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RESEARCH PAPER

Productivity and nutrient use efficiency of hybrid rice (*Oryza sativa* L.) in response to integrated use of organic and inorganic sources of nutrients

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Abstract : An experiment was carried out during the *Kharif* 2002 and 2003, to study the productivity and nutrient use efficiency of hybrid rice (*Oryza sativa* L.) in response to integrated use of organic and inorganic sources of nutrients at Research farm, IGAU, Raipur (CG). 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 results revealed that application of inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} significantly increased number of active leaf, leaf area, leaf area index and dry matter accumulation at later stages as compared to lower level of inorganic fertilizer. The conjunction of 100:60:40 kg NPK ha^{-1} along with PM or N blended with CDU found to be equally effective to that of inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} for above growth parameters. The chlorophyll content during crop period under above level was the highest under said treatment. The highest crop growth rate was observed between 60-90 DAT followed by 90 DAT-harvest and 30-60 DAT, respectively. The per day accumulation of dry matter during 60-90 DAT period was almost three to four times of that accumulated during 30-60 DAT. Thereafter growth rate almost declined till maturity during both the years.The increased concentration of N at different growth stages and its uptake by plant helped in increasing the yield components and grain yield. The critical analysis of grain yield observations revealed that conjunction of lower levels of inorganic fertilizer (100:60:40 or 50:30:20 kg NPK ha^{-1}) along with CDU or PM gave the saving of 50 kg N, 20 kg P and 20 kg K ha^{-1} for the cultivation of hybrid rice. Moreover, the higher buildup of available N and K has been also observed under said combination of organic and inorganic fertilizer treatments. The application of 150:80:60 kg NPK ha^{-1} along with PSB gave the highest buildup of available phosphorus. Inorganic level of 150:80:60 kg NPK ha^{-1} gave the highest production efficiency and productivity rating index, which was followed by application of inorganic fertilizer of 100:60:40 kg NPK ha^{-1} along with PM and blending of N with CDU, respectively. The application inorganic fertilizer of 50:30:20 kg NPK ha^{-1} + PM gave the highest nutrient efficiency during both the years. 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 : Nitrogen, Phosphorus, Potassium, Balance sheet, Cholorophyll content, Leaf area index, Active leaf, Nutrients, Hybrid rice

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INTRODUCTION

Rice (*Oryza sativa* L .) is the second most widely consumed cereal in the world next to wheat. it is the most important and extensively cultivated food crop

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grown in tropical and sub tropical region which provides half of the daily food for one of every three persons on the earth. About 70% of the world population takes rice as staple food while in Asia alone, more than 2 billion people 60-70% of their energy intake from rice and its derivatives (Kumari *et al*., 2014). Its cultivation supports livelihood for more than 2 billion people. Rice is the major crop in India and occupies the largest cropped area of 43.19 million ha with annual production of 110.15 million tons and productivity of 2.55 tons/ha (Anonymous, 2017). The productivity of rice in India is quite low compared to China (6.2 tons/ha) and Japan (6.5 tons/ha). With increasing population, India will have to produce more rice to meet the growing demand which is likely to be 130 million tons of rice by 2030. The productivity of rice in Chhattisgarh is around 1.3 ton/ha, which is extremely low as compared to the national productivity. This big yield gap can be bridged with the introduction of improved cultivars of rice hybrids and soil, water, nutrient, weeds, insects and pest management parties.The high-yielding cultivars of hybrid rice, which have higher nutrient requirements, the use of inorganic fertilizers alone has increased considerably imbalance of nutrients in soil (Hossain and Singh, 2000). Perverse to detrimental effects of inorganic fertilizers, organic manures are available indigenously which improve soil health resulting in enhanced crop yield. However, the use of organic manures alone might not meet the plant requirement due to limited availability and presence of relatively low levels of nutrients (Kumar *et al*., 2014). It is widely recognized that neither use of organics alone nor chemical fertilizers can achieve the sustainability of the yield under the modern intensive farming. Therefore, adoption of modern integrated nutrient management (INM) farming practices consisting chemical fertilizers in conjunction with application of organics such as FYM, crop residues, industrial and urban wastes, poultry manures are essential to produce rice crop of standards quality and in enough quantity (Ramalakshmi *et al*., 2012). Since, much attention has not been paid on the integrated use of organic and inorganic fertilizers on rice crop, the present research work was conducted.

MATERIAL AND METHODS

The studies were conducted at the at Research farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during *Kharif* 2002 and 2003 on hybrid rice (*Oryza sativa* L.) under irrigated condition, to screen productivity and nutrient use efficiency of hybrid rice (*Oryza sativa* L.) in response to integrated use of organic and inorganic sources of nutrients. These experiment comprised a series of different integrated nutrient management practices. 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) (T_7); 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}). One seedling $hill^{-1}$ was planted with the spacing of 20 cm x 15 cm.

Number of leaves :

Total number of leaves $hill^{-1}$ were counted from ten tagged hills of each plot at different intervals. Active leaves included newly emerged folded leaves and leaves with more than 50 % greenness. Dead or dry leaves were excluded. The average number of leaves was worked out.

Leaf area :

Leaf area was recorded manually at 30, 60 and 90 DAT. The leaves of selected plants were collected and grouped into 3 categories according to their length and width and then one representative leaf of each group was traced on a graph paper to find out the length and breadth. The leaf area was worked out by following formula :

Leaf area (cm^2) = Length (cm) x width (cm) x Correction factor (K)

Correction factor (K) used was 0.75 as suggested by IRRI (1972).

Chlorophyll content:

The chlorophyll "a" and "b" as well as total chlorophyll content of third leaf from top were determined at 60 DAT by acetone extraction procedure (Yoshida *et*

al., 1972), Chlorophylls "a" and "b" and total chlorophyll were calculated by using the following formula :

$$\text{Chlorophyll "a"} = \frac{12.7 \times A\,663 - 269 \times A\,645}{a \times 1000 \times W} \times V$$

$$\text{Chlorophyll "b"} = \frac{22.9 \times A\,645 - 468 \times A\,663}{a \times 1000 \times W} \times V$$

$$\text{Totalchlorophyll} = \text{Chl "a"} + \text{Chl "b"} \text{ or } \frac{A\,652 \times V}{34.5 \times W} \times V$$

where,

A= Absorbance or optical density a = Length of light path 1cm

W = Weight of sample V = Volume of solution.

Dry matter production :

In order to get dry matter production hill^{-1}, five hills, in each plot were carefully uprooted and the dry wt. was taken after oven drying at 60^{0}C for 48 hours at different intervals. Then average dry wt. hill^{-1} was worked out.

Computation on crop growth parameters :

Leaf area index (*LAI*):

The leaf area index was calculated by the following formula :

$$\text{Leaf area index (LAI)} = \frac{\text{Total leaf area (cm}^2\text{)}}{\text{Total ground area (cm}^2\text{)}}$$

Crop growth rate (*CGR*):

The mean crop growth rate was calculated with the help of the following formula :

$$\text{Crop growth rate, g day}^{-1}\text{ plant}^{-1} = \frac{W_2 = W_1}{t_2 - t_1}$$

where, W_2 and W_1 are the total dry weight of plant at the time t_2 and t_1, respectively

Relative growth rate (*RGR*):

The mean relative growth rate was worked out with the help of following formula:

$$\text{Relative growth rate (RGR), g}^{-1}\text{ day}^{-1}\text{ hill}^{-1} = \frac{\text{lnw}_2 - \text{lnw}_1}{T_2 - T_1}$$

where, lnw_1 and lnw_2 are the natural logarithm of total dry weight of plant hill^{-1} at the time interval T_1 and T_2.

Computation of crop yield parameters:

Productivity rating indices (*PRI*):

The productivity rating indices for different treatments of hybrid rice were determined in vertisols. The actual yield data were used for calculating PRI. It was calculated by using the following formula:

$$\text{PRI} = \frac{\text{Average yield of hybrid rice (q ha}^{-1}\text{) obtained from experimental plot}}{\text{Standard yield of hybrid rice (q ha}^{-1}\text{)}} \times 100$$

Where, the term standard yield was used for the maximum possible yield of hybrid rice (Proagro-6201) as reported in directorate of rice research bulletin, Hyderabad, to be 61.0 q ha^{-1} (Ahmad *et al.,* 2000).

Production efficiency :

Production efficiency of hybrid rice was calculated by using formula as follows :

$$\text{PE, kg ha}^{-1}\text{ day}^{-1} = \frac{\text{Seed yield, kg ha}^{-1}}{\text{Duration of the crop (days)}}$$

Chemical analysis:

N, P and K contents and uptake in plant and soil :

Soil samples were analyzed for available nitrogen, phosphorus, potassium, pH and organic carbon. Three soil samples were collected from 20 cm depth from each plot. Composite soil samples were sun dried and ground and passed through 2 mm sieve. Available soil nitrogen was determined by alkaline potassium permanganate method described by Subbiah and Asija (1956). Available phosphorus was extracted by the method described by Olsen *et al*. (1954). Available K was extracted by neutral normal ammonium acetate (pH 7) and determined with the help of flame photometer as described by Jackson (1967). Soil pH was determined by pH meter from 1:2.5 Soil : Water ratio.Walkley determined organic carbon and Black's rapid titration method as described by Piper (1967). Rice plant samples, grains and straw samples were collected from individual plots separately at 30, 60 and 90 DAT and at harvest, analysed for nitrogen (Micro Kjeldahl method), phosphorus (Vanadomolybdo phosphoric yellow colour method) and potassium (Flame photometry) contents (Jackson, 1967). N, P and K uptake was computed by multiplying the dry weight with respective concentrations. Nutrient uptake= Concentration (%) x dry mater yield (q ha^{-1}) or (kg ha^{-1}).

Soil analysis :

Available nitrogen in soils was determined by alkaline potassium permanganate method, as suggested by Subbiah and Asija, (1956). Whereas, available P was extracted by 0.05 N $NaHCO_3$ (pH 8.5) as suggested by

Olsen (1954). The available K was determined by flame photometer (Jackson, 1967).

Balance sheet :

Nitrogen, phosphorus and potassium balance sheets were prepared taking into account the initial nutrient content, amount added through organic and inorganic sources, plant uptake and the final nutrient content in the soil at harvest (Sarawagi *et al.*, 1999).

Plant analysis:

Grain and straw samples collected from individual plots at harvest were separately analyzed for N, P and K contents. The nitrogen was determined by using Micro Kjeldahl method as described by Subbiah and Asija (1956). Whereas, phosphorus was determined by vanadomolybdo phosphoric acid yellow colour method, using blue filter. The potassium was determined by flame photo meter (Jackson, 1987).

RESULTS AND DISCUSSION

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

Number of active leaves:

Number of active leaves recorded at different crop growth stages have been presented in Table 1. It was clearly observed that irrespective of the treatments, number of active leaves increased up to 60 DAT and declined thereafter. As regards to treatments comparison, among different levels of inorganic fertilizer, the increasing levels of fertilizer from 50:30:20 kg NPK ha^{-1} (T_3) to 150:80:60 kg NPK ha^{-1} (T_1) significantly increased the number of active leaves at all the growth stages.Whereas, when inorganic fertilizer level of 100:60:40 kg NPK ha^{-1} (T_2) was combined with organic fertilizer of either PM or N was blended with CDU (T_9 and T_{10}) produced more active leaves than that of inorganic level of 100:60:40 kg NPK ha^{-1}. Moreover, the said conjunction of organic and inorganic fertilizer produced the comparable number of active leaves to that of inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} (T_1).This was true for all the stages during both the years. The additional treatments of 150:80:60 kg NPK ha^{-1} + BGA (T_{12}) or PSB (T_{13}) tested during 2003 only also produced number of active leaves comparable to that of 150:80:60 kg NPK ha^{-1} (T_1). The lowest number of active leaves was observed under control (T_{14}) at all the stages during both the years.

Leaf area and Leaf area index :

The leaf area (LA) and leaf area index (LAI) were observed at 30, 60, 90 DAT and at harvest (Fig. 1 and

Table 1: Effect of organic and inorganic fertilizer on number of active leaves, leaf area index, dry matter accumulation, g $hill^{-1}$ at successive stages of hybrid rice

Treatments	Number of active leaves		Leaf area index		Dry matter accumulation, g $hill^{-1}$	
	Harvest		Harvest		Harvest	
	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	31.56	32.89	2.25	2.27	63.22	62.53
T_2: 100:60:40 kg NPK ha^{-1}	25.45	26.57	2.19	2.23	54.70	54.50
T_3: 50:30:20 kg NPK ha^{-1}	18.21	20.32	1.35	1.36	47.04	49.62
T_4: T_3 + FYM 10 t/ha^{-1}	23.91	25.26	1.97	1.99	53.74	53.44
T_5: T_3 + BL of N with CDU	21.80	22.51	1.84	1.87	50.24	52.07
T_6: T_3 + PM 3 t/ha^{-1}	21.93	22.73	1.90	1.92	51.43	52.72
T_7: T_3 + SRN (NC treated N)	20.39	22.39	1.66	1.68	48.67	50.97
T_8: T_2 + FYM 3 t/ha^{-1}	26.28	27.49	2.23	2.25	58.96	56.20
T_9: T_2 + BL of N with CDU	27.32	28.56	2.24	2.26	58.55	57.35
T_{10}: T_2 + PM 3 t/ha^{-1}	28.58	29.40	2.24	2.27	60.47	57.41
T_{11}: T_2 + SRN (NC treated N)	25.67	27.03	2.21	2.24	55.70	55.20
T_{12}: T_1 + BGA	-	34.77	-	2.28	-	64.39
T_{13}: T_1 + PSB	-	33.30	-	2.26	-	59.23
T_{14}: Control (No NPK)	17.33	19.00	1.31	1.33	37.64	42.74
S.E.±	1.48	2.03	0.013	0.011	2.49	2.39
C.D. (P=0.05)	4.29	6.31	0.04	0.03	4.99	7.02

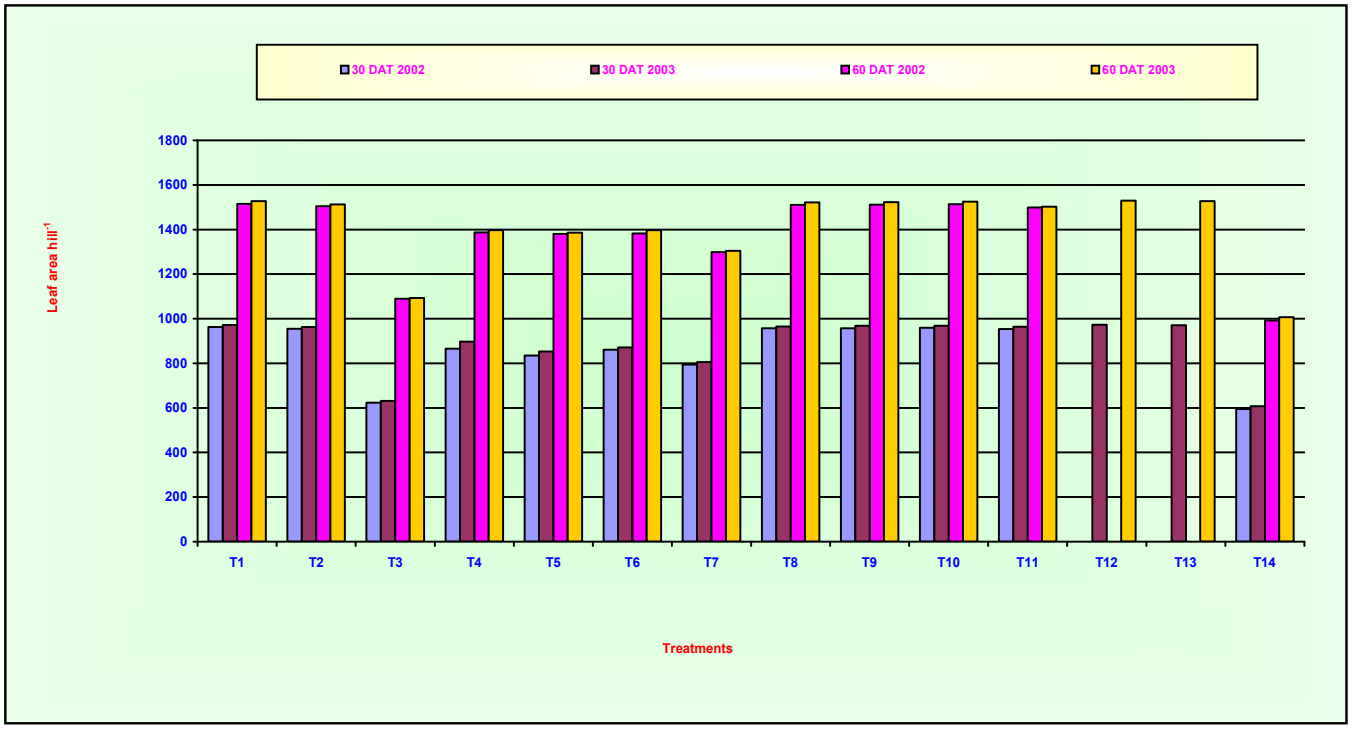

Fig 1 : Effect of organic and inorganic fertilizer on leaf area hill^{-1} at successive stages of hybrid rice

Table 1). It is clear from the table that under all the treatments, expansion of leaf continued upto 60 days stage and declined thereafter, which is reflected by data observed at 90 DAT and at harvest stage of the crop. The highest LA was observed under the application of inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} (T_1), which was significantly superior than other treatments except those, where inorganic fertilizer of 100:60:40 kg NPK ha^{-1} (T_2) applied along with organic fertilizer of either FYM or PM or BL of N with CDU (T_8, T_9 and T_{10}). This was true during both the years at all the stages for LA and at harvest for LAI. Furthermore, in case of LAI at 30, 60 and 90 DAT, significant increase was observed with increasing levels of inorganic fertilizers from 50:30:20 kg NPK ha^{-1}(T_3) to 100:60:40 kg NPK ha^{-1} (T_2). At these stages LAI remained at par under the inorganic fertilizer levels of 150:60:40 (T_1) and 100:60:40 kg NPK ha^{-1} or T_2 + FYM or PM or BL of N with CDU during both the years. The additional treatments of 150:80:60 kg NPK ha^{-1} applied in combination with BGA (T_{12}) or PSB (T_{13}) during 2003 failed to bring any benefit over application of inorganic fertilizer of 150:80:60 kg NPK ha^{-1} for LA and LAI. The lowest leaf area index (LAI) and leaf area (LA) was observed under control (T_{14}) treatment at all the stages during both the year

Chlorophyll content in leaves :

The chlorophyll a, b and total chlorophyll content in leaves analyzed at 75 and 85 DAT were influenced significantly due to application of inorganic and organic fertilizer (Table 2). The value was found to be the highest at 75 DAT and gradually decreased at 85 DAT. During both the stages and years, chlorophyll a, b and total increased significantly with increasing level of inorganic fertilizer from 50:30:20 kg NPK ha^{-1} to 150:80:60 kg NPK ha^{-1}. When inorganic fertilizer level of 100:60:40 kg NPK ha^{-1} was combined either with FYM or N blended with CDU or PM (T_8, T_9 and T_{10}), it gave chlorophyll content similar to that of inorganic fertilizer of 150:80:60 kg NPK ha^{-1}. Moreover, the application of above organic fertilizers along with inorganic fertilizer of 100:60:40 kg NPK ha^{-1} were found to be significantly better than that of application of inorganic fertilizer 100:60:40 kg NPK ha^{-1} alone at both the stages and years for a, b and total chlorophyll content in leaves. The application of BGA or PSB along with higher level of inorganic fertilizer (150:80:60 kg NPK ha^{-1}) did not bring any improvement in chlorophyll a, b and total over inorganic fertilizer of 150:80:60 kg NPK ha^{-1}. The lowest chlorophyll a, b and total were observed under control treatment during both the years and stages.

Dry matter accumulation (*DMA*):

Observations on dry matter accumulation were recorded at 30, 60 and 90 DAT and at the time of harvest (Table 1). The plants continued to acquire dry matter with their advancing growth stages, but in general, the rate of increase in dry weight was more from 60 DAT onwards. At 30 DAT, the increasing level of inorganic fertilizer from 50:30:20 kg NPK ha^{-1} to 100:60:40 kg NPK ha^{-1} significantly increased the DMA. Further increase in crop age to 60 DAT onwards the increase in DMA was observed upto, inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} as compared to lower levels. The application of lowest level of inorganic fertilizer (50:30:20 kg NPK ha^{-1}) along with FYM also produced comparable dry matter to that of inorganic fertilizer of 100:60:40 kg NPK ha^{-1}. Moreover, the addition of BGA or PSB along with 150:80:60 kg NPK ha^{-1} (T_{12} and$_{13}$) failed to bring any additional increase in dry matter accumulation over said level of inorganic fertilizer at all the stages of crop growth during 2003. As regard to conjunctive use of organic and inorganic fertilizers application of 100:60:40 kg NPK ha^{-1} (T_2) combined with organic sources of either FYM or BL of N with CDU or PM or SRN (NC treated N) (T_8, T_9, T_{10} and T_{11}) gave the comparable dry matter accumulation to that of inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} (T_1). Furthermore, the addition of above organic fertilizer along with T_2 also accumulated significantly higher dry matter than that of T_2 alone. The lowest dry matter accumulation was observed under control (T_{14}) during both the years at all the stage.

Crop growth rate and relative crop growth rate:

Crop growth rate of hybrid rice was calculated between 30-60 and 60-90 DAT and 90 DAT – harvest intervals (Fig. 2 and 3). It was very interesting to note that, irrespective of treatments plants continued to accumulate dry matter till maturity. The highest crop growth rate was observed to be between 60-90 DAT followed by 90 DAT – harvest and 30-60 DAT. The per day accumulation of dry matter during 60-90 DAT period was almost three to four times of that accumulated during 30-60 DAT, respectively. There after growth rate almost declined till maturity during both the years. Among the treatments, the highest crop growth rate was observed under inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} (T_1), which was significantly superior than that of other treatments except inorganic level of 100:60:40 kg NPK ha^{-1} applied along with FYM or BL of N with CDU or PM or SRN (T_8, T_9, T_{10} and T_{11}). These treatments were statistically at par to that of inorganic level of 150:80:60 kg NPK ha^{-1} between 30-60 DAT and 60-90 DAT intervals during both the years. The additional treatments (T_1 + BGA or PSB) studied during 2003 only were also found to be equally effective to that of

Table 2: Effect of organic and inorganic fertilizers on Chlorophyll content in flag leaf at successive stages of hybrid rice

Treatments	Chlorophyll at 75 DAT, mg g^{-1} fresh weight						Chlorophyll at 85 DAT, mg g^{-1} fresh weight					
	Chlorophyll(a)		Chlorophyll(b)		Total(a+b)		Chlorophyll(a)		Chlorophyll(b)		Total(a+b)	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	1.48	1.51	1.13	1.15	2.61	2.66	1.23	1.26	0.83	0.83	2.06	2.09
T_2: 100:60:40 kg NPK ha^{-1}	1.17	1.18	0.86	0.89	2.03	2.07	0.99	1.01	0.64	0.69	1.63	1.70
T_3: 50:30:20 kg NPK ha^{-1}	0.74	0.76	0.53	0.54	1.27	1.30	0.64	0.65	0.43	0.46	1.07	1.11
T_4: T_3 + FYM 10 t/ha^{-1}	1.02	1.03	0.74	0.77	1.76	1.80	0.84	0.87	0.59	0.61	1.43	1.48
T_5: T_3 + BL of N with CDU	0.87	0.89	0.68	0.71	1.55	1.60	0.75	0.79	0.52	0.56	1.27	1.35
T_6: T_3 + PM 3 t/ha^{-1}	0.90	0.92	0.72	0.75	1.62	1.67	0.79	0.81	0.50	0.53	1.29	1.34
T_7: T_3 + SRN (NC treated N)	0.87	0.88	0.70	0.72	1.57	1.60	0.69	0.73	0.47	0.48	1.16	1.21
T_8: T_2 + FYM 3 t/ha^{-1}	1.33	1.37	1.03	1.05	2.36	2.42	1.12	1.14	0.69	0.73	1.81	1.87
T_9: T_2 + BL of N with CDU	1.36	1.39	1.07	1.10	2.43	2.49	1.14	1.19	0.75	0.76	1.89	1.95
T_{10}: T_2 + PM 3 t/ha^{-1}	1.43	1.48	1.09	1.13	2.52	2.61	1.17	1.20	0.79	0.81	1.96	2.01
T_{11}: T_2 + SRN (NC treated N)	1.20	1.21	0.89	0.93	2.09	2.14	1.07	1.09	0.68	0.72	1.75	1.81
T_{12}: T_1 + BGA	-	1.54	-	1.19	-	2.73	-	1.28	-	0.86	-	2.14
T_{13}: T_1 + PSB	-	1.51	-	1.13	-	2.64	-	1.25	-	0.83	-	2.08
T_{14}: Control (No NPK)	0.63	0.65	0.52	0.53	1.15	1.18	0.54	0.57	0.42	0.43	0.96	1.00
S.E.±	0.051	0.054	0.037	0.023	0.11	0.092	0.037	0.044	0.056	0.042	0.11	0.14
C.D. (P=0.05)	0.15	0.17	0.10	0.07	0.31	0.27	0.11	0.13	0.17	0.13	0.33	0.41

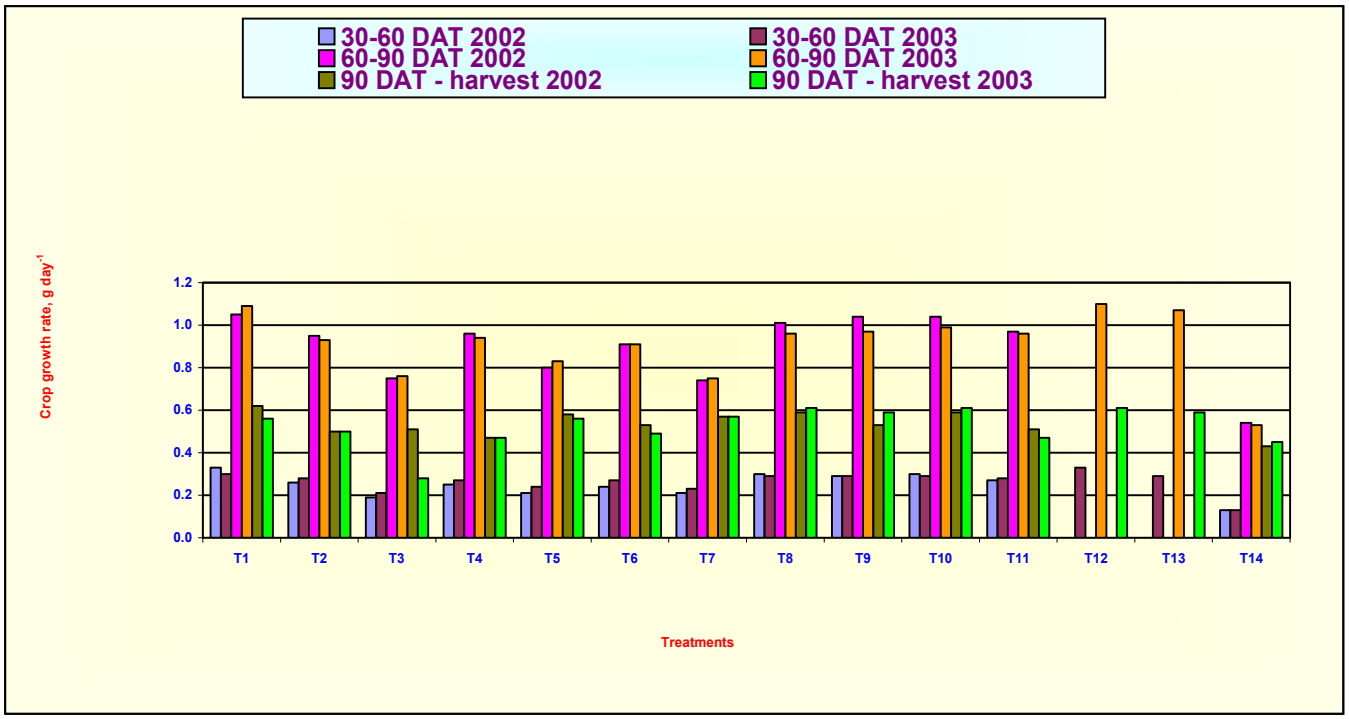

Fig 2 : Effect of organic and inorganic fertilizer on Crop growth rate, g day^{-1} at successive stages of hybrid rice

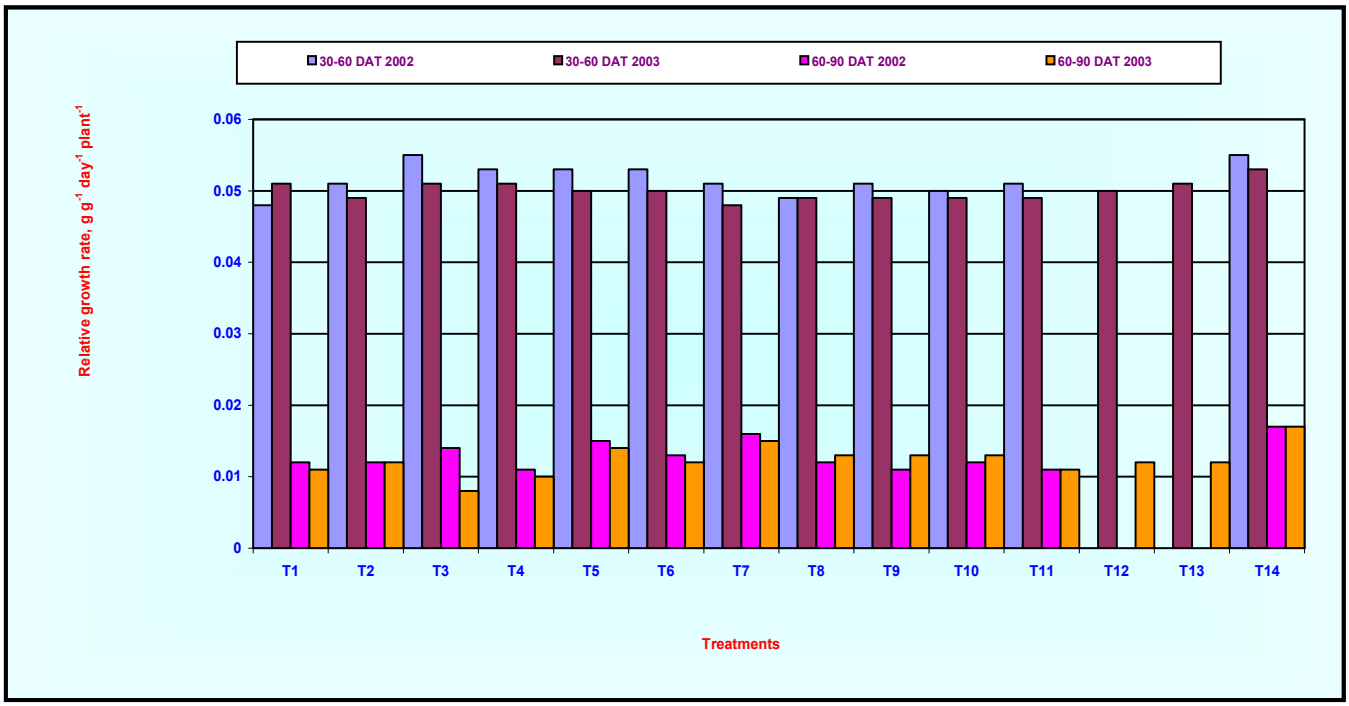

Fig 3 : Effect of organic and inorganic fertilizer on Relative growth rate, g g^{-1} day^{-1} plant^{-1}at successive stages of hybrid rice

application of inorganic fertilizer of 150:80:60 kg NPK ha^{-1} (T_1) at entire growth stages. The lower level of inorganic fertilizer 50:30:20 kg NPK ha^{-1} applied along with other organic sources increased crop growth rate as compared to 50:30:30 kg NPK ha^{-1}. The lowest crop growth rate during entire growth period was observed under control (T_{14}) treatment during both the years of investigation. A reverse trend was observed for relative

crop growth rate.

N, P and K uptake by hybrid rice:

The uptake of N, P and K was calculated at 30 and 60 DAT and at harvest for grain and straw given in Table 5. At 30 and 60 DAT, nitrogen uptake under inorganic level of 150:80:60 kg NPK ha^{-1} was significantly superior over other treatments. The addition of organic fertilizer either FYM or BL of N with CDU or PM (T_8, T_9 and T_{10}) along with inorganic fertilizer of 100:60:40 kg NPK ha^{-1} gave the comparable N uptake to that of 150:80:60 kg NPK ha^{-1}. Moreover, uptake of N by grain and straw under inorganic level of 100:60:40 kg NPK ha^{-1} (T_2) along with organic sources either BL of N with CDU or PM (T_9 and T_{10}) was found comparable to that of T_1 during both the year at 30 and 60 DAT and at harvest. The application of BGA or PSB with inorganic level of 150:80:60 kg NPK ha^{-1} tested in the year 2003 failed to bring about any additional increase in N uptake at 30 and 60 DAT and at harvest for grain and straw. Phosphorus uptake at 30 DAT was maximum under inorganic level of 150:80:60 kg NPK ha^{-1} and was followed by inorganic level of 100:60:40 kg NPK ha^{-1} applied along with either FYM or BL of N with CDU or PM or SRN during both the years. At harvest, phosphorus uptake by grain was maximum under inorganic level of 150:80:60 kg NPK ha^{-1} and was followed by inorganic level of 100:60:40 kg NPK ha^{-1} along with organic sources BL of N with CDU or PM or SRN during 2002. The additional treatment of BGA or PSB tested in the year 2003 failed to bring any additional increase in P uptake at 30 and 60 DAT for grain. Significant differences were not observed for phosphorus uptake by straw among the treatments during both the years. Potassium uptake at 30 and 60 DAT was maximum under inorganic level of 150:80:60 kg NPK ha^{-1} followed by inorganic level 100:60:40 kg NPK ha^{-1} applied along with organic sources either FYM or BL of N with CDU or PM. The application of BGA (T_{12}) or PSB (T_{13}) with inorganic level of 150:80:60 kg NPK ha^{-1} tested in the year 2003 failed to bring about any additional increase in K uptake at 30 and 60 DAT during both the years. Inorganic level of 150:80:60 kg NPK ha^{-1} was found significantly superior than other treatments except inorganic level of 100:60:40 kg NPK ha^{-1} applied along with organic sources either FYM or BL of N with CDU or PM or SRN (T_8, T_9, T_{10} and T_{11}). Almost similar trend was observed for K uptake by grain and straw. The application of BGA (T_{12}) or PSB (T_{13}) with inorganic level of 150:80:60 kg NPK ha^{-1} tested in the year 2003 failed to bring any additional increase in K uptake by grain and straw at harvest during both the years.

Table 3: Effect of organic and inorganic fertilizer on nitrogen, phosphorus, potassium concentration percentage in plant, grain and straw of hybrid rice

Treatments	Nitrogen concentration, %				Phosphorus concentration, %				Potassium concentration, %			
	Harvest				Harvest				Harvest			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	1.57	1.61	0.64	0.67	0.34	0.37	0.109	0.110	0.43	0.45	0.734	0.759
T_2: 100:60:40 kg NPK ha^{-1}	1.43	1.45	0.52	0.55	0.27	0.29	0.107	0.106	0.37	0.38	0.685	0.698
T_3: 50:30:20 kg NPK ha^{-1}	1.29	1.31	0.44	0.45	0.21	0.22	0.054	0.055	0.25	0.27	0.437	0.450
T_4: T_3 + FYM 10 t/ha^{-1}	1.38	1.39	0.47	0.49	0.24	0.25	0.063	0.064	0.33	0.36	0.592	0.611
T_5: T_3 + BL of N with CDU	1.35	1.36	0.6	0.48	0.22	0.24	0.057	0.059	0.30	0.32	0.618	0.631
T_6: T_3 + PM 3 t/ha^{-1}	1.36	1.38	0.46	0.48	0.25	0.27	0.059	0.062	0.31	0.32	0.604	0.627
T_7: T_3 + SRN (NC treated N)	1.38	1.39	0.45	0.46	0.22	0.23	0.057	0.061	0.29	0.31	0.613	0.629
T_8: T_2 + FYM 3 t/ha^{-1}	1.47	1.51	0.47	0.09	0.29	0.31	0.099	0.102	0.38	0.39	0.695	0.719
T_9: T_2 + BL of N with CDU	1.51	1.54	0.55	0.60	0.31	0.34	0.101	0.104	0.39	0.42	0.698	0.721
T_{10}: T_2 + PM 3 t/ha^{-1}	1.53	1.55	0.57	0.62	0.33	0.35	0.103	0.106	0.41	0.43	0.719	0.738
T_{11}: T_2 + SRN (NC treated N)	1.52	1.53	0.55	0.58	0.33	0.34	0.098	0.101	0.37	0.40	0.713	0.735
T_{12}: T_1 + BGA	-	1.62	-	0.69	-	0.38	-	0.112	-	0.47	-	0.763
T_{13}: T_1 + PSB	-	1.59	-	0.68	-	0.39	-	0.111	-	0.43	-	0.762
T_{14}: Control (No NPK)	1.25	1.26	0.40	0.43	0.20	0.21	0.049	0.051	0.22	0.23	0.401	0.419
S.E.±	0.037	0.044	0.031	0.033	0.010	0.01	0.003	0.002	0.03	0.044	0.012	0.014
C.D. (P=0.05)	0.11	0.13	0.09	0.09	0.03	0.03	0.008	0.007	0.11	0.13	0.037	0.042

Improvement in uptake of N, P and K in hybrid rice under different inorganic level and their combination with different organic sources may be due to improvement in soil conditions, which encouraged the proliferation of roots. Which improved synchrony between supply and plant demand, which in turn drew more nutrients from larger area and greater depth, as reported by Jha *et al*. (2001).

Studies on soil properties:

Available N, P and K in soil :

The available N, P and K was analyzed at harvest and was influenced due to application of different levels of inorganic fertilizers and their conjunction with organic fertilizers inorganic fertilizer level of 100:60:40 kg NPK ha^{-1} (T_2) applied along with PM or FYM or N blended with CDU was found to be equally effective for available N, P and K status in soil (Table 4). This treatment gave significantly higher available N in soil than that of other treatments. The available P and K under these treatments were at par to that of inorganic fertilizer level of 150:80:60 kg NPK ha^{-1} (T_1). This level of inorganic fertilizer was found to be significantly superior than those of lower level of inorganic fertilizer (100:60:40 or 50:40:30 kg NPK ha^{-1}) for maintaining N, P and K status in soil. The application of PSB increased available P in soil, year of but advantage of BGA was not noticed over T_1 in the year of 2003. The lowest N, P and K in soil was observed under control plot. Increased availability of N with blending was also reported by Lakpale *et al*. (1999). Increased N and availability might be also due to reduced N losses by formation of organo-mineral complexes through exchange reaction (Singh and Singh, 1987 and Sharma and Mittra, 1989).

Balance sheet of available major nutrients of soil:

Nitrogen :

The balance sheet of available nitrogen of soil was worked out at harvest and is presented in Table 6. It was noticed that the gain of available N of soil was more when inorganic fertilizer of 100:60:40 kg NPK ha^{-1} applied along with PM followed by 50:30:20 kg NPK ha^{-1} + SRN and 100:60:40 kg NPK ha^{-1} + BL of N with CDU during 2002. During 2003, maximum gain of available N of soil was under inorganic level of 150:80:60 kg NPK ha^{-1} with BGA (T_{12}) followed by inorganic level of 100:60:40 kg NPK ha^{-1} + SRN and 50:30:20 kg NPK ha^{-1}+ SRN. Inorganic level of 100:60:40 kg NPK ha^{-1} applied along with FYM recorded the maximum depletion of available soil N followed inorganic level of 50:30:20 kg NPK ha^{-1} during both the years.

Phosphorus :

The balance sheet of available phosphorus of soil

Table 4: Effect of organic and inorganic fertilizer on available nitrogen, phosphorus and potassium in soil at harvest of hybrid rice

Treatments	Available soil nitrogen, kg ha^{-1}		Available phosphorus, kg ha^{-1}		Available potassium, kg ha^{-1}	
	Harvest		Harvest		Harvest	
	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	210.52	211.39	22.78	24.29	348.72	350.28
T_2: 100:60:40 kg NPK ha^{-1}	197.15	198.78	19.85	20.82	330.89	331.39
T_3: 50:30:20 kg NPK ha^{-1}	162.64	164.09	17.70	18.68	301.29	303.42
T_4: T_3 + FYM 10 t/ha^{-1}	218.57	218.75	20.85	22.37	330.86	331.81
T_5: T_3 + BL of N with CDU	202.27	203.41	19.79	20.81	309.37	311.05
T_6: T_3 + PM 3 t/ha^{-1}	206.35	208.19	20.65	22.67	315.84	316.79
T_7: T_3 + SRN (NC treated N)	199.70	201.23	18.29	20.79	301.55	302.25
T_8: T_2 + FYM 3 t/ha^{-1}	228.43	229.50	22.18	23.04	346.34	348.31
T_9: T_2 + BL of N with CDU	228.63	231.07	22.84	24.19	348.83	349.75
T_{10}: T_2 + PM 3 t/ha^{-1}	230.41	232.54	22.63	23.96	348.27	349.21
T_{11}: T_2 + SRN (NC treated N)	217.53	218.89	21.77	22.42	338.04	339.50
T_{12}: T_1 + BGA	-	217.15	-	25.42	-	351.47
T_{13}: T_1 + PSB	-	210.30	-	26.77	-	349.70
T_{14}: Control (No NPK)	168.52	169.97	13.47	15.37	289.92	291.31
S.E.±	0.89	1.49	0.93	0.97	1.45	2.29
C.D. (P=0.05)	2.51	4.71	2.65	2.87	4.39	6.77

Table 5 : Effect of organic and inorganic fertilizer on nitrogen, phosphorus and potassium uptake of hybrid rice

Treatments	Nitrogen uptake, kg ha^{-1}				Phosphorus uptake, kg ha^{-1}				Potassium uptake, kg ha^{-1}			
	Harvest				Harvest				Harvest			
	Grain		Straw		Grain		Straw		Grain		Straw	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	114.15	118.22	63.86	66.42	24.72	27.17	10.88	8.08	31.27	33.04	42.91	44.61
T_2: 100:60:40 kg NPK ha^{-1}	90.30	93.51	48.35	52.36	17.05	18.70	9.95	10.09	23.37	24.51	34.40	36.18
T_3: 50:30:20 kg NPK ha^{-1}	61.65	60.59	29.63	28.73	10.04	10.18	3.64	3.51	11.95	12.49	16.83	17.24
T_4: T_3 + FYM 10 t/ha^{-1}	89.05	90.89	42.19	43.99	15.49	16.35	5.66	6.46	21.29	23.54	29.62	33.73
T_5: T_3 + BL of N with CDU	80.72	84.63	38.94	42.54	13.15	14.94	4.83	5.23	17.94	19.91	25.39	28.36
T_6: T_3 + PM 3 t/ha^{-1}	88.94	91.98	42.12	44.49	16.35	17.99	5.40	5.75	20.27	21.33	28.38	29.66
T_7: T_3 + SRN (NC treated N)	73.40	78.50	33.43	35.85	11.70	12.99	4.23	4.75	15.43	17.51	21.54	24.16
T_8: T_2 + FYM 3 t/ha^{-1}	100.05	104.72	44.95	47.72	19.74	21.49	9.47	9.93	25.86	27.05	36.34	37.98
T_9: T_2 + BL of N with CDU	105.25	109.62	53.27	59.09	21.61	24.20	9.78	10.24	27.18	29.89	39.71	42.35
T_{10}: T_2 + PM 3 t/ha^{-1}	109.66	113.01	56.37	61.14	23.65	25.52	10.19	10.45	29.38	31.35	40.55	42.40
T_{11}: T_2 + SRN (NC treated N)	101.76	104.42	52.33	55.82	22.09	23.21	9.32	9.72	24.77	27.30	35.21	38.49
T_{12}: T_1 + BGA	-	120.39	-	69.34	-	28.24	-	11.25	-	34.93	-	47.23
T_{13}: T_1 + PSB	-	117.15	-	68.24	-	28.74	-	11.14	-	31.68	-	43.15
T_{14}: Control (No NPK)	30.59	32.31	16.48	19.37	4.89	5.38	2.02	2.29	5.38	5.89	9.06	10.36
S.E.±	2.87	3.63	3.79	3.52	1.13	1.94	0.10	0.05	2.19	2.59	2.63	2.21
C.D. (P=0.05)	8.92	11.03	11.23	10.71	3.37	5.71	NS	NS	6.61	7.91	7.73	6.67

NS= Non-significant

Table 6 : Effect of organic and inorganic fertilizers on balance sheet of available nitrogen (N) of soil with crop of hybrid rice

Treatments	Initial available, N		Applied, N		Total available, N		Uptake of N		Net available, N		Balance of available, N after harvest		Buildup (+) / depletion (-) of available, N	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	217	215	150.00	150.00	367.00	365.00	178.08	184.64	188.92	180.36	210.52	211.39	21.60	31.03
T_2: 100:60:40 kg NPK ha^{-1}	217	215	100.00	100.00	317.00	315.00	138.65	145.87	178.35	169.13	197.15	198.78	18.80	29.65
T_3: 50:30:20 kg NPK ha^{-1}	217	215	50.00	50.00	267.00	265.00	91.28	89.32	175.76	175.68	162.64	164.09	-13.12	-11.59
T_4: T_3 + FYM 10 t/ha^{-1}	217	215	103.00	101.80	320.00	316.80	131.24	134.88	188.76	181.92	218.57	218.75	29.81	36.83
T_5: T_3 + BL of N with CDU	217	215	57.41	57.59	274.41	272.59	119.66	127.17	154.75	145.42	202.27	203.41	47.52	57.99
T_6: T_3 + PM 3 t/ha^{-1}	217	215	55.18	55.21	272.18	270.21	131.06	136.47	141.12	133.74	206.35	208.19	65.23	74.45
T_7: T_3 + SRN (NC treated N)	217	215	115.99	115.54	332.99	330.54	106.83	114.35	226.16	216.19	199.70	201.23	-26.46	-14.96
T_8: T_2 + FYM 3 t/ha^{-1}	217	215	107.41	107.59	324.41	322.59	145.00	152.44	179.41	170.15	228.43	229.50	49.02	59.35
T_9: T_2 + BL of N with CDU	217	215	105.18	105.21	322.18	320.21	158.52	168.71	163.66	151.50	228.63	231.07	64.97	79.57
T_{10}: T_2 + PM 3 t/ha^{-1}	217	215	90.56	93.20	307.56	308.20	166.03	174.15	141.53	134.05	230.41	232.54	88.88	98.49
T_{11}: T_2 + SRN (NC treated N)	217	215	140.56	140.41	357.56	355.41	154.09	160.24	203.47	195.17	217.53	218.89	14.06	23.72
T_{12}: T_1 + BGA	217	215	-	173.00	-	388.00	-	189.73	-	198.27	-	217.15	-	18.88
T_{13}: T_1 + PSB	217	215	-	150.00	-	365.00	-	185.39	-	179.61	-	210.30	-	30.69
T_{14}: Control (No NPK)	217	215	-	-	217.00	215.00	47.07	51.68	169.93	163.32	168.52	169.97	-1.41	6.65

was worked out at harvest and is presented in Table 7. It was observed that maximum buildup of available soil P was under inorganic level of 50:30:20 kg NPK ha^{-1} applied along with organic source PM (T_6) followed by 100:60:40 kg NPK ha^{-1} + BL of N with CDU (T_9) during 2002. The application of PSB (T_{13}) with inorganic level of 150:80:60 kg NPK ha^{-1} tested in the year 2003 gave highest buildup of available soil P followed by 50:30:20 kg NPK ha^{-1} + PM (T_6) and 100:60:40 kg NPK ha^{-1} + BL of N with CDU (T_9), whereas, minimum buildup of available soil P was noticed under 100:60:40 kg NPK ha^{-1} + SRN during both the year.

Potassium :

The balance sheet of available potassium of soil was worked out at harvest and is presented in (Table 8).

Table 7: Effect of organic and inorganic fertilizers on balance sheet of available phosphorus (P) of soil with crop of hybrid rice

Treatments	Initial available, P		Applied, P		Total available, P		Uptake of, P		Net available, P		Balance of available, P after harvest		Buildup (+)/ depletion (-) of available, P	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	18.5	18.2	34.93	34.93	53.43	53.13	35.60	35.25	17.83	17.88	22.78	24.29	4.95	6.41
T_2: 100:60:40 kg NPK ha^{-1}	18.5	18.2	26.20	26.20	44.70	44.40	27.00	28.79	17.70	15.61	19.85	20.82	2.15	5.21
T_3: 50:30:20 kg NPK ha^{-1}	18.5	18.2	13.10	13.10	31.60	31.30	13.68	13.69	17.92	17.61	17.70	18.68	-0.22	1.07
T_4: T_3 + FYM 10 t/ha^{-1}	18.5	18.2	52.80	54.00	71.30	72.20	21.15	22.81	50.15	49.39	20.85	22.37	-29.30	-27.02
T_5: T_3 + BL of N with CDU	18.5	18.2	16.61	16.67	35.11	34.87	17.98	20.17	17.13	14.70	19.79	20.81	2.66	6.11
T_6: T_3 + PM 3 t/ha^{-1}	18.5	18.2	14.16	14.18	32.66	32.38	21.75	23.74	10.91	8.64	20.65	22.67	9.74	14.03
T_7: T_3 + SRN (NC treated N)	18.5	18.2	38.11	38.47	56.61	56.67	15.93	17.74	40.68	38.93	18.29	20.79	-22.39	-18.14
T_8: T_2 + FYM 3 t/ha^{-1}	18.5	18.2	29.71	29.77	48.21	47.97	29.21	31.42	19.00	16.55	22.18	23.04	3.18	6.49
T_9: T_2 + BL of N with CDU	18.5	18.2	27.26	27.28	45.76	45.48	31.39	34.44	14.37	11.04	22.84	24.19	8.47	13.15
T_{10}: T_2 + PM 3 t/ha^{-1}	18.5	18.2	56.15	56.30	74.65	74.50	33.84	35.77	40.81	38.73	22.63	23.96	-18.18	-14.77
T_{11}: T_2 + SRN (NC treated N)	18.5	18.2	69.25	69.40	87.75	87.60	31.41	32.93	56.34	54.67	21.77	22.42	-34.57	-32.25
T_{12}: T_1 + BGA	-	-	-	34.93	-	53.13	-	39.49	-	13.64	-	25.42	-	11.78
T_{13}: T_1 + PSB	-	-	-	26.20	-	44.40	-	39.88	-	4.52	-	26.77	-	22.25
T_{14}: Control (No NPK)	18.5	18.2	-	-	18.50	18.20	6.91	7.67	11.59	10.53	13.47	15.37	1.88	4.84

Table 8 : Effect of organic and inorganic fertilizers on balance sheet of available potassium (K) of soil with crop of hybrid rice

Treatments	Initial available, K		Applied, K		Total available, K		Uptake of, K		Net available, K		Balance of available, K after harvest		Buildup (+)/ depletion (-) of available, K	
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	326	325	50.00	50.00	376.00	375.00	74.18	77.65	301.82	297.35	348.72	350.28	46.90	52.93
T_2: 100:60:40 kg NPK ha^{-1}	326	325	33.33	33.33	359.33	358.33	57.77	60.69	301.56	297.64	330.89	331.39	29.33	33.75
T_3: 50:30:20 kg NPK ha^{-1}	326	325	16.67	16.67	342.67	341.67	28.78	29.73	313.89	311.94	301.29	303.42	-12.60	-8.52
T_4: T_3 + FYM 10 t/ha^{-1}	326	325	129.87	130.67	455.87	455.67	50.91	57.27	404.96	398.40	330.86	331.81	-74.10	-66.59
T_5: T_3 + BL of N with CDU	326	325	26.72	35.41	352.22	360.41	43.33	48.27	309.39	312.14	309.37	311.05	-0.02	-1.09
T_6: T_3 + PM 3 t/ha^{-1}	326	325	18.13	18.13	344.13	343.13	48.65	50.99	295.48	292.14	315.84	316.79	20.36	24.65
T_7: T_3 + SRN (NC treated N)	326	325	67.29	67.53	393.29	392.53	36.97	41.67	356.32	350.86	301.55	302.25	-54.77	-48.61
T_8: T_2 + FYM 3 t/ha^{-1}	326	325	43.38	52.47	369.38	377.47	62.20	65.03	307.18	312.44	346.34	348.31	39.16	35.87
T_9: T_2 + BL of N with CDU	326	325	34.76	34.79	360.76	359.79	66.89	72.24	293.87	287.55	348.83	349.75	54.96	62.20
T_{10}: T_2 + PM 3 t/ha^{-1}	326	325	35.81	36.26	361.81	361.26	69.93	73.75	291.88	287.51	348.27	349.21	56.39	61.07
T_{11}: T_2 + SRN (NC treated N)	326	325	52.47	52.92	378.47	377.47	59.98	65.79	318.49	311.68	338.04	339.50	19.55	27.82
T_{12}: T_1 + BGA	-	325	-	50.00	-	375.00	-	82.16	-	292.84	-	351.47	-	58.63
T_{13}: T_1 + PSB	-	325	-	33.33	-	358.33	-	74.83	-	283.50	-	349.70	-	66.20
T_{14}: Control (No NPK)	326	325	-	-	326.00	325.00	14.44	16.25	311.56	308.75	289.92	291.31	-21.64	-17.44

Perusal of data indicated that 100:60:40 kg NPK ha^{-1} + PM (T_{10}) recorded the maximum gain of available potassium followed by 100:60:40 kg NPK ha^{-1} + BL of N with CDU and higher inorganic level of 150:80:60 kg NPK ha^{-1} (T_1) during 2002. The application of PSB (T_{13}) tested in the year of 2003 with inorganic level 150:80:60 kg NPK ha^{-1} registered maximum buildup of available soil potassium followed by 150:80:60 kg NPK ha^{-1} + BL of N with CDU and 100:60:40 kg NPK ha^{-1} + FYM (T_8). Whereas, least buildup of available soil potassium was worked out under 50:30:20 kg NPK ha^{-1} + BL of N with CDU (T_5) during both the year. At latter growth stages and in grain and straw N, P and K concentration in plant tissue was increased with increasing levels of inorganic fertilizer. The soil was in general poor with available nitrogen, medium in available phosphorus and rich with exchangeable potassium. However, capacity of the soil to supply nutrients as per crop demand was fulfilled with the application of either The addition of inorganic fertilizer of 150:80:60 kg NPK ha^{-1} or inorganic level of 100:60:40 kg NPK ha^{-1} supplemented with CDU of N or PM especially at later growth stages. The uptake of N was

Table 9 : Effect of organic and inorganic fertilizer on nutrient use efficiency, production efficiency (kg ha^{-1} day^{-1}), productivity rating Index of hybrid rice

Treatments	Nutrient use efficiency		Production efficiency, kg ha^{-1} day^{-1}		Productivity rating Index	
	2002	2003	2002	2003	2002	2003
T_1: 150:80:60 kg NPK ha^{-1}	20.53	20.34	56.36	57.16	119.19	120.38
T_2: 100:60:40 kg NPK ha^{-1}	24.25	24.35	48.95	49.99	103.52	105.72
T_3: 50:30:20 kg NPK ha^{-1}	29.23	25.84	37.05	35.85	78.34	75.82
T_4: T_3 + FYM 10 t/ha^{-1}	14.02	13.88	50.02	50.69	105.79	107.19
T_5: T_3 + BL of N with CDU	35.06	33.36	46.35	48.24	98.02	102.02
T_6: T_3 + PM 3 t/ha^{-1}	46.79	46.86	50.69	51.67	107.21	109.62
T_7: T_3 + SRN (NC treated N)	12.97	13.92	41.23	43.78	87.19	92.59
T_8: T_2 + FYM 3 t/ha^{-1}	24.15	23.03	52.76	53.76	111.57	113.69
T_9: T_2 + BL of N with CDU	27.05	27.22	54.03	55.18	114.26	116.69
T_{10}: T_2 + PM 3 t/ha^{-1}	25.86	25.45	55.56	56.52	117.49	119.52
T_{11}: T_2 + SRN (NC treated N)	16.19	16.23	51.89	52.91	109.75	111.89
T_{12}: T_1 + BGA	-	28.14	-	57.61	-	121.84
T_{13}: T_1 + PSB	-	32.03	-	57.12	-	120.79
T_{14}: Control (No NPK)	-	-	18.97	19.88	40.11	42.03

Table 10 : Composition and chemical properties of organic blending material used

Organic sources	Year of study	Composition				C:N ratio	pH	Moisture
		C	N	P	K			
FYM	2002	6.510	0.533	0.397	1.132	12.21	7.5	18.20
	2003	6.743	0.518	0.409	1.140	12.49	7.8	16.94
Cow dung (fresh)	2002	15.152	0.271	0.135	0.326	55.91	7.3	80.68
	2003	14.914	0.273	0.121	0.338	54.63	7.3	82.53
Cow dung	2002	14.581	0.258	0.126	0.330	56.52	7.1	81.73
(10 days decomposed)	2003	14.493	0.262	0.120	0.331	55.32	6.8	83.42
Cow dung	2002	13.972	0.247	0.117	0.335	56.57	6.4	82.34
(20 days decomposed)	2003	13.754	0.253	0.119	0.327	54.36	6.5	83.29
Poultry manure	2002	-	1.352	1.435	0.638	-	6.9	76.79
	2003	-	1.347	1.440	0.653	-	6.8	78.32
Neem cake	2002	-	5.18	1.06	1.43	-	-	-
	2003	-	5.21	1.08	1.46	-	-	-

Table 11 : N, P and K supplied through organic blended materials and inorganic sources, kg ha^{-1}

Treatments	Through inorganic (kg ha^{-1})			Through blending material (kg ha^{-1})						Total applied (kg ha^{-1})					
				Kharif 2002			*Kharif* 2003			*Kharif* 2002			*Kharif* 2003		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1: 150 : 80 : 60 kg NPK/ha	150	34.93	50	-	-	-	-	-	-	150	34.95	50	150	34.93	50
T_2: 100 : 60 : 40 kg NPK/ha	100	26.20	33.33	-	-	-	-	-	-	100	26.20	33.33	100	26.20	33.33
T_3: 50 : 30 : 20 kg NPK/ha	50	13.10	16.67	-	-	-	-	-	-	50	13.10	16.67	50	13.10	16.67
T_4: T_3 + FYM 10 t/ha	50	13.10	16.67	53	39.7	113.2	51.8	40.9	114	103	52.80	129.87	101.80	54.00	130.67
T_5: T_3 + Blending of N with CDU, 3 t/ha	50	13.10	16.67	7.41	3.51	10.05	7.59	3.57	19.14	57.41	16.61	26.72	57.54	16.67	35.41
T_6: T_3 + Slow release N (*Neem* cake)	50	13.10	16.67	5.18	1.06	1.43	5.21	1.08	1.46	55.18	14.16	18.13	55.21	14.18	18.13
T_7: T_2 + FYM 3 t/ha	100	26.20	33.33	15.99	11.91	33.96	15.54	12.27	34.20	115.99	38.11	67.29	115.54	38.47	67.53
T_8: T_2 + Blending of N with CDU 3 t/ha	100	26.20	33.33	7.41	3.51	10.05	7.59	3.57	19.14	107.41	29.71	43.38	107.59	29.77	52.47
T_9: T_2 + Slow release N	100	26.20	33.33	5.18	1.06	1.43	5.21	1.08	1.46	105.18	27.26	34.76	105.21	27.28	34.79
T_{10}: T_3 + Poultry manure 3 t/ha	50	13.10	16.67	40.56	43.05	19.14	40.41	43.20	19.59	90.56	56.15	35.81	93.20	56.30	36.26
T_{11}: T_2 + Poultry manure 3 t/ha	100	26.20	33.33	40.56	43.05	19.14	40.41	43.20	19.59	140.56	69.25	52.47	140.41	69.40	52.92
T_{12}: RFD + BGA	150	34.93	50	-	-	-	23	-	-	-	-	-	173	34.93	50
T_{13}: RFD + PSB	150	34.93	50	-	-	-	-	-	-	-	-	-	150	34.93	50
T_{14}: Control	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

rapid between early tillering (Hammisa *et al,.* 1989), which in general, contributes to one third of the total N uptake in rice. In contrast, Yang *et al.* (1987) noticed, 8-13 per cent N uptake in hybrid rice was during transplanting to tillering, 48-53 per cent during tillering to heading and 33-44 per cent heading to ripening. The increased leaf area, chlorophyll content and overall dry matter demanded for high nutrient in plant.

Nutrient use efficiency, production efficiency and productivity rating index:

The Table 9 revealed that inorganic level of 150:80:60 kg NPK ha^{-1} gave the higher production efficiency and productivity rating index, which was followed by application of inorganic fertilizer of 100:60:40 kg NPK ha^{-1} alongwith PM and blending of N with CDU, respectively. Whereas, application inorganic fertilizer 50:30:20 kg NPK ha^{-1} + PM gave highest nutrient followed by T_5 and T_3, respectively during both the years. Inorganic level of 100:60:40 kg NPK ha^{-1} and their combination with organic sources either blending of N with CDU or PM or FYM gave comparable uptake. The result also confirmed the findings of Chandrakar *et al*. (1990); Kadu *et al*. (1991) and Yadvinder *et al*. (1995). This may be due to maximum availability of N and K in soil solution. Inorganic N and K might have been immobilized short while during blending with cow dung urine mixture but during the crop growing period they are mineralized and released slowly and kept in pace with requirement of the crop. Due to this, their losses might have been reduce and availability increased resulting in maximum uptake in these treatments.

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