Performance of direct seeded sali rice as influenced by sowing dates, sowing methods and nutrient management practices

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ABSTRACT
A field experiment was carried out at Instructional-cum-farm, Assam Agricultural University, Jorhat during kharif 2015. The experiment was laid out in split-plot design replicated thrice with four sowing dates in main plots viz., 1May, 11 May, 21 and 31 May along with combination of two methods of sowing viz., direct seeding and transplanting as well as with two nutrient management practices RDF and INM package in sub-plots. Results revealed that May 11 date recorded significantly higher in almost all the growth and yield attributing parameters followed by May 1. The highest grain (40.24 q/ha) and straw (68.07 q/ha) yields were obtained in May 11 sown crop and was significantly superior to that of May 21 and May 31. Between the two methods of sowing, transplanting resulted significantly superior in regards to almost all the growth, yield attributes and yield of sali rice. The increase in grain yield under transplanting over direct seeding was 4.90 per cent. The corresponding increase in straw yield was 4.31 per cent. In respect of nutrient management; INM resulted in higher grain and straw yield over RDF. From the economic point of view May 11 sown crop recorded the highest net return ( ₹ 57625.00/ha) with B:C ratio of 1.57 whereas in case of methods of sowing and nutrient management practices, direct seeding and INM practice recorded the highest net return and B:C ratio.

Key words: Direct seeding, INM, RDF, Sali rice, Sowing dates, Transplanting.

INTRODUCTION
Among all the cereals, rice is the principal cereal crop grown in India, which plays a major role in Indian economy. Rice is the most important crop to millions of small farmers who grow it on millions of hectares throughout the region (IRRI, 2015). Moreover, with the present trend of growth in human population, the demand for food grains is increasing every year.

In Assam sali rice, transplanting method is mostly followed in case of sali (kharif) rice. At present, farmers are facing problems in timely preparing the land for transplanting, fertilizer application and sometimes in harvesting due to shortage of human labour. As compared to transplanting requirement of labour as well as growing time is comparatively less in direct seeded rice which is one of the scarce resources during peaksali season. Though fertilizer is undoubtedly the fastest way to boost up crop growth, yet long term use or total dependence on it could lead to deterioration of soil health (FAO, 1984). An integrated nutrient management system target at sustainable crop production involving minimum deterioration of soil health and least disturbance to the rice ecosystem. This is possible through combined use of inorganic fertilizers and organic manures and by promoting the inherent nutrient supplying capacity of soil through appropriate management practices. Keeping all these in view, the present investigation was undertaken to study the performance of direct seeded sali rice under various sowing dates, methods of sowing as well as nutrient management practices under rainfed condition.

MATERIALS AND METHODS
A field experiment was conducted during kharif 2015 at Instructional-cum-Research (ICR) farm of Assam Agricultural University, with sali rice. The experiment was carried out in a split-plot design (Gomez and Gomez, 1984) with different treatments consisted of four dates of sowing in main plot viz., 1 May, 11 May, 21 May and 31 May along with two methods of sowing viz., direct seeding and transplanting and two nutrient management practices viz., recommended doses of fertilizer (RDF) 60-20-40 N:P:O; K,O kg/ha and INM package (Organic manure @ 1 t/ha + mixed inocula of Azospirillum sp. and Bacillus megaterium P-5 @ 4 kg/ha, Rock Phosphate @ 10 kg P,O/ha, MOP @ 40 kg K,O/ha) in sub-plots. In case of RDF, nitrogen was applied in 3 split doses i.e., ½ of N at final ploughing, ½ at active tillering stage and remaining ¼ at panicle initiation stage. All the phosphatic and potassic fertilizers were applied one day ahead of sowing. For INM treatments, organic manure, rock phosphate and MOP was also applied one day ahead of sowing as per treatment. The rice variety TTB 404 (Shraboni) was sown @ 75 kg/ha in the main field as per seeding dates at a row spacing of 20

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cm. The same date of seeding in nursery bed for transplanting method was maintained and 28 days of old seedlings were transplanted in respective dates at a spacing of 20 cm × 15 cm. The harvesting of rice at all the dates of sowing was 2-7 days earlier in case of direct seeding over transplanting method. The rainfall received during the whole crop growing season was 1619.7 mm.

RESULTS AND DISCUSSIONS

Growth and yield attributing parameters

Effect of dates of sowing: Higher plant height was found at May 11 (107.72 cm) and May 1 (105.93 cm) sown crop and was statistically at par. This might be due to favourable weather conditions such as temperature and rainfall during the critical growth period which enabled the plant to improve its growth and development as compared to other sowing dates. These results were in line with Khakwani et al. (2006). Panicle/m², plant length, filled grains/panicle, 1000-grain weight etc. were found to be reduced due to delay in sowing, which might be due to congenial climatic condition during the early growth period that resulted in higher yield attributes than the later. The number of filled grains/panicle showed a better response with early sowing because in late sowing the plants might have suffered from moisture stress which ultimately resulted in drying of pollen; also late sowing shortened the growth period of the plant and therefore reduced the length of panicle and 1000-grain weight. Similar, findings were reported by Akram et al. (2007) and Khalifa (2009). Similar effects were found on plant population which decreased significantly with delay in sowing. The maximum number of plant population was recorded for May 11 (305.87/m²) sowing and thereafter, a declining trend was observed. The increase in the number of plant population was attributed due to the favourable temperature and rainfall viz.

Table 1: Effect of dates of sowing, methods of sowing and nutrient management on growth and yield attributes of salicr. rice

| Treatment                     | Plant height (cm) | Plant population (number/m²) | Panicles/m² | Panicle length (cm) | Filled grains/panicle | Test weight (g) |
|-------------------------------|-------------------|------------------------------|-------------|---------------------|-----------------------|-----------------|
| Dates of sowing               |                   |                              |             |                     |                       |                 |
| 1 May                         | 105.93            | 299.93                       | 205.93      | 22.43               | 103.36                | 22.10           |
| 11 May                        | 107.72            | 305.87                       | 217.77      | 24.42               | 106.48                | 22.76           |
| 21 May                        | 102.30            | 288.52                       | 197.85      | 22.03               | 100.55                | 21.98           |
| 31 May                        | 96.16             | 286.53                       | 193.53      | 21.73               | 99.59                 | 21.69           |
| S.Ed. (±)                     | 2.02              | 5.65                         | 5.84        | 0.87                | 1.06                  | 0.16            |
| C.D (P=0.05)                  | 4.94              | 13.83                        | 14.28       | NS                  | 2.60                  | 0.38            |
| Methods of sowing             |                   |                              |             |                     |                       |                 |
| Direct Seeding                | 99.40             | 282.14                       | 190.86      | 22.19               | 101.87                | 22.06           |
| Transplanting                 | 106.66            | 308.29                       | 216.68      | 23.11               | 103.15                | 22.21           |
| S.Ed. (±)                     | 1.91              | 7.13                         | 7.20        | 0.45                | 0.96                  | 0.25            |
| C.D (P=0.05)                  | 3.94              | 14.72                        | 14.85       | NS                  | NS                    | NS              |
| Nutrient management           |                   |                              |             |                     |                       |                 |
| RDF                           | 100.20            | 292.92                       | 201.31      | 22.10               | 101.67                | 21.89           |
| INM                           | 105.85            | 297.50                       | 206.23      | 23.21               | 103.35                | 22.38           |
| S.Ed. (±)                     | 1.91              | 7.13                         | 7.20        | 0.45                | 0.96                  | 0.25            |
| C.D (P=0.05)                  | 3.94              | NS                           | NS          | 0.93                | NS                    | NS              |

N.B: RDF: 60-20-40 N; P₂O₅; K₂O kg/ha; INM package (Organic manure @ 1 t/ha + mixed inocula of Azospirillum sp. and Bacillus megaterium P-5 @ 4 kg/ha, Rock Phosphate @ 10 kg P₂O₅/ha, MOP @ 40 kg K₂O/ha)
respectively than RDF. In both the conditions viz., direct seeding and transplanting, INM showed significant results as compared to RDF which might be due to favourable soil condition, soil fertility improvement in INM due to the presence of organic matter that resulted in higher moisture holding capacity and favoured uptake of nutrients. These results were in line with Alagappan and Venkiteswamy, 2014 and Thiyagarajan (2003). Between the nutrient management practices, higher grain and straw yield and yield attributing characters had been found in the INM than the RDF practices. Except panicle length all the parameters related to yield characters had been found non-significant. Panicle length differed significantly in INM than that of RDF which might be due to enhanced and continuous supply of nutrients by the enriched organs leading to increased panicle length. These findings were similar with Mohandas and Appavu (2000).

Yield

**Effect of dates of sowing:** Grain and straw yield in rice were highly influenced by dates of sowing (Table 2). Among the yield components recorded, number of panicle per unit area in the above table was the most important yield contributing factor. This might be attributed to the cumulative effect of more number of productive tillers per unit area. Early sowing on May 11 (217.77/m²) and May 1 (205.93/m²) significantly produced higher panicles than that of May 31 (193.53/m²) sowing. Hence, considerable reduction in yield was observed due to the effect of sowing dates. Higher grain and straw yield were found in May 11 (40.24 q/ha) sown crop which was highly significant to May 21 (37.30 q/ha) and May 31 (37.22 q/ha). This might be due to increase in all the growth and yield attributing characters in May 11 which ultimately contributed the yield of rice due to favourable climatic condition which might have resulted in higher uptake of nutrients as well as net assimilation of photosynthates in respect to other sowing dates. Both grain and straw yield were reduced due to delay in sowing in rice. Similar results were also reported by Rakesh and Sharma (2004).

**Effects of methods of sowing:** Higher grain (40.26 q/ha) and straw (68.12 q/ha) yield was found in transplanted condition than direct sowing which might be due to higher yield attributing characters and higher uptake of nutrients because of proper spacing for good management, photosynthetic activities, assimilate partitioning, thereby resulting in good yield in well-spaced rice fields. The results are quite in line with Maqsoos (1998) and Ali *et al.* (2013). No significant effect in harvest index had been observed between the two sowing methods. However, transplanting method gave the highest harvest index (37.18 %) as compared to direct sowing in rice which might be due to higher economic and biological yield as compared to direct sowing Ehsanullah *et al.* (2000).

**Effects of nutrient management:** Higher grain (39.75 q/ha) and straw (67.52 q/ha) yield had also been found in INM practices than RDF which might be due to higher yield attributing characters and higher uptake of nutrients because of the fact that physiologically proper partitioning might have occurred from source to sink, resulting in improved yield attributes. INM increased the nutrient supply capacity of the soil for a longer period as organic manure acts as a binding agent that will prevent the nutrients from loss and supply the nutrients to the crop continuously for longer time resulting better growth and development in yield attributes that ultimately had reflected in grain and straw yield (Alagappan *et al.*, 2014). INM recorded the highest harvest index (37.01 %) as compared to RDF in rice which might be due to higher economic and biological yield.

**Table 2:** Effect of dates of sowing, methods of sowing and nutrient management on yield (q/ha) and economics of *salarice*

| Treatment | Dates of sowing | Grain yield (q/ha) | Straw yield (q/ha) | Harvest index (%) | Net Return (q/ha) | B: C Ratio |
|-----------|-----------------|--------------------|--------------------|------------------|------------------|------------|
| **1 May** | 38.78           | 65.76              | 37.04              | 54280.00         | 1.48             |
| **11 May** | 40.24           | 68.07              | 37.12              | 57625.00         | 1.57             |
| **21 May** | 37.30           | 64.33              | 36.72              | 51345.00         | 1.40             |
| **31 May** | 37.22           | 63.09              | 36.98              | 50605.00         | 1.38             |
| S.Ed. (+) | 0.92            | 1.35               | 0.83               | -                | -                |
| C.D (P=0.05) | 2.25        | 3.31               | NS                 | -                | -                |
| **Methods of sowing** |               |                    |                    |                  |                  |
| **Direct Seeding** | 36.51         | 62.50              | 36.75              | 52355.00         | 1.55             |
| **Transplanting** | 40.26         | 68.12              | 37.18              | 54565.00         | 1.37             |
| S.Ed. (+) | 0.98            | 1.52               | 0.58               | -                | -                |
| C.D (P=0.05) | 2.01         | 3.14               | NS                 | -                | -                |
| **Nutrient management** |               |                    |                    |                  |                  |
| **RDF** | 37.02           | 63.10              | 36.93              | 50265.00         | 1.34             |
| **INM** | 39.75           | 67.52              | 37.01              | 56675.00         | 1.58             |
| S.Ed. (+) | 0.98            | 1.52               | 0.58               | -                | -                |
| C.D (P=0.05) | 2.01         | 3.14               | NS                 | -                | -                |

N.B: RDF: 60-20-40 N; P<sub>2</sub>O<sub>5</sub>; K<sub>2</sub>O kg/ha; INM package (Organic manure @ 1 t/ha + mixed innocula of Azospirillum sp. and Bacillus megaterium P-5 @ 4 kg/ha, Rock Phosphate @ 10 kg P<sub>2</sub>O<sub>5</sub>/ha, MOP @ 40 kg K<sub>2</sub>O/ha)
Economics was given on Table 2 with only net return and benefit-cost ratio of different treatments. The input and output costs were taken as per the market price during the kharif 2015 season. The highest net return (57625/ha) and B: C ratio (1.57) were recorded under 11 May sown crop that of other dates. This corroborates the finding of Osman et al. (2015) who found that early sowing resulted in higher net return due to higher grain and straw yield. The B: C ratio increased in direct seeding which was 1.55 in spite of low grain and straw yield than transplanting. This might be due to less cost of cultivation in direct seeding due to the omission of operations such as nursery bed preparation, transplanting, puddling etc., which were required in transplanting. These findings were in close conformity with the findings of Kumar and Ladha (2011). The relative economic indices like gross return (92385/ha), net return (56675/ha) and benefit-cost ratio 1.58 increased with INM practices which might be attributed to higher grain and straw yield resulting from the higher uptake of nutrients in comparison with RDF. These findings were in close conformity with the findings of Bali and Wani (2004).

CONCLUSION

Early sowing dates resulted in increased in growth attributes such as plant height, number of plant population per unit area as compared to the late sowing which in turn might have affected the yield and its attributing characters of the rice plant. The sowing dates on 11 May and 1 May recorded the highest in all the above mentioned characters than May 21 and May 31, respectively. Higher grain and straw yield were also obtained in May 11 and May 1 sown crops as compared to others. So far methods of sowing was concerned, transplanting recorded the highest grain and straw yield and its attributes. Similar, effects were obtained in case of INM where grain and straw yield were recorded the highest than RDF. Economically, early sowing results in higher B: C ratio than others whereas in methods of sowing, direct seeding resulted in higher B: C ratio which may be due to less labour inputs. In nutrient management practices, INM recorded the highest B: C ratio than RDF. Hence, we can go for May 11 transplanting of sati rice with INM practice for obtaining higher yield and maximum utilization of the inputs applied.

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