 + BL of N with CDU (T_9); T_2 + PM 3t ha^{-1} (T_{10}); T_2 + SRN (NC treated N) (T_{11}) and No N, P and K (T_{12}). The total rainfall of 208.66 mm was received during *Kharif* 2002 and 349.73 mm during 2003. It was laid out in Randomized Block Design (RBD) with three replications. One seedling hill-1 was planted with the spacing of 20 cm x 15 cm. Cow-dung urine mixture was prepared by taking cow-dung and urine in ratio of 9:7. The decomposition of cow-dung was made following a simulated technique of biogas slurry preparation.

Quality characters:

Physical quality characters :

Observation on milling and head rice recovery (percentage) was recorded on the basis of 100 g seed sample collected from each plot. These samples were hulled and milled by Stake huller and miller and milling percentage and head rice recovery was calculated.

Kernel length and breadth (*mm*):

Ten milled grains were taken and average length and breadth were recorded in millimeter.

Kernel length: breadth ratio :

This was calculated by the following formula:

$$\text{Lenght : breadth ratio of kemel} = \frac{\text{Length of milled grains}}{\text{Breadth of milled grains}}$$

Kernel length after cooking (*mm*) (*KLAC*):

Sample of 5 g milled rice was taken for each plot and was embedded in 12 ml of distilled water for 10-12 minutes, followed by cooking for 15 minutes. The cooked rice kernels were transferred to Petri plates covered with filter paper. Ten cooked kernels were taken and their length measured individually (Pellaijar and Mahandos, 1988).

Length breadth ratio of cooked rice:

This was calculated by the following formula:

$$\text{Lenght : breadth (Cooked rice)} = \frac{\text{Length of cooked grains}}{\text{Breadth of cooked grains}}$$

Elongation ratio (*ER*):

This was calculated by the following formula:

$$\text{Elongation ratio} = \frac{\text{Length of cooked kernel}}{\text{Length of row kernel}}$$

Physio-chemical quality characters:

Amylose content (*%*):

Cleared rice samples were kept in the same room for two days to develop uniform moisture content. Grinding of the samples was done through welly mill using 60 mesh sieves. The 100 mg ground sample, weighed in duplicate was taken in 100 ml volumetric flask, 4 ml of absolute methanol was added in each flask carefully to wash down any powder sample adhering to the sides of flask. Flasks were kept in standing position for 2½ hours. The methanol was then removed with the help of pipette carefully. 1 ml of ethanol and 9 ml sodium hydroxide (1N) was now added with the help of burette without disturbing the samples. Then samples were heated for 10 minutes vigorously on boiling water bath and later on volume was made up to 100 ml with distilled water and mixed well by uniform shaking. Then, in each 100 ml volumetric flask containing 50 ml of water, place the aliquots (5 ml) of each sample.

The 1 ml acetic acid (1N) was added and mixed well. Freshly prepared iodine reagent (2 ml) was added and the volume was made upto 100 ml with distilled solution containing 1 ml acetic acid (1N) and freshly prepared iodine reagent (2 ml) in 100 ml volumetric flask. This was kept for 20 minutes and afterwards transmission at 620 mm was read with the use of blank. The per cent amylase was calculated with the use of standard curve of potato amylase of the concentration 4 x 10^{-2} mg/ml under identical conditions (Juliano, 1971). The data collected from field observations and statistical analysis by standard analysis of variance technique as described in "Statistical procedures for Agricultural Research" by (Gomez and Gomez,1984).

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Yield components (fertile grain panicle^{-1} and sterility percentage):

Data pertaining to yield attributing characters *i.e.* effective tillers panicle length, test weight, fertile grain panicle^{-1} and sterility percentage are embodied. These

Table 1: Effect of organic and inorganic fertilizer on yield components and sterility per cent of hybrid rice

Treatments	Fertile grains panicle^{-1}, No.		Sterility, %	
	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	152.05	154.09	17.59	17.87
T_2: 100:60:40 kg NPK ha^{-1}	150.08	150.50	16.42	17.21
T_3: 50:30:20 kg NPK ha^{-1}	119.66	120.06	15.45	15.92
T_4: T_3 + FYM 10 t/ha^{-1}	144.93	145.25	15.94	17.14
T_5: T_3 + BL of N with CDU	146.36	148.81	13.79	14.18
T_6: T_3 + PM 3 t/ha^{-1}	145.78	146.02	13.40	14.21
T_7: T_3 + SRN (NC treated N)	146.36	147.92	13.50	14.77
T_8: T_2 + FYM 3 t/ha^{-1}	149.52	150.84	14.47	17.68
T_9: T_2 + BL of N with CDU	150.12	153.07	14.38	14.57
T_{10}: T_2 + PM 3 t/ha^{-1}	150.24	153.18	17.59	14.82
T_{11}: T_2 + SRN (NC treated N)	149.79	151.47	16.92	14.52
T_{12}: T_1 + BGA	-	158.72	-	18.26
T_{13}: T_1 + PSB	-	155.22	-	18.10
T_{14}: Control (No NPK)	116.44	116.61	13.79	15.44
S.E.±	0.75	1.90	0.29	0.19
C.D. (P=0.05)	2.17	5.79	0.81	0.53

characters however, were significantly influenced due to application of inorganic fertilizers and conjunctive use of inorganic and organic fertilizer. The effective tillers, panicle length, fertile grains panicle^{-1} and test weight significantly increased with increasing level of inorganic fertilizer from 50:30:20 kg NPK ha^{-1} to 150:80:60 kg NPK ha^{-1} during both the years. As regard to conjunctive use of organic and inorganic fertilizers, application of inorganic level of 100:60:40 kg NPK ha^{-1} along with organic fertilizer as BL of N with CDU or PM (T_9 and T_{10}) were found to be statistically at par to that of inorganic level 150:80:60 kg NPK ha^{-1} for above yield components during both the years. Almost similar trend was noticed when said organic fertilizer was combined with lower level of inorganic fertilizer (50:30:20 kg NPK ha^{-1}), which tended to produce above yield components comparable to that of inorganic fertilizer level of 100:60:40 kg NPK ha^{-1}.

The conjunction of lowest level of inorganic fertilizer *i.e.* 50:30:20 kg NPK ha^{-1} with PM or CDU gave the lowest sterility percentage during the years of 2002 and 2003. These treatments were however, comparable to that of T_8, T_9 and T_{14} treatments. The additional treatments T_1 + BGA (T_{12}) or PSB (T_{13}) studied during 2003 also found to be equally effective to that of application of inorganic fertilizer of 150:80:60 kg NPK ha^{-1} (T_1). Moreover, at this level, additional advantage from BGA (T_{12}) or PSB (T_{13}) could not be noticed. The lower level of inorganic fertilizer along with organic could not be comparable to that of inorganic fertilizer level of 100:60:40 kg NPK ha^{-1} (T_2). This was true for both the years of experimentation. The control (T_{14}) treatment gave the lower value of yield attributes of hybrid rice during both the years, which was significantly inferior than those of other treatments.

Grain quality :

Hulling and milling percentage, kernel length, kernel breadth and kernel L:B ratio:

The grain quality was significantly influenced due to application of different inorganic fertilizer levels and conjunctive use of inorganic and organic fertilizers. Among the inorganic fertilizer levels, increasing level of nutrients from 50:30:20 kg NPK ha^{-1} to 100:60:40 kg NPK ha^{-1} significantly increased the hulling and milling percentage and length and breadth of kernel during both the years. Further increase in inorganic level of fertilizer to150:80:60 kg NPK ha^{-1} increased the above grain quality parameters over inorganic fertilizer level of 100:60:40 kg NPK ha^{-1}. On the other hand, conjunctive use of inorganic nutrient level of 100:60:40 kg NPK ha^{-1} along with organic fertilizer of FYM or BL of N with CDU or PM (T_8, T_9 and T_{10}) proved to be equally effective to that of inorganic fertilizer level of 100:60:40 kg NPK ha^{-}

Table 2: Effect of organic and inorganic fertilizer on hulling percentage, milling percentage, kernel length, breadth and length: Breadth ratio of hybrid rice

Treatments	Hulling percentage		Milling percentage		Karnal length, cm		Karnal breadth, cm		Karnal L:B	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	73.63	73.69	64.69	65.48	6.54	6.44	2.87	2.89	2.28	2.23
T_2: 100:60:40 kg NPK ha^{-1}	72.84	72.89	64.69	64.85	6.17	6.14	2.78	2.84	2.22	2.16
T_3: 50:30:20 kg NPK ha^{-1}	69.87	69.93	58.97	59.32	5.46	5.49	2.30	2.31	2.37	2.38
T_4: T_3 + FYM 10 t/ha^{-1}	70.90	71.83	63.50	64.43	5.62	5.60	2.51	2.54	2.24	2.20
T_5: T_3 + BL of N with CDU	71.50	71.55	62.80	63.97	5.57	5.58	2.39	2.41	2.33	2.32
T_6: T_3 + PM 3 t/ha^{-1}	71.69	71.73	63.49	64.21	5.58	5.58	2.43	2.45	2.29	2.28
T_7: T_3 + SRN (NC treated N)	71.47	71.50	62.67	63.70	5.55	5.58	2.32	2.36	2.39	2.36
T_8: T_2 + FYM 3 t/ha^{-1}	72.67	72.59	64.43	64.66	5.92	5.85	2.67	2.79	2.22	2.10
T_9: T_2 + BL of N with CDU	73.69	73.71	66.45	66.56	6.39	5.89	2.86	2.82	2.23	2.09
T_{10}: T_2 + PM 3 t/ha^{-1}	73.59	73.64	64.59	65.35	6.43	5.93	2.86	2.89	2.25	2.05
T_{11}: T_2 + SRN (NC treated N)	72.59	72.61	63.75	64.57	5.83	5.68	2.60	2.57	2.24	2.21
T_{12}: T_1 + BGA	-	73.79	-	67.43	-	6.55	-	2.90	-	2.26
T_{13}: T_1 + PSB	-	73.62	-	67.03	-	6.51	-	2.87	-	2.27
T_{14}: Control (No NPK)	69.68	69.72	60.72	62.43	4.93	4.95	2.23	2.26	2.21	2.19
S.E.±	0.36	0.48	0.79	0.94	0.33	0.31	0.11	0.13	0.01	0.02
C.D. (P=0.05)	1.03	1.21	2.03	2.79	0.89	0.91	0.32	0.37	NS	NS

[1] for said grain quality parameters. The L:B ratio of kernel was not influenced due to application of nutrients. The lowest hulling, milling kernel length and breadth was observed under control treatment which was significantly inferior than rest of the treatments.

Kernel length after cooking (KLAC), Elongation ratio (ER) and Amylose contents:

The KLAC, ER and amylose content were observed for cooked rice, which were greatly influenced due to application of different levels of inorganic fertilizer and conjunctive use of inorganic and organic fertilizer during both the years. Among the various treatments, application of 100:60:40 kg NPK ha^{-1} in conjunction with PM gave the highest values of KLAC, ER and amylose content, which was significantly superior to other treatments except those where inorganic fertilizer level of 100:60:40 kg NPK ha^{-1} was applied along with organic

Table 3: Effect of organic and inorganic fertilizer on KLAC, mm, ER and amylose content of hybrid rice

Treatments	KLAC, mm		ER		Amylose content	
	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	8.07	8.11	1.83	1.85	22.34	22.39
T_2: 100:60:40 kg NPK ha^{-1}	7.50	7.53	1.57	1.58	21.75	21.76
T_3: 50:30:20 kg NPK ha^{-1}	7.33	7.36	1.36	1.39	21.24	21.26
T_4: T_3 + FYM 10 t/ha^{-1}	7.46	7.51	1.56	1.58	21.67	21.71
T_5: T_3 + BL of N with CDU	7.41	7.45	1.47	1.49	21.40	21.41
T_6: T_3 + PM 3 t/ha^{-1}	7.45	7.50	1.49	1.53	21.59	21.63
T_7: T_3 + SRN (NC treated N)	7.37	7.39	1.38	1.42	21.31	21.33
T_8: T_2 + FYM 3 t/ha^{-1}	7.55	7.57	1.64	1.67	22.08	22.10
T_9: T_2 + BL of N with CDU	7.59	7.61	1.79	1.80	22.19	22.23
T_{10}: T_2 + PM 3 t/ha^{-1}	7.63	7.65	1.80	1.82	22.27	22.28
T_{11}: T_2 + SRN (NC treated N)	7.54	7.55	1.59	1.60	21.86	21.88
T_{12}: T_1 + BGA	-	8.17	-	1.87	-	22.42
T_{13}: T_1 + PSB	-	7.71	-	1.81	-	22.25
T_{14}: Control (No NPK)	6.97	7.01	1.30	1.34	21.18	21.19
S.E.±	0.19	0.21	0.06	0.03	0.08	0.07
C.D. (P=0.05)	0.49	0.58	0.17	0.08	0.23	0.21

Table 4: Effect of organic and inorganic fertilizer on cost incurred, grass realization, net realization and return rupees^{-1} invested ha^{-1} on hybrid rice

Treatments	Cost incurred, Rs. ha^{-1}		Gross realization, Rs. ha^{-1}		Net realization, Rs. ha^{-1}		Return $rupee^{-1}$ invested	
	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	20172	20741	40718	41121	28528	28310	1.41	1.36
T_2: 100:60:40 kg NPK ha^{-1}	18757	19320	35364	36114	24045	24410	1.29	1.24
T_3: 50:30:20 kg NPK ha^{-1}	17560	18122	26762	25900	14588	12886	0.83	0.71
T_4: T_3 + FYM 10 t/ha^{-1}	20060	20622	36137	36618	23259	23491	1.16	1.14
T_5: T_3 + BL of N with CDU	18310	18872	33482	34849	21944	23067	1.20	1.22
T_6: T_3 + PM 3 t/ha^{-1}	18910	19472	36624	37324	25039	25266	1.32	1.30
T_7: T_3 + SRN (NC treated N)	17960	18522	29786	31629	17768	19342	0.98	1.04
T_8: T_2 + FYM 3 t/ha^{-1}	19497	20061	38114	38836	26268	26566	1.35	1.32
T_9: T_2 + BL of N with CDU	19638	20203	39032	39861	27142	27536	1.38	1.36
T_{10}: T_2 + PM 3 t/ha^{-1}	20097	20661	40135	40829	27950	27386	1.39	1.33
T_{11}: T_2 + SRN (NC treated N)	19147	19710	37492	38220	25957	26209	1.35	1.32
T_{12}: T_1 + BGA	-	21439	-	41619	-	28219	-	1.32
T_{13}: T_1 + PSB	-	20344	-	41261	-	27851	-	1.36
T_{14}: Control (No NPK)	16302	16863	13703	14358	697	1098	0.04	1.07

fertilizer of FYM or BL of N with CDU or 50:30:20 kg NPK ha^{-1} supplemented with FYM or BL of N with CDU. These treatments were comparable to each other for KLAC, ER and amylose content during both the years. Among the inorganic nutrient levels, application of 50:30:20 kg NPK ha^{-1} was found to be significantly inferior than those of 100:60:40 and 150:80:60 kg NPK ha^{-1} for KLAC, ER and amylose content in rice grain. The later both levels were equally effective for above grain quality parameters. The lowest KLAC, ER and amylose content were noticed under no NPK (control).

Economics:

The highest input cost, net profit and $rupee^{-1}$ investment was calculated under the treatment of inorganic level of 150:80:60 kg NPK ha^{-1} followed by application of 100:60:40 kg NPK ha^{-1} along with PM during both the year. Maximum gross realization was obtained under inorganic level of 150:80:60 kg NPK ha^{-1} followed by inorganic level 100:60:40 kg NPK ha^{-1} along with organic sources BL of N with CDU (T_9) and PM (T_{10}) during 2002. The addition of BGA (T_{12}) and PSB (T_{13}) along with higher level of inorganic fertilizer 150:80:60 kg NPK ha^{-1} tested during the year 2003 gave maximum gross realization followed by 150:80:60 kg NPK ha^{-1} (T_1), 100:60:40 kg NPK ha^{-1} + BL of N with CDU (T_9) and 100:60:40 kg NPK ha^{-1}+ PM (T_{10}). The said economical parameters were the lowest under control during both the years.

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