International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(6): 2509-2513

Received: 04-09-2019
Accepted: 06-10-2019

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# Studies on green manure incorporation and integrated nutrient management approaches on soil available nitrogen, productivity and economics in transplanted rice – rice – green gram cropping system

**S Muralidharan, K Vaiyapuri, K Ramamoorthy, R Santhi and P Jeyakumar**

**Abstract**
A Field study was conducted at wetland farm, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during *kharif- Rabi* – summer seasons (June/July, December/January, April /May, respectively) in 2014-15 and 2015-16 to study the integrated nutrient management for sustainable growth and production in rice-rice-green gram cropping sequence. The experiment was laid out in split plot design with the three replications. The main plot treatments comprised of incorporation of green manures and residue addition of 30% of paddy straw during both the kharif and rabi season in rice viz., $M_1$- *kharif*- No application of green manure; *rabi*- No application of crop residue, $M_2$- *kharif*- Dhaincha@ 6.25t $ha^{-1}$; *rabi*-No. application of crop residue, $M_3$-*kharif*- No application of crop residue; *rabi*-Residue addition of 30% paddy straw and $M_4$- *kharif*- Dhaincha@6.25t/ha; *rabi*- Residue addition of 30% paddy straw and subplot consists of various fertilizer management approaches- $S_1$-Recommended dose of NPK, $S_2$- STCR approach, $S_3$- LCC based N application. The soil N status, yield and economics were assessed during the course of study. The results revealed that the treatment combination of $M_4S_3$ ($M_4$-*kharif*- Dhaincha@ 6.25t $ha^{-1}$; *rabi*- Residue addition of 30% paddy straw; $S_3$- LCC based N application) found to be significantly superior over the other treatments.

**Keywords:** Soil available N**,** dhaincha, yield and economics

## Introduction
Rice (*Oryzasativa* L.) is well known as' Wonder cereal' and is cultivated in a variety of ecological zones with wide variations in productivity. Interestingly, it is the crop that cannot be replaced by any other crop in high rainfall areas and deltaic river belts in the world. Stagnation in yield levels and increased food demand warrant an urgent need to increase the productivity of rice, the staple food for millions of people in Asia. In Asia alone, more than 2.0 billion people obtained 60 to 70 percent of their food energy from rice alone and its derived products (Kumar, 2005). India is the leading rice producer in terms of area and the second largest country in terms of productivity next to China. In India, rice is cultivated in 44.1 million hectares with an annual production of approximately 105.5 million tons and in Tamil Nadu alone contributed 3.9 percent to national rice production from an area of 2.0 million hectares with a production of 4.1 MT (Indiastat, 2018). The yield level of rice had to rise by 25 to 30 percent from the current level if the country had to remain self-sufficient by 2050.
The present study was formulated to establish most suitable and economic integrated approach of nutrient management under rice - rice - green gram cropping system with the objectives of studying the growth and productivity of sustainable rice crop production system with residue recycling and nutrient management approaches to advocate the most suitable nutrient management practice in rice – rice – green gram in sequential cropping system and working out the economics for sustainable rice production in the system as a whole.

## Material and Methods
A Field experiment was conducted at Wetland farm, Department of Farm Management, Tamil Nadu Agricultural University, Coimbatore during 2014-16 to investigate the impact of

"Integrated nutrient management for sustainable growth and production in Rice- Rice - Green gram cropping system" on clay loam soils in Western agro-climatic zone of Tamil Nadu.). The soil of the experimental site was slightly alkaline (pH = 7.76) with low soluble salts (EC = 0.63 $dSm^{-1}$), medium in organic carbon content (0.68%), low in available Nitrogen (241 kg $ha^{-1}$), medium in Phosphorus (35.0 kg $ha^{-1}$) and high in potassium (451 kg $ha^{-1}$). The experiment was laid out in a split plot design having four main plot treatments and three subplot treatments replicated thrice. The treatment details of the experiment were as follows

The treatment details of the experiment were as follows

| | I Crop | II Crop |
|---|---|---|
| $M_1$ | No application of green manure | No Application of crop residue |
| $M_2$ | Dhaincha @6.25 t/ha | No Application of crop residue |
| $M_3$ | No Application of crop residue | Paddy straw residue Addition @ 30% |
| $M_4$ | Dhaincha @6.25 t/ha | Paddy straw residue Addition @ 30% |

The sub plot treatments were as follows

| Sub plot | | |
|---|---|---|
| $S_1$ | : | Recommended dose of NPK |
| $S_2$ | : | STCR approach |
| $S_3$ | : | LCC based N application |

Inorganic fertilizer was applied based on the treatment schedules. Initially recommended dose of fertilizer (150:50:50) N, P2O5 and $K_2O$ kg $ha^{-1}$were applied in the form of Urea, SSP and MOP ($S_1$). Prior to sowing, soil sample were collected from the experimental plot for the detection of N, $P_2O_5$ and $K_2O$ content based on STCR approach. In LCC approach that followed, $P_2O_5$ and $K_2O$ were applied in full dose as basal, nitrogen was applied in four equal splits viz., at 50% at basal and remaining N at three equal split viz., active tailoring, and panicle initiation and flowering stages. Dhaincha (*Sesbania aculeate*) was incorporated @ 6.25 t $ha^{-1}$ on dry weight basis two weeks prior to transplanting along with the recommended dose of 150:50:50 NPK kg $ha^{-1}$, where N, P and K were applied in the form of urea, single super phosphate and muriate of potash to the rice crop (*Kharif* season). As per the treatment schedule to the second crop of rice (*Rabi* season), 30% of paddy straw residue was incorporated two weeks prior to transplanting. However no fertilizers were applied to the summer raised green gram which utilizes only the residual nutrients for its growth and development. The seed rate used for study was 60 kg $ha^{-1}$ of rice with a spacing of 20 x 10 cm and seed rate of 20-25 kg $ha^{-1}$ with a spacing of 30 x 10 cm for green gram.

## Results and Discussion

### Soil available nitrogen

Soil available nitrogen was highly influenced by the incorporation of Dhaincha @ 6.25 t $ha^{-1}$ and residue addition of 30% paddy straw residue during both the years of 2015 and 2016. Incorporation of Dhaincha in the first crop of rice and residue addition of 30% paddy straw in the second crop of rice ($M_4$) registered higher soil available N (244.02 and 269.14 kg $ha^{-1}$) during summer 2015 and 2016. The lower soil available N was recorded in the treatment $M_1$ (175.33 and 193.37 kg $ha^{-1}$) during the respective stages. Among the subplot treatments, the fertilizer recommendation as per LCC based N application method ($S_3$) recorded higher soil available N (974 and 890 kg $ha^{-1}$) during summer 2015 and 2016 as compared to other fertilizer application approaches. Interaction effect have showed significant effect over the grain yield of green gram by the addition of Dhaincha @ 6.25 t $ha^{-1}$and 30% of paddy straw residue with LCC based N application ($M_4S_3$) produced higher soil available N (255.61 and 281.76 kg $ha^{-1}$) during summer 2015 and similar trend was noticed during 2016. The lower soil available N was recorded in the treatment combination $M_1S_1$ (156.00 and 172.11 kg $ha^{-1}$) simultaneously during both the years of study irrespective of the season as compared to all treatment combinations. This might be due to combined use of organic and inorganic sources of nutrients which in turn could attribute better synchrony of nutrient availability to the rice crop resulting in better biomass production and higher nitrogen use efficiency. Similar findings are also reported by Mwale *et al*., 2000 [5]. The INM practices found to enhance the microbial activity which in turn stimulated the conversion of unavailable nutrients into available form through improving the physico- chemical properties of the soil (Katkar *et al*., 2011) [1].

### Yield of rice

Grain yield recorded during both *kharif* and *rabi* seasons were significantly influenced by the integrated nutrient management practices. Among the main plot treatments, incorporation of Dhaincha @6.25t $ha^{-1}$ during first season with the addition of 30% crop residue in the second season recorded higher grain (6481 and 5396 kg $ha^{-1}$) and straw yield (10396 and 9994 kg $ha^{-1}$) during *kharif* and *rabi* seasons respectively during irrespective of the seasons and year of study. With regard to fertilizer recommendation, fertilizer applied as per the LCC based N application ($S_3$) registered higher grain yield irrespective of the seasons and years of study. The fertilizer application as per LCC based N application ($S_3$) recorded higher grain yield (5487and 4983 kg $ha^{-1}$) and straw yield (8831and 8444 kg $ha^{-1}$) during *kharif* and *rabi* 2014 respectively. Similar trend was obtained during 2015 in both the seasons. Interaction effect was significant in the treatment combination where Dhaincha was incorporated at 6.25t $ha^{-1}$in the first crop of rice and residue addition of 30% of paddy straw along with LCC based N application ($M_4S_3$) produced higher grain yield in both the seasons of 2014 and 2015 which recorded significantly higher grain yield (6777 and 5998 kg $ha^{-1}$) during kharif and rabi during 2014 respectively. The same treatment combination recorded higher grain yieldin rice irrespective of the seasons of both 2014 and 2015. In both the seasons of study the lowest grain yield was found in $M_1S_1$. (No application of green manure and recommended dose of NPK) which recorded (3835 and 3765 kg $ha^{-1}$) during kharif and rabi. Similar trend was recorded during 2015 also irrespective of the seasons. Increase in yield of rice with nitrogen application might be due to higher N uptake, resulting in higher biomass production and photo synthates translocation to reproductive parts. Improvement in the nutrient use efficiency of the applied inorganic nitrogen in transplanted rice after green manure incorporation; also may be the reason for higher yield. This result was supported by Yadvinder-Singh *et al*. (1991) [7].

### Residual effect on succeeding green gram

Significant impact was noticed by incorporation of Dhaincha@6.25 t $ha^{-1}$ and residue addition of 30% paddy straw residue in rice crops with regard to grain yield of green gram. Incorporation of Dhaincha in the first crop of rice and residue addition of 30% paddy straw in the second crop of

rice ($M_4$) registered higher grain yield (604 and 579 kg ha$^{-1}$) and haulm yield (1243 and 1210 kg ha$^{-1}$) during summer 2015 and 2016 respectively. This was next followed by treatment $M_2$ during the summer season of both the years. The lower grain yield was recorded in the treatment $M_1$ (449 and 424 kg ha$^{-1}$) during the same respective stages. Among the subplot treatment, the fertilizer recommendation as per LCC based N application method ($S_3$) recorded higher grain yield of green gram (552 and 521 kg ha$^{-1}$) during summer 2015 and 2016 respectively when compared to other fertilizer application methods. Interaction effect have showed significant effect over the grain yield of green gram by the addition of Dhaincha@ 6.25 t ha$^{-1}$ and 30% of paddy straw residue with LCC based N application ($M_4S_3$) produced higher grain yield (625 and 634 kg ha$^{-1}$) during summer 2015 and similar trend was noticed during 2016 respectively. The lower grain yield was recorded in the treatment combination $M_1S_1$ (401 and 387 kg ha$^{-1}$) simultaneously during both the years of study irrespective of the season. These results are in conformity with Pramanick *et al.* (2007).

**Economics**

The economic analysis of integrated nutrient management revealed that higher economic benefits were realized under $M_4S_3$ ($M_4$-*kharif*- Dhaincha @ 6.25t ha$^{-1}$; *rabi*- Residue addition of 30% paddy straw; $S_3$- LCC based N application) ratio was also associated with $M_4S_3$ ($M_4$-*kharif*- Dhaincha @ 6.25t ha$^{-1}$; *rabi*- Residue addition of 30% paddy straw; $S_3$- LCC based N application) (3.99 and 4.08). It may be concluded that $M_4S_3$ ($M_4$-*kharif*- Dhaincha @ 6.25t ha$^{-1}$; *rabi*- Residue addition of 30% paddy straw; $S_3$- LCC based N application) can be a suitable and economical integrated nutrient management for transplanted rice and higher productivity. The cost of cultivation was higher in all the treatments compared to control, which might be due to additional inputs. The highest gross returns, net returns and returns per rupee investment were recorded with $M_4S_3$. This might be due to higher yields of rice - rice-greengram sequence that resulted in higher net returns and benefit cost ratio. These results are in conformity with Mathew (1994) [4].

**Table 1:** Effect on post-harvest soil available N (kg ha$^{-1}$) as influenced by INM on succeeding greengram during summer 2015-16

| Treatment | Soil available N (kg ha$^{-1}$)- Summer 2015 | | | | Soil available N (kg ha$^{-1}$)- Summer 2016 | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 156.00 | 184.00 | 186.00 | 175.33 | 172.11 | 203.00 | 205.00 | 193.37 |
| $M_2$ | 202.00 | 211.00 | 214.00 | 209.00 | 223.23 | 221.00 | 236.43 | 226.89 |
| $M_3$ | 187.13 | 198.54 | 207.43 | 197.70 | 207.00 | 226.32 | 229.12 | 220.81 |
| $M_4$ | 232.32 | 244.12 | 255.61 | 244.02 | 256.65 | 269.00 | 281.76 | 269.14 |
| Mean | 194.36 | 209.42 | 215.76 | | 214.75 | 229.83 | 238.08 | |

| | M | S | M at S | S at M | M | S | M at S | S at M |
|---|---|---|---|---|---|---|---|---|
| SEd | 10.46 | 4.07 | 12.39 | 8.13 | 11.09 | 8.14 | 17.31 | 16.28 |
| CD(P=0.05) | 25.60 | 8.62 | 29.16 | 17.25 | 27.13 | 17.26 | 39.02 | 34.51 |

Main plot Sub plot

| | I Crop | II Crop | | |
|---|---|---|---|---|
| $M_1$ | No application of green manure | No Application of crop residue | $S_1$ | Recommended dose of NPK |
| $M_2$ | Dhaincha @6.25 t/ha | No Application of crop residue | $S_2$ | STCR approach |
| $M_3$ | No Application of crop residue | Residue Addition of 30% paddy straw | $S_3$ | LCC based N application |
| $M_4$ | Dhaincha @6.25 t/ha | Residue Addition of 30% paddy straw | | |

(192493ha$^{-1}$ and 195073 ha$^{-1}$) followed by $M_2S_2$ ($M_2$- *kharif*- Dhaincha @ 6.25t ha$^{-1}$; *rabi*-No. application of crop residue, $S_2$- STCR approach (163239 ha$^{-1}$ and 161607 ha$^{-1}$) cropping system as a whole during 2014-15 and 2015-16. Higher benefit-cost

**Table 2:** Grain yield (kg ha$^{-1}$) as influenced by INM practices in rice during *kharif* 2014-15

| Treatment | Grain yield (kgha$^{-1}$) – Kharif 2014 | | | | Grain yield (kg ha$^{-1}$) – Rabi 2014 | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 3835 | 4206 | 4748 | 4263 | 3765 | 3911 | 4577 | 4084 |
| $M_2$ | 4885 | 5967 | 5481 | 5444 | 4761 | 5440 | 4475 | 4892 |
| $M_3$ | 4245 | 5887 | 4940 | 5024 | 5063 | 5593 | 4882 | 5179 |
| $M_4$ | 5905 | 6760 | 6777 | 6481 | 5276 | 4915 | 5998 | 5396 |
| Mean | 4718 | 5705 | 5487 | | 4716 | 4965 | 4983 | |
| | M | S | M at S | S at M | M | S | M at S | S at M |
| SEd | 247 | 170 | 371 | 339 | 223 | 131 | 309 | 263 |
| CD(P=0.05) | 605 | 359 | 841 | 719 | 546 | 278 | 708 | 557 |

**Table 2a:** Straw yield (kg ha$^{-1}$) as influenced by INM practices in rice during *rabi* 2014-15

| Treatment | Straw yield (kg ha$^{-1}$) - Kharif 2014 | | | | Straw yield (kg ha$^{-1}$) - Rabi 2014 | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 5562 | 6566 | 7936 | 6688 | 5704 | 7617 | 6533 | 6618 |
| $M_2$ | 8977 | 10549 | 9134 | 9553 | 7231 | 8017 | 8185 | 7811 |
| $M_3$ | 7041 | 8418 | 7380 | 7613 | 8242 | 8420 | 8082 | 8248 |
| $M_4$ | 9575 | 10743 | 10871 | 10396 | 9124 | 9879 | 10978 | 9994 |
| Mean | 7789 | 9069 | 8831 | | 7575 | 8483 | 8444 | |
| | M | S | M at S | S at M | M | S | M at S | S at M |
| SEd | 370 | 141 | 436 | 283 | 425 | 234 | 572 | 468 |
| CD(P=0.05) | 905 | 300 | 1027 | 599 | 1041 | 497 | 1316 | 993 |

Main plot Sub plot

| | I Crop | II Crop | | |
|---|---|---|---|---|
| $M_1$ | No application of green manure | No Application of crop residue | $S_1$ | Recommended dose of NPK |
| $M_2$ | Dhaincha @6.25 t/ha | No Application of crop residue | $S_2$ | STCR approach |
| $M_3$ | No Application of crop residue | Residue Addition of 30% paddy straw | $S_3$ | LCC based N application |
| $M_4$ | Dhaincha @6.25 t/ha | Residue Addition of 30% paddy straw | | |

**Table 3:** Grain yield (kg ha$^{-1}$) as influenced by INM practices in rice during *kharif*2015

| Treatment | Grain yield ( kg ha$^{-1}$) – kharif 2015 | | | | Grain yield (kg ha$^{-1}$) – Rabi 2015 | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 4340 | 4941 | 4809 | 4697 | 4138 | 5042 | 4859 | 4680 |
| $M_2$ | 5425 | 5696 | 5295 | 5472 | 4687 | 5780 | 5265 | 5244 |
| $M_3$ | 5188 | 4680 | 5430 | 5099 | 5549 | 4595 | 5365 | 5170 |
| $M_4$ | 6370 | 6745 | 6920 | 6679 | 5498 | 6053 | 6093 | 5881 |
| Mean | 5331 | 5516 | 5614 | | 4968 | 5368 | 5396 | |

| | M | S | M at S | S at M | M | S | M at S | S at M |
|---|---|---|---|---|---|---|---|---|
| SEd | 232 | 151 | 339 | 303 | 265 | 166 | 379 | 333 |
| CD(P=0.05) | 569 | 321 | 772 | 642 | 648 | 352 | 864 | 705 |

**Table 3a:** Straw yield (kg ha$^{-1}$) as influenced by INM practices in rice during *kharif* 2015

| Treatment | Straw yield (kg ha$^{-1}$) - kharif 2015 | | | | Straw yield (kg ha$^{-1}$) - Rabi 2015 | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 6979 | 8066 | 9173 | 8073 | 5404 | 7103 | 7959 | 6822 |
| $M_2$ | 9292 | 7825 | 8025 | 8381 | 7807 | 7291 | 9473 | 8190 |
| $M_3$ | 7804 | 8247 | 8994 | 8349 | 6538 | 7317 | 8615 | 7490 |
| $M_4$ | 9109 | 10891 | 10791 | 10263 | 10155 | 9773 | 10018 | 9982 |
| Mean | 8296 | 8757 | 9246 | | 7476 | 7871 | 9016 | |

| | M | S | M at S | S at M | M | S | M at S | S at M |
|---|---|---|---|---|---|---|---|---|
| SEd | 345 | 207 | 483 | 414 | 321 | 227 | 490 | 454 |
| CD(P=0.05) | 844 | 439 | 1105 | 879 | 785 | 481 | 1108 | 962 |

Main plot Sub plot

| | I Crop | II Crop | | |
|---|---|---|---|---|
| $M_1$ | No application of green manure | No Application of crop residue | $S_1$ | Recommended dose of NPK |
| $M_2$ | Dhaincha @6.25 t/ha | No Application of crop residue | $S_2$ | STCR approach |
| $M_3$ | No Application of crop residue | Residue Addition of 30% paddy straw | $S_3$ | LCC based N application |
| $M_4$ | Dhaincha @6.25 t/ha | Residue Addition of 30% paddy straw | | |

**Table 4:** Grain yield kg ha$^{-1}$ by INM of greengram during summer 2015-16

| Treatment | Grain yield kg ha$^{-1}$ (2015) | | | | Grain yield kg ha$^{-1}$ (2016) | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 401 | 472 | 474 | 449 | 387 | 462 | 424 | 424 |
| $M_2$ | 484 | 477 | 584 | 515 | 458 | 533 | 518 | 503 |
| $M_3$ | 450 | 513 | 527 | 497 | 501 | 436 | 506 | 481 |
| $M_4$ | 573 | 614 | 625 | 604 | 580 | 522 | 634 | 579 |
| Mean | 477 | 519 | 552 | | 482 | 488 | 521 | |

| | M | S | M at S | S at M | M | S | M at S | S at M |
|---|---|---|---|---|---|---|---|---|
| SEd | 23 | 11 | 29 | 22 | 21 | 12 | 29 | 25 |
| CD(P=0.05) | 57 | 23 | 68 | 47 | 52 | 26 | 67 | 53 |

**Table 4a:** Haulm yield kg ha$^{-1}$ by INM of green gram during summer2015-16

| Treatment | haulm yield kg ha$^{-1}$ (2015) | | | | haulm yield kg ha$^{-1}$ (2016) | | | |
|---|---|---|---|---|---|---|---|---|
| | $S_1$ | $S_2$ | $S_3$ | Mean | $S_1$ | $S_2$ | $S_3$ | Mean |
| $M_1$ | 879 | 1017 | 1026 | 974 | 796 | 933 | 942 | 890 |
| $M_2$ | 1150 | 1034 | 1166 | 1117 | 940 | 1045 | 1061 | 1015 |
| $M_3$ | 1109 | 1124 | 1134 | 1122 | 1005 | 1020 | 1030 | 1018 |
| $M_4$ | 1188 | 1237 | 1304 | 1243 | 1154 | 1212 | 1265 | 1210 |
| Mean | 1082 | 1103 | 1158 | | 974 | 1053 | 1075 | 1034 |

| | M | S | M at S | S at M | M | S | M at S | S at M |
|---|---|---|---|---|---|---|---|---|
| SEd | 47 | 29 | 67 | 59 | 46 | 32 | 69 | 64 |
| CD(P=0.05) | 115 | 62 | 153 | 124 | 112 | 68 | 157 | 136 |

Main plot Sub plot

| | I Crop | II Crop | | |
|---|---|---|---|---|
| $M_1$ | No application of green manure | No Application of crop residue | $S_1$ | Recommended dose of NPK |
| $M_2$ | Dhaincha @6.25 t/ha | No Application of crop residue | $S_2$ | STCR approach |
| $M_3$ | No Application of residue | Residue Addition of 30% paddy straw | $S_3$ | LCC based N application |
| $M_4$ | Dhaincha @6.25 t/ha | Residue Addition of 30% paddy straw | | |

**Table 5:** Economic of rice rice green gram cropping system 2014-16

| Treatment | 2014-15 | | | | 2015-16 | | | |
|---|---|---|---|---|---|---|---|---|
| | Cost of Cultivation (Rs./ha) | Gross return (Rs./ha) | Net return (Rs./ha) | BCR | Cost of Cultivation (Rs./ha) | Gross return (Rs./ha) | Net return (Rs./ha) | BCR |
| M1S1 | 56873 | 151198 | 94325 | 2.66 | 56343 | 164374 | 108031 | 2.92 |
| M1S2 | 55543 | 168626 | 113083 | 3.04 | 54846 | 195139 | 140293 | 3.56 |
| M1S3 | 56357 | 185636 | 129279 | 3.29 | 55731 | 192343 | 136612 | 3.45 |
| M2S1 | 60223 | 194098 | 133875 | 3.22 | 59603 | 200481 | 140878 | 3.36 |
| M2S2 | 58893 | 222132 | 163239 | 3.77 | 58196 | 219803 | 161607 | 3.78 |
| M2S3 | 59707 | 207005 | 147298 | 3.47 | 59081 | 211227 | 152146 | 3.58 |
| M3S1 | 61223 | 185475 | 124252 | 3.03 | 60603 | 206199 | 145596 | 3.40 |
| M3S2 | 60547 | 222002 | 161455 | 3.67 | 59196 | 184681 | 125485 | 3.12 |
| M3S3 | 60289 | 197776 | 137487 | 3.28 | 60081 | 213841 | 153760 | 3.56 |
| M4S1 | 64573 | 225587 | 161014 | 3.49 | 63953 | 236446 | 172493 | 3.70 |
| M4S2 | 63661 | 238767 | 175106 | 3.75 | 62546 | 248032 | 185486 | 3.97 |
| M4S3 | 64293 | 256786 | 192493 | 3.99 | 63431 | 258504 | 195073 | 4.08 |

Data not statistically analysed

## Conclusion

From the above results, it can be concluded that higher soil available nitrogen, yield, gross returns and net returns were obtained with $M_4S_3$ ($M_4$-*kharif*- Dhaincha@ 6.25t $ha^{-1}$; *rabi*- Residue addition of 30% paddy straw with $S_3$- LCC based N application), however it was on par with $M_4S_3$ ($M_2$- *kharif*- Dhaincha@ 6.25t $ha^{-1}$; *rabi*-No. application of crop residue, $S_2$- STCR approach). Over all, it can be concluded that from the present investigation, $M_4S_3$ ($M_4$-*kharif*- Dhaincha@ 6.25t $ha^{-1}$; *rabi*- Residue addition of 30% paddy straw; $S_3$- LCC based N application) can be recommended for effective integrated nutrient management and higher productivity and profitability of transplanted rice.

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