



## Growth, yield and nutrient uptake of hybrid rice as influenced by nutrient management modules and its impact on economic of the treatments

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**Abstract:** Field experiment was conducted at Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad to develop nutrient management modules for efficient cultivation of hybrid rice. Results showed that growth and yield characters viz. plant height, number of tillers and panicles per hills were highest under nutrient management module of 100% NPK + 5 t pressmud (T<sub>3</sub>). Significantly higher grain and straw yield was recorded under treatment T<sub>3</sub> over all the treatment except treatment T<sub>1</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> which were recorded on par. Uptake of NPKS and Zn was significantly improved under treatments having organic manure along with inorganic levels (100%, 75% and 50% NPK) of fertilizer over alone levels of inorganic fertilizer. NPKS and Zn uptake was higher in treatment module T<sub>3</sub> followed by treatment T<sub>2</sub> (100% NPK + 10 t FYM ha<sup>-1</sup>). The net return Rs. 27373.70 ha<sup>-1</sup> and 26087.0 ha<sup>-1</sup> and benefit: cost ratio (1.53 and 1.45) was maximum in treatment T<sub>3</sub> closely followed by T<sub>2</sub>. Findings of this study warranted that treatment module T<sub>3</sub> resulted higher growth and yield of rice crop. Net return was also higher in this treatment.

**Keywords:** Economic of treatments, Growth, Hybrid rice, Nutrient management modules, Nutrients uptake, Yield

### INTRODUCTION

India ranks first in acreage and second in rice production only after China. Rice is India's predominant crop and the staple food of the eastern and southern part of the country (Prabakaran and Sivapragasam, 2014 and Singh *et al.*, 2012). During the year 2013-2014, India produced 106.65 million tonnes rice from 44.13 million hectare area (Anonymous, 2015-16). Hybrid rice possessed 10 to 15 per cent yield advantage over inbred varieties due to more vigorous and extensive root system (Young *et al.*, 1999) increased growth rate during vegetative stage (Yamauchi, 1994), more efficient sink formation, faster rate of translocation of photosynthates and greater sink size (Kabaki, 1993). However, high productivity of hybrid rice cannot be sustained unless the declining trend in soil fertility resulting from the huge nutrient removal by hybrid rice is replenished properly through integrated nutrient management practices (Singh, 2013).

Diverse organic sources including farmyard manure (FYM), pressmud, water hyacinth, green manure and blue green algae (BGA) are available for use in agriculture. Conjunctive use of organic nutrients along with chemical fertilizers provides an opportunity to attain long term sustainability in crop production system without deterioration of land (Reddy, 2000).

Hence, selection of proper variety and adoption of advanced agronomic practices could play an important role in increasing productivity (Singh *et al.*, 2008). The use of local bio-degradable, non-toxic and cost effective agro waste can be well affordable for the Indian agrarian (Ashok *et al.*, 2015). Keeping in view the above facts, the present study was, therefore, carried out to develop effective nutrient management modules for sustaining productivity of hybrid rice and increasing profitability by use of locally available resources.

### MATERIALS AND METHODS

The research study was carried out on the field of Instructional Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (U.P.) during *kharif* 2004-05 and 2005-06 to find out the effect of nutrient management modules on growth, yield, nutrients uptake of hybrid rice and economic feasibility of the various treatments. The experimental site falls under subtropical zone in Indo-Gangetic plains having alluvial calcareous soil and lies between latitude 26.47° north and at longitude 82.12° east with elevation of about 113 m from sea level. The experiment comprised of eighteen treatments module viz. T<sub>1</sub> (100% NPK), T<sub>2</sub> (100% NPK + 10 t FYM), T<sub>3</sub> (100% NPK + 5 t pressmud), T<sub>4</sub> (100% NPK + 5 t water hya-

cinth), T<sub>5</sub> (100% NPK + 5 t green manure), T<sub>6</sub> (100% NPK + 10 kg BGA Crust), T<sub>7</sub> (75% NPK), T<sub>8</sub> (75% NPK + 10 t FYM), T<sub>9</sub> (75% NPK + 5 t pressmud), T<sub>10</sub> (75% NPK + 5 t water hyacinth), T<sub>11</sub> (75% NPK + 5 t green manure), T<sub>12</sub> (75% NPK + 10 kg BGA crust ha<sup>-1</sup>), T<sub>13</sub> (50% NPK (75: 37.5:37.5 NPK kg ha<sup>-1</sup>), T<sub>14</sub> (50% NPK + 10 t + FYM), T<sub>15</sub> (50% NPK + 5 t pressmud), T<sub>16</sub> (50% NPK + 5 t water hyacinth), T<sub>17</sub> (50% NPK + 5 t green manure) and T<sub>18</sub> (50% NPK + 10 kg BGA crust) and tested in a randomized block design and replicated three times. To lay out the experiment field was divided into plots of 5 m x 4 m by providing 30 cm high and 50 cm wide bunds all around each plot. The treatments to the plots were allotted randomly and incorporated uniformly in the soil. FYM and pressmud was incorporated uniformly in the plots 7 days before transplanting of rice to the depth of 10-15 cm. However, water hyacinth was applied in the field 15 days before transplanting. Treated plots were left for 15 days in order to facilitate the complete decomposition of water hyacinth. Dhaincha (*Sesbania aculeata*) was collected from the outside field. The Sesbania green manure crop was cut down after chopping with the help of sickle and it was incorporated in to the field according to treatment in to the top 15 cm soil one week before of rice transplanting. BGA crust was incorporated uniformly in the plots 20 days after transplanting of rice crop. Full dose of phosphorus and potassium and half dose of nitrogen were applied as basal while remaining half dose of nitrogen was applied in two equal splits at tillering and panicle initiation stages. A common dose of zinc sulphate @ 25 kg ha<sup>-1</sup> was applied at the time of transplanting. Transplanting was done manually at 20 cm x 15 cm distance using one seedling per hill. A thin film of water (2-3 cm) was maintained during the initial stage of seedling establishment. Thereafter, crop was irrigated as and when required to maintain the water level. Weeds were removed manually at 20 and 40 days after transplanting. The plant height was measured at harvest stage on three hills located at different places in the plot with the help of a meter scale from base of the plant to the tip of the tallest plant part. The number of panicles per hills was counted randomly from the selected five hills. Length of five panicles was measured randomly in each plot with the help of meter scale at maturity. Five panicles from each plot were taken randomly at maturity stage for counting the number of spikelets per panicle. Three panicles from each plot were taken randomly at maturity stage for counting the number of grains per panicle and averaged. After taking the bundles weight of the harvested produce of each net plot, their grains were separated manually. The grain yield was recorded at 14 per cent moisture from each net plot after threshing and the values were converted to q ha<sup>-1</sup>. Random grain samples were collected from the produce of each net plot and 1000 grains were counted

and weighed with the help of electronic balance to obtain test weight. Harvest index of each experimental plot was calculated considering both grain and straw yield. Modified Kjeldahl's method was followed for determination of N content in plant and grain samples as described by (Jackson, 1973). P content was determined in the digested plant material by vanadomolybdate phosphoric yellow colour method as described by Jackson (1973). K was determined by flame photometer (Jackson, 1973). S content was determined by turbidimetric method as described by Chesnin and Yein (1951). Zn content in plants and grains was determined on atomic absorption spectrophotometer by using zinc hollow cathode lamp (Lindsey and Narwell, 1978). The nutrient uptake by grain and straw of rice crop were calculated in relation to dry matter production and their nutrient contents. The cost of cultivation was worked out by the considering expenses incurred due to treatment cost and common cost. The experimental data were analyzed using "Analysis of variance" in randomized block design. The critical differences at 5 per cent level of probability were calculated for testing the significance of difference between any two means whereas 'F' test was significant (Snedecor and Cochran, 1967).

## RESULTS AND DISCUSSION

**Growth and yield attributing characters:** The plant height as affected by different treatment combinations given in Table 1. The significant difference was observed in plant height due to different organic and inorganic fertilizer treatments. Significantly higher plant height was recorded under all the treatments over treatment 50% NPK alone. The highest plant height was measured in the treatment T<sub>3</sub>. The increase in plant height might be due to stimulation of cell, elongation, division and enlargement as reported by Thukral *et al.* (1994). Parasuraman (2005) also observed that integrated use of N fertilizer with Dhaincha found to be favourably affect the growth and yield attributes such as plant height and total dry matter production in rice crop.

The number of tillers and panicles hill<sup>-1</sup> are the most important yield attributing characters. Influence of

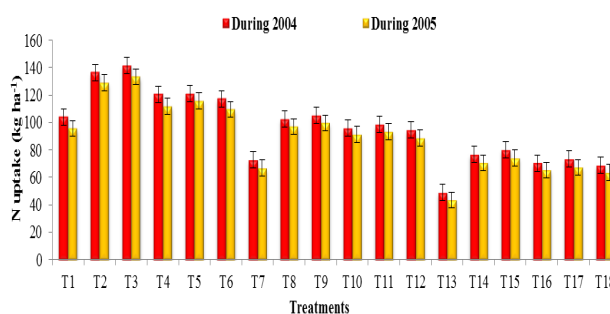
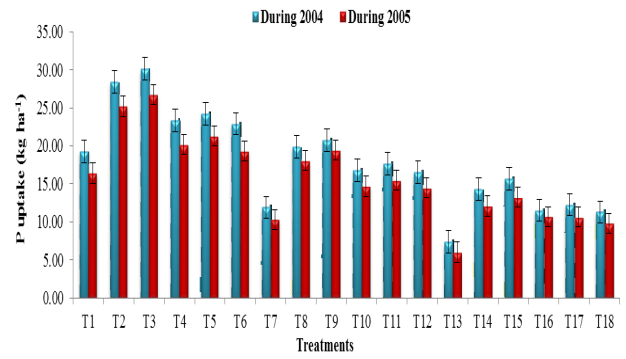


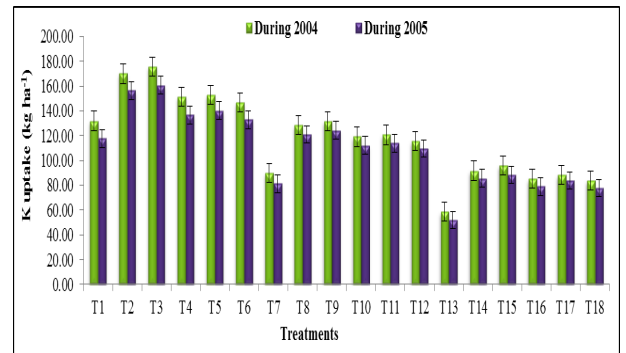
Fig. 1. Effect of nutrient management modules on N uptake by hybrid rice crop.

**Table 1.** Effect of nutrient management modules on growth and yield attributing parameters of rice.

Treatments	Plant height (cm)		No. of tillers hill <sup>-1</sup>		No. of panicles hill <sup>-1</sup>		Panicle length (cm)		Number of spikelets panicle <sup>-1</sup>		Number of grains panicle <sup>-1</sup>	
	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005	2004	2005
100% NPK (150:75:75 kg ha <sup>-1</sup> )	112.75	108.40	14.30	13.65	13.20	12.45	22.15	20.10	113.35	110.98	95.00	87.43
100% NPK + 10 t FYM ha <sup>-1</sup>	120.92	116.81	17.70	17.45	16.53	16.10	27.50	25.50	130.35	127.89	115.00	108.77
100% NPK + 5 t pressmud ha <sup>-1</sup>	122.32	118.45	18.25	18.14	17.10	17.00	28.90	26.60	133.25	130.69	120.77	112.87
100% NPK + 5 t water hyacinth ha <sup>-1</sup>	118.10	114.50	17.15	16.55	16.10	15.43	25.70	22.90	126.90	123.78	108.20	95.67
100% NPK + 5 t Green manure ha <sup>-1</sup>	119.25	115.12	17.45	17.12	16.33	15.60	26.60	24.90	128.36	126.35	111.77	97.00
100% NPK + 10 kg BGA crust ha <sup>-1</sup>	116.57	112.67	15.60	15.20	14.53	14.00	24.70	23.20	124.80	121.99	109.67	96.10
75% NPK (112.5:56.25:56.25 kg ha <sup>-1</sup> )	100.32	96.07	9.12	8.60	8.10	7.35	14.75	13.87	100.45	95.85	74.20	68.23
75% NPK + 10 t FYM ha <sup>-1</sup>	109.52	105.64	15.60	14.12	14.20	13.53	21.20	20.30	122.30	120.00	100.87	92.63
75% NPK + 5 t pressmud ha <sup>-1</sup>	110.25	106.72	15.85	15.16	14.53	14.00	22.70	21.70	122.99	119.99	102.67	93.97
75% NPK + 5 t water hyacinth ha <sup>-1</sup>	108.63	104.53	13.68	13.25	12.53	12.10	21.50	20.20	118.65	116.60	96.20	88.20
75% NPK + 5 t Green manure ha <sup>-1</sup>	109.23	105.29	14.80	13.65	13.10	12.53	21.20	20.80	120.65	118.25	98.43	89.63
75% NPK + 10 kg BGA crust ha <sup>-1</sup>	108.58	104.10	13.63	12.45	12.20	11.20	20.10	19.70	117.56	114.85	95.10	87.40
50% NPK (75:37.5:37.5 kg ha <sup>-1</sup> )	90.63	86.85	8.12	8.00	6.68	6.50	12.50	12.20	76.45	72.88	55.53	48.20
50% NPK + 10 t FYM ha <sup>-1</sup>	101.53	97.42	12.35	12.00	11.10	10.53	19.20	18.50	104.39	101.87	82.53	70.10
50% NPK + 5 t pressmud ha <sup>-1</sup>	102.25	98.62	12.40	12.28	11.30	10.66	20.00	19.17	106.66	103.60	84.53	76.63
50% NPK + 5 t water hyacinth ha <sup>-1</sup>	100.32	96.82	11.92	11.90	10.53	10.25	18.60	18.17	103.25	101.15	80.43	73.77
50% NPK + 5 t Green manure ha <sup>-1</sup>	101.28	97.12	12.15	11.95	11.10	10.53	18.90	18.20	105.48	103.12	82.53	74.77
50% NPK + 10 kg BGA crust ha <sup>-1</sup>	98.52	96.15	11.80	11.68	10.10	10.20	17.90	17.70	100.60	98.20	78.00	72.40
SEm ±	2.51	2.59	1.16	1.27	1.13	1.25	1.83	1.85	5.49	5.63	6.02	6.44
C.D. (P=0.05)	7.23	7.45	3.33	3.65	3.25	3.60	5.27	5.32	15.80	16.20	17.35	18.56



**Fig. 2.** Effect of nutrient management modules on P uptake by hybrid rice crop.



**Fig. 3.** Effect of nutrient management modules on K uptake by hybrid rice crop.

conjunctive use of organic and inorganic fertilizer treatments on number of tillers and panicles hill<sup>-1</sup> found to be significant Table 1. The maximum number of tillers and panicles hill<sup>-1</sup> were counted under the treatment having 100% NPK + 5 t. pressmud. Increased number of tillers and panicles hill<sup>-1</sup> with these treatments could be explained on the basis of balanced nutrient supply which enhances better translocation of photosynthates from source to sink and there by favored highest yield attributes under these treatments. Similarly, Lin and Lin (1985) reported that high N levels resulted in higher tiller number and leaf area index throughout the growing season of rice. Jeyajothi and Durairaj (2016) found that application of green leaf manure @ 6.25 t ha<sup>-1</sup> + Azophosmet + 100% NPK registered significantly the highest dry matter production at all growth stages of rice.

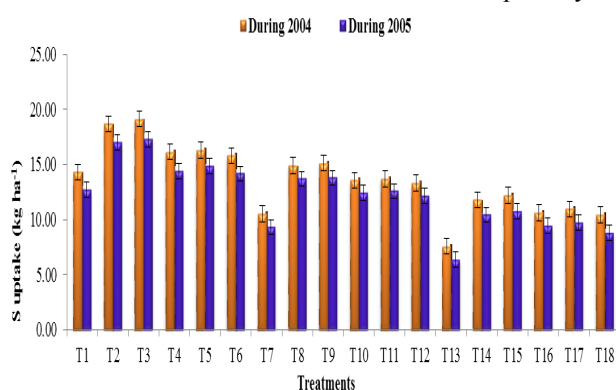
The highest panicle length, number of spikelets panicle<sup>-1</sup> and number of grains panicle<sup>-1</sup> was recorded under treatment T<sub>3</sub> followed by treatment T<sub>2</sub>. All the treatments were found significantly superior over treatment T<sub>13</sub> (50% NPK alone) except T<sub>7</sub> (75% NPK alone) for panicle length Table 1. Increased panicle length, number of spikelets and number of grains panicle<sup>-1</sup> with these treatments might be due to balanced nutrient availability which augments cell division, photosynthesis and later on converted into reproductive phase resulted more panicle length, number of spikelets panicle<sup>-1</sup> and number of grains panicle<sup>-1</sup>. Sim-

**Table 2.** Effect of nutrient management modules on yield, harvest index and test weight of rice.

Treatments	Grain yield (q ha <sup>-1</sup> )		Harvest index		Test weight (g)	
	2004	2005	2004	2005	2004	2005
100% NPK (150:75:75 kg ha <sup>-1</sup> )	56.72	53.25	44.44	44.24	22.90	22.60
100% NPK + 10 t FYM ha <sup>-1</sup>	68.55	65.63	44.64	44.44	23.40	23.40
100% NPK + 5 t pressmud ha <sup>-1</sup>	70.15	67.12	44.84	44.84	23.60	23.50
100% NPK + 5 t water hyacinth ha <sup>-1</sup>	62.85	59.46	44.31	44.44	23.40	23.10
100% NPK + 5 t Green manure ha <sup>-1</sup>	63.00	60.70	44.20	44.24	23.40	23.20
100% NPK + 10 kg BGA crust ha <sup>-1</sup>	61.80	58.70	44.27	44.24	23.10	23.00
75% NPK (112.5:56.25:56.25 kg ha <sup>-1</sup> )	42.50	40.00	44.05	43.85	22.15	22.00
75% NPK + 10 t FYM ha <sup>-1</sup>	55.55	53.85	44.24	44.05	22.70	22.50
75% NPK + 5 t pressmud ha <sup>-1</sup>	56.32	54.46	44.44	44.25	22.70	22.70
75% NPK + 5 t water hyacinth ha <sup>-1</sup>	53.90	52.00	43.86	43.66	22.50	22.40
75% NPK + 5 t Green manure ha <sup>-1</sup>	54.58	52.80	44.24	44.05	22.60	22.40
75% NPK + 10 kg BGA crust ha <sup>-1</sup>	53.10	51.35	44.05	43.86	22.40	22.17
50% NPK (75: 37.5:37.5 kg ha <sup>-1</sup> )	30.25	27.10	42.73	42.55	20.50	20.97
50% NPK + 10 t FYM ha <sup>-1</sup>	43.55	40.65	43.29	43.10	21.23	21.90
50% NPK + 5 t pressmud ha <sup>-1</sup>	44.80	41.80	43.47	43.29	21.77	22.00
50% NPK + 5 t water hyacinth ha <sup>-1</sup>	41.85	39.70	43.10	42.91	21.80	21.60
50% NPK + 5 t Green manure ha <sup>-1</sup>	42.70	40.20	42.91	42.73	21.80	21.70
50% NPK + 10 kg BGA crust ha <sup>-1</sup>	41.00	38.65	42.73	42.56	21.70	21.60
SEm ±	3.56	3.61	-	-	0.40	0.46
C.D. (P=0.05)	10.25	10.41	-	-	1.15	1.32

ilarly, Singh (2013) reported that combined use of organic with inorganic fertilizers helped in increasing crop growth, physiological parameters viz. chlorophyll content and leaf area index, yield attributing characters such as panicle length, panicle weight and yield of the hybrid rice.

**Grain yield:** The grain yield of hybrid rice was significantly influenced by various nutrient management modules (Table 2) (). Maximum grain yield (70.15 q ha<sup>-1</sup> and 67.12 q ha<sup>-1</sup>) of rice crop was recorded under nutrient management module T<sub>3</sub> followed by T<sub>2</sub>. Significantly higher grain yield was recorded under treatment having 100% NPK + 5 t pressmud over all the treatment except treatment T<sub>1</sub>, T<sub>2</sub>, T<sub>4</sub>, T<sub>5</sub> and T<sub>6</sub> which were recorded on par. Among the various nutrient management modules application of 5 t pressmud ha<sup>-1</sup> found to be most superior at 100% NPK, 75% NPK as well as 50% NPK levels considering the grain yield of hybrid rice. The increase in grain yield might be due to improved yield attributes, morphological and biological characters and better translocation of photosyn-

**Fig. 4.** Effect of nutrient management modules on S uptake by hybrid rice crop.

thates from source to sink. Superior crop growth was observed in pressmud treated plot might be due to its effectiveness in the improvement of physical as well as chemical properties of the soil and providing good environment to plant. Similarly, Singh (2014a) reported highest yield of hybrid rice from plot treated with 75% RDF+ green manure along with 40 kg zinc sulphate ha<sup>-1</sup>. Kumar *et al* (2001) observed maximum rice grain and straw yield with 100 % NPK+20 t. FYM + 10 kg BGA ha<sup>-1</sup>

**Test weight and harvest index:** Data pertaining to the effect of nutrient management modules on test weight and harvest index revealed that highest test weight and harvest index was found under the treatment T<sub>3</sub>, while the lowest test weight was recorded in treatment T<sub>13</sub> (50% NPK alone) Table 2. The harvest index of hybrid rice was higher (44.29) in the integrated application of nutrients (75% RDF + green manuring) as compared to the sole application of either organic or inorganic source of nutrient Singh (2014b).

**Nitrogen uptake:** Data with respect to N uptake by

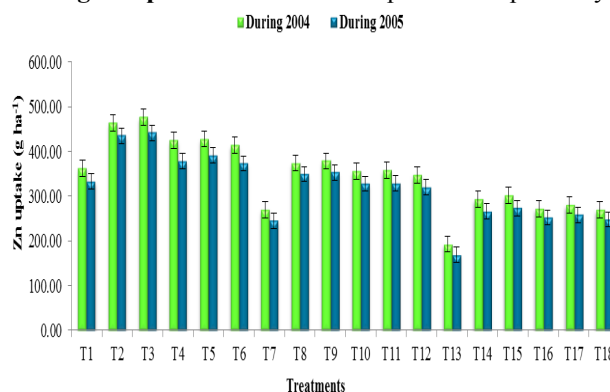
**Fig. 5.** Effect of nutrient management modules on Zn uptake by hybrid rice crop.

Table 3. Effect of nutrient management modules on economics of various treatments.

Treatments	Cost of cultivation (Rs. ha <sup>-1</sup> )		Gross income (Rs. ha <sup>-1</sup> )		Net income (Rs. ha <sup>-1</sup> )		B: C ratio	
	2004	2005	2004	2005	2004	2005	2004	2005
100% NPK (150:75:75 kg ha <sup>-1</sup> )	16399.90	16399.90	36726.20	35050.90	20326.30	16651.00	1.24	1.02
100% NPK + 10 t FYM ha <sup>-1</sup>	18199.90	18199.90	44338.00	43151.20	26138.10	24951.30	1.44	1.37
100% NPK + 5 t pressmud ha <sup>-1</sup>	17949.90	17949.90	45323.60	44036.90	27373.70	26087.00	1.53	1.45
100% NPK + 5 t water hyacinth ha <sup>-1</sup>	17199.90	17199.90	40725.30	39096.00	23525.40	21896.10	1.37	1.27
100% NPK + 5 t Green manure ha <sup>-1</sup>	17949.90	17949.90	40847.80	39954.70	22897.90	22004.80	1.28	1.23
100% NPK + 10 kg BGA crust ha <sup>-1</sup>	16899.90	16899.90	40054.00	38638.30	23154.10	21738.40	1.37	1.29
75% NPK (112.5:56.25:56.25 kg ha <sup>-1</sup> )	15445.65	15445.65	27577.90	26384.00	12132.25	10938.35	0.79	0.71
75% NPK + 10 t FYM ha <sup>-1</sup>	17245.65	17245.65	36007.30	35481.10	18761.65	18235.45	1.09	1.06
75% NPK + 5 t pressmud ha <sup>-1</sup>	16995.65	16995.65	36467.20	35844.90	19471.55	18849.25	1.15	1.11
75% NPK + 5 t water hyacinth ha <sup>-1</sup>	16245.65	16245.65	35013.30	34335.60	18767.65	18089.95	1.16	1.11
75% NPK + 5 t Green manure ha <sup>-1</sup>	16995.65	16995.65	35378.70	34789.50	18383.05	17793.85	1.08	1.05
75% NPK + 10 kg BGA crust ha <sup>-1</sup>	15945.65	15945.65	34456.10	33869.90	18510.45	17924.25	1.17	1.12
50% NPK (75:37.5:37.5 kg ha <sup>-1</sup> )	14491.45	14491.45	19777.10	18007.60	5285.65	3516.15	0.36	0.24
50% NPK + 10 t FYM ha <sup>-1</sup>	16291.45	16291.45	28381.50	26926.00	12090.05	10634.55	0.74	0.65
50% NPK + 5 t pressmud ha <sup>-1</sup>	16041.45	16041.45	29164.80	27658.50	13123.35	11617.05	0.82	0.72
50% NPK + 5 t water hyacinth ha <sup>-1</sup>	15291.45	15291.45	27302.80	26325.00	12011.35	11033.55	0.79	0.72
50% NPK + 5 t Green manure ha <sup>-1</sup>	16041.45	16041.45	27887.30	26684.20	11845.85	10642.75	0.74	0.66
50% NPK + 10 kg BGA crust ha <sup>-1</sup>	14991.45	14991.45	26805.80	25682.40	11814.35	10690.95	0.79	0.71

rice indicates that significant improvement in N uptake was noticed under treatments consisting organic manure along with 100%, 75% and 50% NPK over 100%, 75% and 50% NPK alone (Fig. 1). The enhanced N uptake in these treatments might be due to adequate N availability in soil which increases the N absorption by the plants and ultimately increases the N content in grain and straw and total biological yield affected the N uptake. Similarly, Singh (2014a) reported higher N uptake under conjunctive use of organic and inorganic fertilizers in hybrid rice.

**Phosphorus uptake:** P uptake increased with increasing level of NPK and addition of organic manure like FYM, pressmud, water hyacinth, green manure and BGA. The maximum uptake of phosphorus (30.13 kg ha<sup>-1</sup> and 26.72 kg ha<sup>-1</sup>) was estimated in treatment T<sub>3</sub>, while least (7.33 kg ha<sup>-1</sup> and 6.01 kg ha<sup>-1</sup>) with treatment T<sub>13</sub> (50% NPK alone) Fig. 2. This may be due to formation of weak acids during decomposition of organic manure which helps to convert the complex forms of phosphorus in to soluble form. Availability of phosphorus increases its content in plants and total biological yield, which ultimately increases the phosphorus uptake. Kumar *et al.* (2001) reported that nutrients uptake (N, P, K, S and Zn) decrease with the reduction in levels of inorganic fertilizers either alone or in combination with FYM and BGA.

**Potassium uptake:** The K uptake as affected by different nutrient management modules have been presented in Fig.3. Maximum K uptake (175.62 and 160.70 kg ha<sup>-1</sup>) was observed in treatment T<sub>3</sub>, while minimum (58.58 kg ha<sup>-1</sup> and 52.03 kg ha<sup>-1</sup>) in treatment T<sub>13</sub> during respective years Fig. 3. The availability of K was increased might be due to application of potassic fertilizer as well as by application of organic manures. Sharma and Sharma (2002) observed that integrated application of NPK +FYM in rice crop increased uptake of N 30-45, P 7-10 and K 25-42 kg ha<sup>-1</sup>.

**Sulphur and Zinc uptake:** The nutrient management modules systems affected the S and Zn uptake by the crop. Highest S uptake noticed in treatment T<sub>3</sub>. Application of FYM and pressmud along with 100%, 75% and 50% NPK increases the S uptake significantly over alone application of 100%, 75% and 50% NPK Fig. 4. The increase in S uptake by the crop of rice might be because of increase in their content in grains and straw as well as total biological yield because uptake is the product of biological yield and concentration of nutrients. Further it is evident by the fig. 5 that maximum Zn uptake was recorded under treatment T<sub>3</sub>. Application of organic manure (FYM, pressmud, water hyacinth, green manure and BGA) along with 100%, 75% and 50% NPK significantly increase Zn uptake over 100%, 75% and 50% NPK alone treatments. Increased uptake of Zn by rice crop with application of organic manure and increase in NPK doses may be attributed to the adequate supply of this nutri-

ent, its content in grain, straw and total biomass. Singh (2014a) reported highest Zn uptake (418.46 g ha<sup>-1</sup> and 424.32 g ha<sup>-1</sup>) with 75% RDF + green manuring. Similarly, Rabeya Khamaan *et al.* (1997) observed that the application of organic manure and bio-fertilizers in addition to the recommended dose of fertilizers produced significantly higher uptake of N, P, K, Ca and S by the rice crop.

**Economic feasibility of various nutrient management modules:** Results revealed that maximum cost of cultivation (Rs. 18199.90 ha<sup>-1</sup>) was recorded in treatment T<sub>2</sub> followed by treatment T<sub>3</sub> and T<sub>5</sub> (17949.90 ha<sup>-1</sup>), while minimum cumulative cost of cultivation was incurred (Rs. 14491.45 ha<sup>-1</sup>) was in treatment T<sub>13</sub>. In respect to economic feasibility the highest net return, and benefit cost ratio (Rs. 27373.70 ha<sup>-1</sup> and Rs. 26087.00 ha<sup>-1</sup>) and (1.53 and 1.45) was computed under the treatment T<sub>3</sub> in respective years Table 3. However, minimum net return (Rs. 5285.65 ha<sup>-1</sup> and 3516.15 ha<sup>-1</sup>) and benefit cost ratio (0.36 and 0.24) was calculated under treatment T<sub>13</sub>, respectively. The net return and benefit cost ratio increased due to low cost of cultivation and higher yield of rice crop under treatment T<sub>3</sub> followed by T<sub>2</sub>. Swaroopa *et al.* (2016) reported that the cultivation of paddy under improved technology viz. use of high yielding variety, seed treatment, adequate supply of fertilizers and applying scientific practices in plant protection measure and weed management practices gave higher net return compared to farmer practices. Similarly, Singh (2014b) in a study on hybrid rice observed highest net return under plot receiving 75% RDF+green manure with 40 kg zinc sulphate ha<sup>-1</sup>

## Conclusion

In the light of results obtained in present investigation it may be concluded that treatment module of 100% NPK + 5 t pressmud ha<sup>-1</sup> resulted higher growth and grain yield (70.15 and 67.12 q ha<sup>-1</sup>) of hybrid rice crop. Application of FYM and pressmud along with 50%, 75% and 100% NPK improved uptake of nutrients (NPKS and Zn) significantly over 50%, 75% and 100% NPK alone. Similarly maximum net return (Rs. 27373.70 and Rs. 26087.00 ha<sup>-1</sup>) and benefit: cost ratio (1.53 and 1.45) was found under treatment having 100%, NPK + 5 t pressmud.

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