# Influence of Planting Methods and Integrated Nutrient Management on Growth, Yield and Economics of Rice

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**Abstract**

**A field experiment was conducted during *kharif* season of 2010-11 and 2011-12 at AICRP on Rice, Agricultural Research Institute (ARI), Rajendranagar, Hyderabad to evaluate different planting methods (SRI, Yangi - China, Kobota transplanter and farmers method) and Integrated Nutrient Management (INM) The experiment was comprising four different planting methods (SRI method of planting (M1), Yangi-China transplanter (M2), Kobota tranplanter (M3) and farmer's method (M4)) as main plots and four INM practices ($I_1$, (100%RDF + FYM @ 5 t ha$^{-1}$), $I_2$ (100%RDF + FYM @ 5 t ha$^{-1}$), $I_3$ (100%RDF +BF @ 7.5 kg/ha (*Azosprillium* @2.5 kg/ha +PSB @ 5 kg ha$^{-1}$) and $I_4$ only RDF (100% RDF 150:60:40 kg NPK ha$^{-1}$) as sub plots in split plot design replicated thrice. The plant height and biomass production of rice at the time of harvest during both the years was higher with Kobota transplanter method among planting methods and with integrated use of 100% RDF + FYM @ 5 t ha$^{-1}$among Integrated Nutrient Management (INM) practices. The maximum mean grain, straw yield and B:C ratio (Average of two years) was recorded with machine (Kobota) transplanting (7.0,16.02 t ha$^{-1}$ and 2.20) followed by farmers method (manual) of planting (6.30, 13.32 t ha$^{-1}$ and 2.00) that was on par with SRI method (5.8, 11.40 t ha$^{-1}$ and 1.60). The lowest mean grain, straw yield and B:C was obtained with Yangi - China transplanter (5.20, 8.42 t ha$^{-1}$ and 1.30). Among the INM treatments significantly superior mean grain, straw yield and B:C ratio were registered with application of 100% RDF + FYM @ 5 t/ ha (6.90, 15.60 t ha$^{-1}$ and 2.00) respectively over the remaining, INM treatments. Application of GLM @ 5 t ha$^{-1}$ + RDF produced higher mean grain and straw yield (6.40 and 13.30 t ha$^{-1}$) and B:C ratio (1.80) followed by RDF + BF 7.5 kg/ha). Significant interaction effect was obtained in straw yield and B:C ratio (Pooled mean). Transplanting with Kobota transplanter along with application of FYM @ 5 t ha$^{-1}$ + RDF ($M_3I_1$) was found best with significantly**

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**highest straw yield over the other combinations and was at par with farmers method of planting along with RDF + FYM @ 5 t ha$^{-1}$ ($M_4I_1$). The average of two years (pooled mean) of B:C ratio was significantly higher with Kobota transplanter along with RDF+FYM @5 t ha$^{-1}$ (2.40) and was at par with RDF+GLM @ 5 t ha$^{-1}$ (2.23) and only RDF (2.10) with the same planting method ($M_3I_2$, $M_3I_4$) and with farmers method of transplanting with RDF +FYM @ 5 t ha$^{-1}$ (2.37) and RDF+GLM @5 t ha$^{-1}$ (2.10).**

**Key words:** SRI, Transplanter, methods, RDF, B:C ratio.

**R**ice is the staple food crop in Asia including India. In the year 2011, the area under rice in India 44.41 m ha with a production of 104 m ha with productivity of 2.2 t ha$^{-1}$ CMIE, 2011). In Andhra Pradesh the area was 4.0 lakh ha and production is 12.8 lakh tonnes. Rice is mainly grown in canal command areas with assured irrigation facilities. Rice is traditionally planted as transplanting method but in recent years, because of scarce labour coupled with higher wages during the peak period of farm operations invariably lead to delay in transplanting. This was aggreviated by untimely release of water from canals and delayed monsoon showers. This lead to indenting alternate methods of rice cultivation without reduction in yield. Among them, transplanting using mechanical transplanter and SRI method of cultivation gained significance among farmers became of easy adoptability and on par yield with that of conventional transplanting method. Rice transplanters are available from different companies. Mechanization (both for planting and harvesting) in rice cultivation revolutioned the rice cultivation by decreasing cost of cultivation. In Andhra Pradesh, which is called as " rice bowl of India", rice growing has become burden on farmers as the cost of labour increased many fold with similar yield. On the other side, mechanical transplanting has its own disadvantages like special nursery, non uniformity in number of seedlings hill$^{-1}$ and main field preparation. Introduction of high yielding varieties responsive to chemical nutrients brought a spectacular increase in use of chemical fertilizers in rice. Nutrient mining by high yielding varieties was usually more than that applied through chemical fertilizers. This type of nutrient mining over years led to improverishment of soil fertility and decline in crop productivity (Nambiar, 1992). Integrated use of chemical fertilisers with manures and green manure crop is important for sustainable rice production. The increased prices of fertilizers also intensified the problem by increasing cost of inputs. Hence the mechanical transplanters and INM practices were evaluated with an aim to reduce the cost of cultivation.

## Materials and Methods

A field experiment was conducted during *kharif* season of 2010-11 and 2011-12 at AICRP on Rice, Agricultural Research Institute, Rajendranagar, Hyderabad. The Soil of the experiment field was Sandy clay loam in texture with pH 7.7, organic carbon 0.67% and available N, $P_2O_5$ and $K_20$ as 245.61, 38.5 and 301 kg/ha respectively during *kharif* season of 2010-11 and during *kharif* season of 2011-12 with pH 7.82, organic carbon 0.65 and available N, $P_2O_5$ and $K_2O$ as 215.1,31.6 and 288.2 kg $ha^{-1}$ respectively. The total rain fall received during *kharif* 2010 [1 st July- 30 October (120 days)] was 485.9 mm in 31 rainy days and during 2011[July –October (127)] the crop period recorded 615.8 mm in 39 rainy days. The experiment was replicated thrice with 16 treatmental combinations comprising four different planting methods (SRI method of planting (M1), Yangi-China transplanter (M2),Kobota tranplanter (M3) and farmer's method (M4)) as main plots and four INM practices $I_1$ (100%RDF + FYM @ 5 t $ha^{-1}$), $I_2$ (100%RDF + FYM @ 5 t $ha^{-1}$), $I_3$ (100%RDF +BF @ 7.5 kg $ha^{-1}$ (*Azosprillium* @2.5 kg $ha^{-1}$ +PSB @ 5 kg $ha^{-1}$) and $I_4$ only RDF (100% RDF 150:60:40 kg NPK $ha^{-1}$) as sub plots in split plot design. The two types of transplanter's transplanted by using mat tray nursery at 15 days old seeding with fixed inter row spacing 30 cm for Kobota and 22.5 cm for Yangi-China transplanter with varying intra row spacing (can be adjusted as per requirement) 12 and 14 cm respectively maintained (fixed) in mechanical transplanters. For SRI method used markers (25 x 25 cm) and transplanted with women labour at 10 days old seedlings and for farmers method of transplanting 25-30 days old seedlings were used and transplanted using labour. FYM and GLM were incorporated one week before transplanting and 100 g SSP was added to GLM treatment for quick decomposition. Rice variety "Satya" was used for the experiment. Organic manures *i.e* FYM and (GLM) @ 5 t $ha^{-1}$ were applied one week before transplanting 1/3 nitrogen, total phosphorus and 2/3 potassium were applied as basally at the time of transplanting. $1/3^{rd}$ N was applied at maximum tillering stage and remaining 1/3 rd N and 1/3 potassium were applied at panicle initiation stage. Nitrogen, phosphorus and potassium were applied in the form of urea, single super phosphate (SSP) and muriate of potash (MOP) respectively. The crop was sown on $1^{st}$ July in both the years. Biofertilizers *i.e* *Azospirillum* @ 2.5 kg $ha^{-1}$ and PSB @ 5 kg $ha^{-1}$ were applied 3 days after transplanting. In SRI method, cono weeder was operated for 3-4 times for control of weeds and aeration but for remaining planting methods, pre-emergence application of butachlor @ 1.5 kg *ai* ha$^{-1}$ was applied 2 days after transplanting followed by one hand weeding at 30 DAT for weed control. The yield attributes, grain and straw yield were recorded at the time of harvest. Economics was calculated based on the cost of prevailing market rate of inputs and yield of rice crop.

Plant height is a direct index to measure the growth and vigour of the plant. The plant height in all planting methods at the time of harvest were insignificant indicating that all the tested planting methods showed at par effect on growth of rice after establishment (Table 1). The effect of INM practices on plant height at harvest revealed that application of FYM @ 5 t ha$^{-1}$ + RDF had registered taller plants over the other treatments during both the years. Application of biofertilizer @ 7.5 kg ha$^{-1}$ produced lesser plant height than FYM but significantly at par with green leaf manuring of Dhaincha @ 5 t ha$^{-1}$ along with RDF during *kharif* 2010-11. The mineralisation during the decomposition of organic manures (FYM and green manure) due to integrated use of inorganic fertilisers might have enhanced nitrogen availability in the rhizosphere resulting in increased nitrogen uptake by the crop which in turn promoted the increase in plant height in the above treatments. Further, synchronised availability of essential plant nutrients to the crop for a longer period with use of organic manures along with inorganic fertilisers has increased plant height as the crop growth advanced Harish *et al.* (2011). The interaction effect of planting methods and INM practices was found insignificant during both the years.

Dry matter production at harvest varied between 1.21 and 2.46 kg ha$^{-1}$ irrespective of treatments. Transplanting with Kobota transplanter has registered highest dry matter production over (2.14, 2.46 kg m$^{-2}$) the other planting methods during both the years. This is because of optimum plant population and tillering ability of the crop. Followed to this, significantly higher dry matter production was observed in farmers method followed by SRI method during both the years. Transplanting with Yangi-China transplanter produced lowest dry matter production during both the years. This may be attributed to non uniform transplanting and less number of tillers hill$^{-1}$. This was supported by Anbumani *et al.* 2004. Among the INM practices, application of FYM @ 5 t ha$^{-1}$ along with RDF has accounted to significantly higher dry matter production (2.09 and 2.41 kg m$^{-2}$) over the other treatments during both the years followed by RDF + GLM @ 5 t ha$^{-1}$ and RDF + BF@ 7.5 kg ha$^{-1}$. Application of RDF alone registered lowest dry matter production during both the years. This may be attributed that combined application of inorganic fertiliser and organic manure could have helped in balanced availability of nutrients till harvesting time Siddarama *et al.* (2011). Similar findings of higher dry matter accumulation with application of FYM, green manuring and biofertilisers was reported by Jagadish Kumar *et al* (2010), Anchal Dass *et al.* (2009) and Balaji Naik and Yakadri, (2004). Interaction between planting methods and INM practices (Table 2.a) revealed that transplanting with Kobota transplanter along with the application of FYM @ 5 t ha$^{-1}$ + RDF was noted to be the best combination with highest dry matter production 2.77 and 2.50 kg m$^{-2}$ in pooled analysis. However, it was followed RDF + FYM @ 5 t ha$^{-1}$ along with farmers method ($M_4$ $I_1$) and significantly at par with RDF + GLM @ 5 t ha$^{-1}$ along with Kobota transplanter ($M_3$ $I_2$) .

Panicles m$^{-2}$ of rice was significantly influenced by planting methods and INM practices during both the years except that INM practices were insignificant during 2011-12. Among the planting methods, transplanting with Kobota transplanter was found best with maximum no. of panicles m$^{-2}$ (498.9 and 566.2) over the other treatments in both the years. However, manual transplanting in farmer's method was found at par to machine transplanting with Kobota with respect to panicle number m$^{-2}$ during both the years. The increase in panicles m$^{-2}$ with Kobota transplanter was mainly due to optimum plant population and plant geometry (30 x 12cm) that resulted in even distribution of light, moisture and nutrients among rice plants in a unit area leading to manifestation of ideal growth and yield attributes. This was supported by Anbumani *et al.* (2004) and Singh *et al.* (2009). Followed to this, farmer's method followed by SRI method produced more number of panicles m$^{-2}$. Transplanting with Yangi-China has putforth crop with lowest number of panicles during both the years.

Effect of INM practices on panicles/m$^2$ was insignificant during 2011-2012. Of the different INM practices, application of FYM @ 5 t ha$^{-1}$ + RDF registered highest panicle number m$^{-2}$ over the other treatments during both the years. But in 2010, green leaf manure treatment along with RDF was found at par to the above treatment with comparably higher panicles m$^{-2}$. Increase in panicles m$^{-2}$ through FYM was supported by Barik *et al*. (2006) and Mirza *et al.* (2005) and through green manuring was supported by Vaiyapuri and Sri Ramachandra Sekaran, (2002). Application of bio fertilizers + RDF produced less number of panicles m$^{-2}$ than above treatments but higher than only RDF. The beneficial effict of biofertilizers was reported by Anchal Dass *et al.* (2009) and Jagdish Kumar *et al.* (2010). Application of RDF alone without any supplementation of organic manures recorded least number of panicles $m^{-2}$. The interaction was found insignificant during both the years.

Significantly highest number of grains/panicle was noted due to transplanting by Kobota transplanter, compared to other transplanting methods during both the years. However, it was at par with farmers method of planting during 2011-12. This may be due to more light interception because of wider spacing (30 x 12 cm), that resulted in more dry matter accumulation and partitioning in to sink (panicles). Farmers method of transplanting produced next higher number of grains panicle $^{-1}$, but was at par with SRI method during both the years and its pooled mean and also with Yangi- China transplanter during 2010-11 only. Lower number of grains/panicle was reported with Yangi- China transplanter method. Among the INM practices, application of RDF + FYM @ 5t ha $^{-1}$ produced more number of grains/panicle during both the years. However it was at par with RDF + GLM @ 5 t ha $^{-1}$ during 2011-12. Nutrients available from decomposing FYM to the rice crop during the reproductive stage were utilised for grain formation and grain filling leading to higher no. of grains per panicle. This was supported by Mirza *et al.* (2005). Application of RDF + GLM @ 5t ha $^{-1}$ attained next level of grains /panicle during 2010-11 but was at par with RDF + BF @ 7.5 kg ha$^{-1}$ during 2010-11. Biofertilizers + RDF gave rise to next level of number of grains/panicle but significantly higher than only RDF application except during 2011-12. Interaction was not significant during 2010-11. During 2011-12 (Table 2.b), farmers method along with RDF + FYM @ 5 t ha $^{-1}$ ($M_4$ $I_1$) produced more number of grains/panicle (381.5) and was at par with same planting method along with application of RDF + GLM @ 5t ha $^{-1}$ ($M_4I_2$), RDF + BF @ 7.5 kg/ha ($M_4I_3$); Kobota transplanter method along with RDF + FYM @ 5 t ha$^{-1}$ ($M_3I$ $_{1}$), RDF + GLM @ 5 t/ha($M_3$ $I_2$) and only RDF application ($M_3$ $I_4$). Better supply of macro and micro nutrients by FYM and green manure besides better establishment and growth conditions due to Kobota transplanting and farmer's method might have helped for more enzymatic activity and physiological process of plant, resulting in better translocation of photosynthates and hence apportioning of sink reflected in no. of grains/panicle. These results are supported by Harish *et al.* (2011).

Grain yield of rice was significantly influenced by planting methods, integrated nutrient management (INM) practices and their interaction during both the years. Among different planting methods, Kobota transplanter recorded highest grain yield which was significantly superior to all crop establishment methods during both the years (6.50 (2010) & 7.50 (2011) t ha $^{-1}$) and their pooled mean (7.00 t ha $^{-1}$). However, during 2011-12, transplanting by farmer's method (6.91 t ha $^{-1}$) was found at par to Kobota transplanting. Better vegetative growth with efficient dry matter accumulation and effective partitioning to the panicles resulting in more no. of panicles m$^{-2}$ and grains/panicle, reflected in grain yield of above treatments. The increase in grain yield in machine transplanting was in agreement with the results reported by Anoop Dixit *et al.* (2007), Manjunath *et al.* (2009) and Venkateshwarlu *et al.* (2011). Followed to this, farmer's method of transplanting produced higher yield and was at par with SRI method of transplanting during 2011-12. Kobota transplanter method gave an yield increase of 11.1, 20.7 and 34.6 per cent (on pooled mean) over farmers method, SRI and Yangi China transplanter respectively. All the tested methods (Kobota, SRI and Yangi - China transplanter) showed an yield increase / decrease of 11.1, -8.0 and -17.5 over farmers method respectively. The lowest yield on the other side was recorded with Yangi-China transplanter (4.61 t ha $^{-1}$) as it is a heavy machine compared to Kobota and sank in the field resulting in uneven planting, higher depth of planting and inturn less number of tillers m$^{-2,}$ less number of panicles m$^{-2}$, number of grains/panicle and inturn yield. Among the integrated nutrient management practices, the higher grain yield (6.41, 7.42 and 6.9 t ha $^{-1}$) was obtained with RDF+FYM@5 t ha $^{-1}$ which was significantly superior to all the other practices during 2010-11 and pooled mean, however during 2011-12, the grain yield exhibited by GLM @ 5 t ha $^{-1}$ + RDF (6.90 t ha $^{-1}$) was found statistically at par with above treatment. The grain yield with application of RDF + GLM @ 5t/ha produced 5.87 and 6.4 t ha $^{-1}$ during 2010-11 and pooled mean respectively and it was followed by RDF + BF @ 7.5 kg/ha and only RDF treatment respectively. Where as during 2011-12, RDF – GLM @ 5 ha$^{-1}$ was at par with RDF + BF @ 7.5 kg ha $^{-1.}$ The increase in yield (pooled mean) was 32.7, 23.1 and 9.6 per cent with FYM, GLM and BF over only RDF treatment. The higher yield with integrated use of organic and inorganic fertilisers might be attributed to increased availability of major and minor nutrients by improving physical and chemical environment of the soils. The superiority of INM practices over sole chemical fertilisation might be due to the presence of humic acid compounds which helps in dissolution of minerals and chelation of micronutrients and enhanced microbial activity. The superiority of FYM in increasing the yield was supported by Barik *et al.* (2006) and Sudhakar (2010). The superiority of green leaf manuring was supported by Rajbir Garg *et al.* (2007), Anchal Dass *et al.* (2009) and Balaji Naik and Yakadri (2004). The superiority of biofertilizers was reported by Jagdish Kumar *et al.* (2010) and Mihilal Roy *et al.* (2011). The interaction effect between planting methods and integrated nutrient management practices was significant only during 2010-11 and 2011-12. During 2010-11 (Table 2.c), Kobota transplanter method along with RDF + FYM @ 5 t ha $^{-1}$ ($M_3$ $I_1$) produced significantly higher grain yield over other treatment combinations but was at par with same transplanter method along with RDF + GLM @ 5t ha $^{-1}$ ($M_3I_2$). Followed to this, farmer's method and SRI method of transplanting along with RDF + FYM @ 5t / ha. ($M_4I_1$ & $M_1I_1$) exhibited higher grain yield. During 2011-12 (Table 3.a), Kobota transplanter along with FYM @ 5 t ha $^{-1}$ ($M_3I_1$ ) exhibited higher grain yield but at par with $M_3I_2$ (Kobota + RDF + GLM @ 5 t ha $^{-1}$), $M_3I_4$ (Kobota + RDF), $M_4$ $I_1$ (Farmers method + RDF + FYM @ 5 t ha $^{-1}$), $M_4I_2$ (Farmers method+ RDF + GLM @ 5 t ha $^{-1}$), $M_4$ $I_3$ (farmers method + RDF + BF @ 7.5 kg ha $^{-1}$) and $M_1$ $I_1$ (SRI method + RDF + FYM @ 5 t ha $^{-1}$). The better performance of crop in the above combinations was the outcome of enhanced growth measured in terms of plant height, hastened development, improved yield attributes that resulted in higher yield. (Shekhar *et al.,* 2009).

Straw yield of rice varied significantly due to planting methods and INM practices. The crop transplanted with Kobota transplanter has maintained comparably higher number of tillers hill$^{-1}$ and accumulated greater biomass during both the years of study and hence their pooled mean. The increase in stalk yield due to Kobota transplanting was to the tune of 20.3 per cent than manual transplanting. On the other side, Yangi-China transplanter method reported lowest straw yield compared to the other methods. This might be due to heavy weight of machine with no adjustment to different puddle conditions that resulted in uneven planting that was expressed through seedlings hill$^{-1}$ and no of hills m$^{-2}$. Farmers method of planting attained straw yield next to Kobota transplanter and was followed by SRI method of planting during both the years and hence pooled mean. Similar increase was reported by Anbumani *et al.* (2004) and Singh *et al.* (2009). The demonstrated effect of FYM along with RDF on grain yield has been repeated once again with stalk yield as adequate stalk production is obligatory for effective photosynthesis and steady transport of nutrients and metabolites required for grain production Ramesh *et al.* (2007). The stalk yield registered in this treatment was found directly proportional to tiller formation and dry matter accumulation in the crop. Application of GLM @ 5 t ha $^{-1}$ + RDF expressed next level of straw yield followed by RDF + bio fertilizer @ 7.5 t ha $^{-1}$. The increase in stalk yield (pooled mean) was 67.6, 42.8 and 18.1 per cent with FYM, GLM and BF over only RDF treatment. As where, application of RDF alone has resulted in production of lowest stalk yield compared to the other INM practices during both the years and pooled mean. The interaction between planting methods and INM practices on straw yield was significant during both the years and pooled mean. Pooled mean of straw yield (Table 3.b) found that transplanting with Kobota transplanter along with application of FYM @ 5 t ha$^{-1}$ + RDF ($M_3I_1$) was found best with significantly highest stalk yield over the other combinations and was followed by farmers method of planting along with RDF + FYM @ 5 t/ha ($M_4I_1$) .

The benefit cost ratio obtained from transplanting rice through different methods, INM practices and their interaction was significant during both the years and pooled mean (Table 3b). Irrespective of treatments, B:C ratio in II year was higher than I year. Among the planting methods, Kobota transplanter method produced highest benefit cost ratio (2.0, 2.4 and 2.20) during both the years and its pooled mean but was at par with farmer method of transplanting during 2011(2.3) and pooled mean (2.0).The higher benefit cost ratio was attributed to higher net returns with reduced cost of cultivation as there is a labour saving of about 11 man days per hectare. The cost of mechanical transplanting was Rs. 25095 ha$^{-1}$ with only 56 labour whereas manual transplanting costs Rs.23289 ha$^{-1}$ with 67 labour. This was supported by Manjunath *et al.* (2009) and Anoop Dixit *et al.* (2007). Followed by this, SRI method of planting attained benefit cost ratio of 1.4,1.8 and 1.6 during both the years and pooled mean and significantly higher than Yangi- China transplanter except at 2011-2012. The higher B.C ratio in SRI method was in accordance with Jayadev and Prabhakara Shetty, (2006) and Hugar *et al*. (2009). Lowest B: C ratio was recorded with Yangi-China tranplanter and was attributed to lower grain yield.

Among the INM practices, application of RDF+ FYM @5 t/ha attained significantly higher B:C ratio (1.83, 2.20 and 2.0)during both the years and pooled mean owing to higher grain yield and inturn higher gross and net returns in this treatment. However, it was on par with application of RDF+GLM @5 t ha $^{-1}$ (2.0) during 2011. Application of RDF + GLM @ 5 t/ha fetched next higher B : C ratio (16,2.0 & 1.8) and significantly higher than RDF+BF @7.5 kg ha $^{-1}$ except pooled mean. The beneficial effect of FYM and GLM in improving the net returns and B:C ratio was also supported by Balaji Naik and Yakadri, (2004), Vikas Gupta and Sharma (2007) and Bali and Vani

(2004). Lowest B:C ratio of 1.22, 1.81 and 1.52 was reported by application of only RDF treatment during both the years and pooled mean and was at par with RDF + BF @7.5kg ha $^{-1}$ during 2011.

The pooled mean of B:C ratio (Table 3.C) was significantly higher with Kobota transplanter along with RDF+FYM @5 t ha $^{-1}$ and was at par with RDF+GLM @ 5 t ha $^{-1}$ (2.40) and only RDF (2.10) with the same planting method ($M_3$ $I_2$, $M_3I_4$) and with farmers method of transplanting with RDF + FYM @ 5 t ha $^{-1}$ (2.37) and RDF+GLM @ 5 t ha $^{-1}$ (2.10).

## Conclusions

The present study had shown that the mechanical transplanting with Kobota transplanter resulted in higher growth, yield attributes and yield in turn B:C ratio in black soils of Andhra Pradesh compared to Yangi-China transplanter. Complimenting RDF with FYM or GLM @5 t ha $^{-1}$ recorded higher growth, yield attributes, yield and economics of rice. Incorporation of FYM, GLM and bio-fertilisers being socially acceptable, economically viable and environmentally sustainable sources of nutrient application help in improving and maintain sustainability of soil and crop productivity.

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**Table 2.a: Interaction effect on Dry matter production (kg) at harvest of paddy as influenced by planting methods and INM practices of pooled**

| Interaction | Dry matter production (kg) – harvest | | | | |
|---|---|---|---|---|---|
| | $M_1$ - SRI | $M_2$ - Yangio china | $M_3$ - Koboto | $M_4$ - Farmer's method | Mean |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 2.10 | 1.67 | 2.77 | 2.50 | **2.26** |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 1.77 | 1.50 | 2.47 | 2.13 | **1.96** |
| $I_3$ - RDF+BF @ 7.5 kg $ha^{-1}$ | 1.60 | 1.20 | 2.03 | 1.87 | **1.68** |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ | 1.43 | 1.07 | 1.97 | 1.33 | **1.45** |
| **Mean** | **1.73** | **1.35** | **2.31** | **1.96** | |
| | | **M x I** | **I x M** | | |
| **S.Em ±** | | 0.06 | 0.08 | | |
| **CD (P=0.05)** | | 0.18 | 0.25 | | |

**Table 2.b: Interaction effect of grains $panicle^{-1}$ of paddy as influenced by planting methods and INM practices during 2011-2012**

| Interaction | Grains $panicle^{-1}$ | | | | |
|---|---|---|---|---|---|
| | $M_1$ - SRI | $M_2$ - Yangio china | $M_3$ - Koboto | $M_4$ - Farmer's method | Pooled |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 344.10 | 331.33 | 378.83 | 381.53 | **358.94** |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 327.00 | 305.17 | 376.93 | 369.03 | **344.53** |
| $I_3$ - RDF+BF @ 7.5 kg $ha^{-1}$ | 315.37 | 302.93 | 317.63 | 363.90 | **324.96** |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ | 308.57 | 293.23 | 362.83 | 245.33 | **302.49** |
| **Pooled** | **323.75** | **308.17** | **359.06** | **339.95** | |
| | | **M x I** | **I x M** | | |
| **S.Em ±** | | 18.0 | 52.6 | | |
| **CD (P=0.05)** | | 16.9 | 18.8 | | |

**Table 2.c: Interaction effect of grain yield t $ha^{-1}$ of paddy as influenced by planting methods and INM practices during 2010-2011**

| Interaction | Grain Yield | | | | |
|---|---|---|---|---|---|
| | $M_1$ - SRI | $M_2$ - Yangio china | $M_3$ - Koboto | $M_4$ - Farmer's method | Mean |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 6.08 | 5.42 | 7.52 | 6.63 | **6.41** |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 5.22 | 5.36 | 7.07 | 5.82 | **5.87** |
| $I_3$ - RDF+BF @ 7.5 kg $ha^{-1}$ | 4.97 | 4.39 | 5.96 | 4.99 | **5.08** |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ | 4.86 | 3.26 | 5.42 | 4.89 | **4.61** |
| **Mean** | **5.28** | **4.61** | **6.50** | **5.58** | |
| | | **M x I** | **I x M** | | |
| **S.Em ±** | | 0.21 | 0.21 | | |
| **CD (P=0.05)** | | 0.60 | 0.65 | | |

**Table 3.a: Interaction effect of grain yield t $ha^{-1}$ of paddy as influenced by planting methods and INM practices during 2011-2012**

| Interaction | Grain Yield | | | | |
|---|---|---|---|---|---|
| | $M_1$ - SRI | $M_2$ - Yangio china | $M_3$ - Koboto | $M_4$ - Farmer's method | Mean |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 6.91 | 6.56 | 8.21 | 8.00 | **6.41** |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 6.51 | 5.77 | 7.82 | 7.51 | **5.87** |
| $I_3$ - RDF+BF @ 7.5 kg $ha^{-1}$ | 6.07 | 5.33 | 6.70 | 7.36 | **5.08** |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ | 5.71 | 5.60 | 7.28 | 4.75 | **4.61** |
| **Mean** | **7.50** | **5.82** | **6.30** | **6.91** | |
| | | **M x I** | **I x M** | | |
| **S.Em ±** | | 0.38 | 0.42 | | |
| **CD (P=0.05)** | | 1.10 | 1.32 | | |

**Table 3.b: Interaction effect of Straw yield (t $ha^{-1}$) of paddy as influenced by planting methods and INM practices (pooled)**

| Interaction | Straw yield (t $ha^{-1}$) | | | | |
|---|---|---|---|---|---|
| | $M_1$ - SRI | $M_2$ - Yangio china | $M_3$ - Koboto | $M_4$ - Farmer's method | Mean |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 14.30 | 10.77 | 19.67 | 17.57 | **15.57** |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 11.73 | 9.50 | 17.13 | 14.67 | **13.25** |
| $I_3$ - RDF+BF @ 7.5 kg $ha^{-1}$ | 10.50 | 7.30 | 13.90 | 12.33 | **11.00** |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ | 9.00 | 6.17 | 13.40 | 8.70 | **9.31** |
| **Mean** | **11.38** | **8.42** | **16.02** | **13.32** | |
| | | **M x I** | **I x M** | | |
| **S.Em ±** | | 0.40 | 0.42 | | |
| **CD (P=0.05)** | | 1.17 | 1.28 | | |

**Table 3.c: Interaction effect of B:C Ratio of paddy as influenced by planting methods and INM practices (pooled)**

| Interaction | B:C Pooled | | | | |
|---|---|---|---|---|---|
| | $M_1$ - SRI | $M_2$ - Yangi china | $M_3$ - Koboto | $M_4$ - Farmer's method | Mean |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 1.77 | 1.47 | 2.40 | 2.37 | **2.00** |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 1.50 | 1.33 | 2.23 | 2.10 | **1.80** |
| $I_3$ - RDF+BF @ 7.5 kg $ha^{-1}$ | 1.53 | 1.17 | 1.97 | 2.07 | **1.70** |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ | 1.47 | 1.03 | 2.10 | 1.47 | **1.52** |
| **Mean** | **1.57** | **1.25** | **2.18** | **2.00** | |
| | | **M x I** | **I x M** | | |
| **S.Em ±** | | 0.09 | 0.10 | | |
| **CD (P=0.05)** | | 0.27 | 0.32 | | |

**Table 1: Growth, yield and economics of rice as influenced by planting methods and Integrated nutrient management practices**

| Treatments | Plant height (cm) | | Dry matter production (kg $m^{-2}$) | | Panicles $m^{-2}$ | | Grains $panicle^{-1}$ | | Grain yield (t $ha^{-1}$) | | | Straw yield (t $ha^{-1}$) | | | B:C Ratio | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | 2010 | 2011 | Pooled | 2010 | 2011 | Pooled | 2010 | 2011 | Pooled |
| **Planting methods** | | | | | | | | | | | | | | | | | |
| $M_1$ - SRI | 113.7 | 114.8 | 1.57 | 1.87 | 450.3 | 528.2 | 319.9 | 323.8 | 5.30 | 6.30 | 5.80 | 10.38 | 12.37 | 11.40 | 1.40 | 1.80 | 1.60 |
| $M_2$ – Yangi - China | 115.4 | 117.5 | 1.21 | 1.52 | 412.1 | 513.6 | 302.5 | 308.2 | 4.61 | 5.82 | 5.20 | 07.51 | 09.36 | 08.42 | 1.00 | 1.53 | 1.30 |
| $M_3$ - Kobota | 120.2 | 121.5 | 2.14 | 2.46 | 498.9 | 566.2 | 348.7 | 359.1 | 6.50 | 7.50 | 7.00 | 14.89 | 17.12 | 16.02 | 2.00 | 2.40 | 2.20 |
| $M_4$ - Farmer's method | 116.3 | 119.2 | 1.75 | 2.17 | 481.9 | 546.5 | 321.5 | 339.9 | 5.58 | 6.91 | 6.30 | 11.87 | 14.75 | 13.32 | 1.70 | 2.30 | 2.00 |
| **SEm±** | 1.72 | 1.93 | 0.04 | 0.10 | 10.5 | 8.7 | 5.6 | 6.3 | 0.11 | 0.27 | 0.15 | 0.20 | 0.47 | 0.23 | 0.04 | 0.12 | 0.06 |
| **CD (P=0.05)** | NS | NS | 013 | 0.35 | 36.5 | 30.0 | 19.2 | 21.9 | 0.38 | 0.92 | 0.51 | 0.70 | 1.64 | 0.79 | 0.15 | 0.41 | 0.22 |
| **INM practices** | | | | | | | | | | | | | | | | | |
| $I_1$ - RDF+FYM@ 5 t $ha^{-1}$ | 122.9 | 126.0 | 2.09 | 2.41 | 495.5 | 556.4 | 353.7 | 358.9 | 6.41 | 7.42 | 6.90 | 14.46 | 16.69 | 15.60 | 1.83 | 2.20 | 2.00 |
| $I_2$ - RDF+GLM @ 5 t $ha^{-1}$ | 116.9 | 121.0 | 1.80 | 2.13 | 477.6 | 545.4 | 330.8 | 344.5 | 5.87 | 6.90 | 6.40 | 12.15 | 14.33 | 13.30 | 1.60 | 2.00 | 1.80 |
| $I_3$ – RDF+B(Azospirllium @ 2.5 kg $ha^{-1}$ + PSB @ 5 kg $ha^{-1}$) | 115.6 | 115.8 | 1.49 | 1.86 | 447.3 | 533.4 | 313.4 | 324.9 | 5.10 | 6.40 | 5.70 | 09.79 | 12.22 | 11.00 | 1.40 | 1.98 | 1.70 |
| $I_4$ - RDF (150 N:60 $P_2O_5$ : 60 $K_2O$ kg $ha^{-1}$ ) | 110.0 | 110.2 | 1.29 | 1.62 | 422.8 | 519.3 | 294.9 | 302.5 | 4.61 | 5.84 | 5.20 | 08.26 | 10.35 | 09.31 | 1.22 | 1.81 | 1.52 |
| **SEm±** | 2.50 | 1.90 | 0.03 | 0.06 | 9.92 | 9.92 | 5.18 | 9.02 | 0.10 | 0.19 | 0.13 | 0.23 | 0.33 | 0.20 | 0.04 | 0.07 | 0.05 |
| **CD (P=0.05)** | NS | 5.6 | 0.1 | 0.16 | 21.7 | NS | 15.1 | 26.3 | 0.30 | 0.55 | 0.36 | 0.67 | 0.97 | 0.59 | 0.13 | 0.21 | 0.13 |
| **M x I** | | | | | | | | | | | | | | | | | |
| **SEm+** | 2.50 | 3.8 | 0.07 | 0.11 | 22.0 | 19.8 | 10.4 | 18.0 | 0.21 | 0.38 | 0.25 | 0.46 | 0.66 | 0.40 | 0.09 | 0.15 | 0.09 |
| **CD** | NS | NS | 0.20 | 0.32 | NS | NS | NS | 52.6 | 0.60 | 1.10 | NS | 1.34 | 1.93 | 1.17 | 0.25 | 0.42 | 0.30 |
| **I x M** | | | | | | | | | | | | | | | | | |
| **SEm+** | 2.7 | 3.8 | 0.07 | 0.14 | 21.7 | 19.2 | 10.5 | 16.9 | 0.21 | 0.42 | 0.26 | 0.46 | 0.74 | 0.42 | 0.09 | 0.17 | 0.10 |
| **CD** | NS | NS | 0.21 | 0.45 | NS | NS | NS | 50.5 | 0.65 | 1.32 | NS | 1.35 | 2.33 | 1.28 | 0.26 | 0.55 | 0.32 |