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# Effect of crop establishment methods and organic manures on the yield of black aromatic rice and chemical properties of soil

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**Abstract**
A field experiment was carried out at the College of Agriculture, CAU, Imphal, Manipur during the kharif season of 2017-18. There were 12 treatments replicated thrice with split plot design. The recent data revealed that among the crop establishment methods in both the season S2 (transplanting conventional method) resulted in marked increased in grain and straw yield as compared with other establishment methods. Among the nutrient management N1 (conventional method 60:40:30 kg/ha) recorded highest grain and straw yield in first season which was at par with the N4 (50% FYM + 50 % Loktak phumdi compost) and in second season N4 (50% FYM + 50% Loktak phumdi compost) showed higher grain and straw yield. Crop establishment methods and organic manures had significant impact on chemical properties of soil. After the harvest of crop, the results revealed that highest organic carbon, available nitrogen, available phosphorus and available potassium were recorded where (System of Rice Intensification) and N4 (50% FYM + 50 % Loktak phumdi compost).

**Keywords:** Direct seeded, transplanting, system of rice intensification, loktak phumdi compost, farm yard manure

## Introduction
Black aromatic rice is a type of the rice species *Oryza sativa* L. which is glutinous, packed with high level of nutrients and mainly cultivated in Asia. The term 'black aromatic rice' actually refers to a variety of rice types from the species Oryza sativa, and is descriptive of the colour of grain, rather than other properties. The dark purple colour of Black rice is due to the high anthocyanin content, located in the pericarp layers (Takashi *et al*. 2001) [21]. Fertilizers are the essential among different factors contributing towards agricultural production. The benefits of increased use of fertilizers in achieving targets of food grain production are well established. Further, chemical fertilizers alone are unable to maintain the long term soil health and sustain crop productivity as they are unable to supply all the essential nutrients, particularly the trace elements (Subbha Rao and Srivastava 1998) [18]. On the other hand, organic manures improved soil physical, chemical and biological properties and thus, resulting in enhanced crop productivity along with maintaining soil health. Although, the organic manures contain plant nutrients in small quantities as compared to the chemical fertilizers, the presence of growth hormones and enzymes, besides plant nutrients make them essential for improving soil fertility, productivity and soil health (Bhuma 2001) [3]. Organic manures also help in plant metabolic activities through supply of important micronutrients in early vigorous growth of the plant (Anburani and Manivannan 2002) [2]. SRI an alternative methodology for traditional flooded rice cultivation developed in the 1980s in Madagascar. The agronomic changes in SRI rice cultivation include the use of much younger seedlings than are normally transplanted, planting them singly and carefully in a square pattern with wide spacing in soil that is kept moist, but not continuously flooded and with increased amendments of organic matter but direct seeding and transplanting conventional method required continuously flooded that lead to leaching loss of soil nutrients. In this context, new technologies like SRI appears to have potential that saves inputs, protects environment and could improve productivity and soil health (Satyanarayana *et al*.,2007; Balasubramanian *et al*., 2004) [14, 4].

## Materials and Methods

A field experiment was conducted on *Kharif* season of 2017-18 at the College of Agriculture, CAU, Imphal, Manipur which is located at 24$^0$81' N latitude and 93$^0$89'E longitude and an altitude of 790 m above the mean sea level. The soil of experimental field was clay soil in texture with a pH of 5.57. The soil as medium in organic carbon 1.3 %, available nitrogen 304.51 kg/ha, available phosphorus 18.90 kg/ha and available potassium 142.02 kg/ha. The experiment was carried out in split plot design with replicated thrice. The treatments comprised of three establishment method viz. direct seeded rice, transplanting conventional method and SRI in main plots and four nutrient management in sub plots viz.,Conventional method (60:40:30 kg/ha),100 % RD of FYM, 100 % RD of Loktak Phumdi compost and 50 % RD of FYM + 50 % RD of Loktak Phumdi compost. The soil samples were collected randomly from 0 to 15 cm depth from 5 spots of the experimental field just before layout of experiment for initial soil status but for final soil analysis soil samples were collected after the harvest of the rice crop. The experimental field was ploughed with the help of tractor drawn plough followed by harrowing and planking followed by flooding and puddling operations done manually. Seeds were sown in the nursery following the recommended package and practices. On the same day direct seeding rice were sown in the experimental plot. 21 days old rice seedlings were transplanted manually at a spacing of 20 cm X 10 cm in the experimental field for normal transplanting crop establishment method. 10 days old rice seedlings were transplanted manually at a spacing of 25 cm X 25 cm in the experimental field for SRI crop establishment method. FYM and Loktak Phumdi Compost were applied 20 days before direct seeding and transplanting as per treatment and well incorporated to the soil. For recommended dose of fertilizer half dose of nitrogen was applied through urea, full dose of phosphorus through SSP and Potassium through MOP were applied as basal. The remaining 50% Nitrogen was top dressed through urea at active tillering stage and panicle initiation stage. Weeding were done during the critical crop weed competition period. Soil analysis of pH, organic carbon, nitrogen, phosphorus and potassium were done as Walkley and Black, 1934, Subbiah and Asija, 1956 and Jackson, 1973) [23, 19, 10].

All data obtained were subjected to analysis of variance (ANOVA) and significant differences between the means were determined using Split plot design at 5 % probability level. (Gomez and Gomoz, 1976) [9].

## Result and Discussion

Grain and straw yield (q/ha): Grain and straw yield (q/ha) differed significantly by various rice establishment methods. Rice established through conventional transplanting ($S_2$) recorded significantly higher grain and straw yield which was at par with system of rice intensification ($S_3$) (Table 1 and 2). This was due to the narrow row may be preferable over wider (Frizzell *et al*., 2006) [7] and due to more number of tillers per area and dry matter production per area which in turn resulted in higher straw yield (Parameshwari and Srinivas, 2014) [12]. Subramanyam *et al*., (2007) [20] also reported similar results. According to pooled analysis, maximum grain and straw yield attained in treatments where 50% FYM+50%Loktak phumdi compost ($N_4$) were due to the fact that superiority in growth parameters and yield attributes due to the application of the combine organic sources which resulted in the enhanced availability of nutrients hence in better growth resulting into increase photosynthesis. This help in storage of more photosynthates and their translocation towards sink and their contributed to increased yields. These finding are in accordance with those of Singh and Mandal (1997) [15] and Das *et al*. (2002) [6]. And also slow acting bulky organic manures like compost and farm yard manure are hard to decompose (because of wider C:N ratio) and making nitrogen available at later stages (Khan *et al*., 2001) [11] that will increase the grain and sraw yield. Interaction effect was found to exist between crop establishment and nutrient management with respect to rice grain and straw yields. Transplanting conventional method with 50% FYM+50%Loktak phumdi compost registered higher yield. However, it was on par with SRI with conventional method (60:40:30 kg/ha).

Soil chemical properties: During kharif season of 2017-18 there is significant difference observed between different crop establishment methods and nutrient managements (Table 3, 4, 5, 6). Among different crop establishment method, SRI brought about marked improvement in residual status of N, P and K after the harvesting of rice significantly higher over direct seeded rice. This was due to required continuous standing water which leads to nutrient loss through leaching (Bheru Lal Kumhar *et al*., 2016) [5]. High weed infestation is major constraint for broader adoption of Direct seeded rice (Rao *et al*., 2007) [13]. Likewise, micronutrient deficiencies such as Zn and Fe, due to imbalanced N fertilization and high infiltration rates in direct seeded rice are of major concern (Gao *et al*., 2006) [8]. Microbes harboring rhizosphere of crops provide benefits to crop through better nutrient availability by way of atmospheric $N_2$ fixation or solubilizing fixed minerals forms of nutrients (Pandey *et al*., 2010). Zhao *et al*. (2011) indicated that higher microbial biomass C and N was obtained under SRI management than with conventional method. But for organic carbon there is no significant difference observed between different crop establishment methods. Among the nutrient management, 50% FYM+50%Loktak phumdi compost showed significant difference in residual nutrients of organic carbon (%), available nitrogen (kg/ha), available phosphorus (kg/ha) and available potassium (kg/ha) in soil from the Conventional method (60:40:30 kg/ha) only chemical fertilizers were applied. This was due to in recent year there has been serious concern about long term adverse effect of continuous and indiscriminate use of inorganic fertilizers on deterioration of soil structure, soil health and environmental pollution (Singh, 2000) [17]. Singh *et al*., (2008) [16] also confirmed the role of organic manures in releasing N and improved N availability in soil. The improvement in the soil available P with FYM or vermicompost addition could be attributed to many factors, such as the addition of P through FYM or Vermicompost and retardation of soil P fixation by organic anions formed during FYM and vermicompost decomposition (Ali *et al*., 2009) [1]. Available K in soil increased with the application of organic manures which is due to solubilizing action of organic acids produced during FYM or vermicompost decomposition and its higher capacity to hold K in available form (Vidyavathi *et al*., 2011) [22]. Interaction effect was found to exist between crop establishment and nutrient management with respect to soil chemical properties. System of rice intensification (SRI) method with 50% FYM+50%Loktak phumdi compost registered maximum residual soil nutrient.

**Table 1:** Grain yield (q/ha) of black aromatic rice as influenced by crop establishment methods and manurial combinations

| Year | 2017 | | | | 2018 | | | | Pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Sub** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** |
| N1 | 18.13 | 19.33 | 18.73 | 18.73 | 17.37 | 19.53 | 18.93 | 18.61 | 17.75 | 19.43 | 18.83 | 18.67 |
| N2 | 15.60 | 17.77 | 17.73 | 17.03 | 16.50 | 17.72 | 18.23 | 17.48 | 16.05 | 17.74 | 17.98 | 17.26 |
| N3 | 16.13 | 17.42 | 18.27 | 17.27 | 16.83 | 17.72 | 18.40 | 17.65 | 16.48 | 17.57 | 18.33 | 17.46 |
| N4 | 17.17 | 19.22 | 18.34 | 18.24 | 18.00 | 20.81 | 19.63 | 19.48 | 17.58 | 20.01 | 18.99 | 18.86 |
| Mean | 16.76 | 18.43 | 18.27 | | 17.17 | 18.94 | 18.80 | | 16.97 | 18.69 | 18.53 | |
| | S | N | SXN | | S | N | SXN | | S | N | SXN | |
| S.Ed± | 0.25 | 0.24 | 0.42 | | 0.46 | 0.42 | 0.72 | | 0.23 | 0.21 | 0.37 | |
| CD(p=0.05) | 0.69 | 0.51 | 0.89 | | 1.27 | 0.87 | 1.51 | | 0.64 | 0.45 | 0.78 | |

**Table 2:** Straw yield (q/ha) of black aromatic rice as influenced by crop establishment methods and manurial combinations

| Year | 2017 | | | | 2018 | | | | pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Sub** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** |
| N1 | 36.93 | 37.37 | 37.23 | 37.18 | 37.37 | 36.77 | 35.90 | 36.68 | 37.15 | 37.07 | 36.57 | 36.93 |
| N2 | 28.40 | 35.29 | 34.30 | 32.66 | 28.63 | 36.48 | 35.67 | 33.59 | 28.52 | 35.88 | 34.98 | 33.13 |
| N3 | 29.63 | 35.32 | 35.83 | 33.59 | 30.07 | 37.43 | 34.73 | 34.07 | 29.85 | 36.37 | 35.28 | 33.84 |
| N4 | 35.03 | 37.32 | 36.27 | 36.21 | 37.40 | 39.41 | 39.07 | 38.62 | 36.22 | 38.37 | 37.67 | 37.42 |
| Mean | 32.50 | 36.32 | 35.91 | | 33.37 | 37.52 | 36.34 | | 32.93 | 36.92 | 36.12 | |
| | S | N | SXN | | S | N | SXN | | S | N | SXN | |
| S.Ed± | 0.73 | 0.68 | 1.18 | | 1.03 | 0.95 | 1.64 | | 0.46 | 0.47 | 0.81 | |
| CD(p=0.05) | 2.03 | 1.43 | 2.48 | | 2.86 | 1.99 | 3.45 | | 1.27 | 0.99 | 1.71 | |

**Table 3:** Effect of crop establishment methods and manurial combinations in the post harvest soil of organic carbon (%) by kharif rice

| Year | 2017 | | | | 2018 | | | | pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Sub** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** |
| N1 | 1.22 | 1.23 | 1.29 | 1.25 | 1.22 | 1.25 | 1.24 | 1.23 | 1.22 | 1.24 | 1.26 | 1.24 |
| N2 | 1.25 | 1.28 | 1.34 | 1.29 | 1.31 | 1.32 | 1.35 | 1.33 | 1.28 | 1.30 | 1.34 | 1.31 |
| N3 | 1.30 | 1.32 | 1.39 | 1.33 | 1.33 | 1.34 | 1.42 | 1.36 | 1.31 | 1.33 | 1.41 | 1.34 |
| N4 | 1.37 | 1.39 | 1.39 | 1.38 | 1.37 | 1.41 | 1.42 | 1.40 | 1.38 | 1.40 | 1.40 | 1.39 |
| Mean | 1.28 | 1.30 | 1.35 | | 1.31 | 1.33 | 1.36 | | 1.30 | 1.31 | 1.35 | |
| | S | N | SXN | | S | N | SXN | | S | N | SXN | |
| S.Ed± | 0.02 | 0.02 | 0.03 | | 0.03 | 0.02 | 0.03 | | 0.05 | 0.02 | 0.04 | |
| CD(p=0.05) | NS | 0.04 | NS | | NS | 0.04 | NS | | NS | 0.04 | NS | |

**Table 4:** Effect of crop establishment methods and manurial combinations in the post-harvest soil of nitrogen (kg/ha) by kharif rice

| Year | 2017 | | | | 2018 | | | | pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Sub** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** |
| N1 | 282.23 | 288.53 | 307.73 | 292.83 | 279.80 | 284.04 | 303.13 | 288.99 | 281.02 | 286.29 | 305.43 | 290.91 |
| N2 | 300.23 | 307.50 | 312.37 | 306.70 | 304.45 | 310.81 | 314.60 | 309.95 | 302.34 | 309.15 | 313.48 | 308.33 |
| N3 | 308.53 | 311.70 | 314.27 | 311.50 | 312.16 | 314.48 | 316.73 | 314.46 | 310.35 | 313.09 | 315.50 | 312.98 |
| N4 | 313.03 | 316.86 | 317.23 | 315.71 | 315.50 | 318.68 | 319.17 | 317.78 | 314.27 | 317.77 | 318.19 | 316.74 |
| Mean | 301.01 | 306.15 | 312.89 | | 302.98 | 307.00 | 313.41 | | 301.99 | 306.57 | 313.15 | |
| | S | N | SXN | | S | N | SXN | | S | N | SXN | |
| S.Ed± | 2.39 | 2.38 | 4.12 | | 2.69 | 2.19 | 3.79 | | 1.56 | 1.55 | 2.68 | |
| CD(p=0.05) | 6.65 | 5.00 | 8.66 | | 7.46 | 4.61 | 7.98 | | 4.34 | 3.26 | 5.64 | |

**Table 5:** Effect of crop establishment methods and manurial combinations in the post harvest soil of phosphorus (kg/ha) by kharif rice

| Year | 2017 | | | | 2018 | | | | pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Main Sub** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** | **S1** | **S2** | **S3** | **Mean** |
| N1 | 13.50 | 14.93 | 16.30 | 14.91 | 13.36 | 14.59 | 16.24 | 14.73 | 13.43 | 14.76 | 16.27 | 14.82 |
| N2 | 15.72 | 16.03 | 18.63 | 16.79 | 17.37 | 18.37 | 19.71 | 18.48 | 16.54 | 17.20 | 19.17 | 17.64 |
| N3 | 17.76 | 17.82 | 18.97 | 18.18 | 19.07 | 19.08 | 20.03 | 19.39 | 18.41 | 18.45 | 19.49 | 18.79 |
| N4 | 18.58 | 19.00 | 19.07 | 18.88 | 20.03 | 19.64 | 20.17 | 19.95 | 19.31 | 19.32 | 19.62 | 19.41 |
| Mean | 16.39 | 16.94 | 18.24 | | 17.46 | 17.92 | 19.04 | | 16.92 | 17.43 | 18.64 | |
| | S | N | SXN | | S | N | SXN | | S | N | SXN | |
| S.Ed± | 0.40 | 0.34 | 0.58 | | 0.39 | 0.30 | 0.52 | | 0.12 | 0.17 | 0.29 | |
| CD(p=0.05) | 1.11 | 0.71 | 1.23 | | 1.08 | 0.64 | 1.10 | | 0.33 | 0.35 | 0.60 | |

**Table 6:** Effect of crop establishment methods and manurial combinations in the post harvest soil of potassium (kg/ha) by kharif rice

| Year | 2017 | | | | 2018 | | | | pooled | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Main Sub | S1 | S2 | S3 | Mean | S1 | S2 | S3 | Mean | S1 | S2 | S3 | Mean |
| N1 | 130.77 | 142.27 | 150.16 | 141.06 | 124.63 | 144.13 | 156.40 | 141.72 | 127.70 | 143.20 | 153.28 | 141.39 |
| N2 | 149.73 | 149.23 | 154.07 | 151.01 | 154.20 | 156.23 | 161.00 | 157.14 | 151.97 | 152.73 | 157.53 | 154.08 |
| N3 | 152.07 | 154.37 | 157.73 | 154.72 | 159.84 | 160.57 | 163.97 | 161.46 | 155.95 | 157.47 | 160.85 | 158.08 |
| N4 | 157.13 | 157.75 | 161.30 | 158.73 | 162.77 | 164.10 | 170.30 | 165.72 | 159.95 | 160.92 | 165.80 | 162.22 |
| Mean | 147.42 | 150.90 | 155.81 | | 150.36 | 156.26 | 162.92 | | 148.89 | 153.58 | 159.36 | |
| | S | N | SXN | | S | N | SXN | | S | N | SXN | |
| S.Ed± | 2.20 | 1.92 | 3.33 | | 2.55 | 2.14 | 3.70 | | 2.31 | 1.99 | 3.45 | |
| CD(p=0.05) | 6.11 | 4.04 | 6.99 | | 7.08 | 4.49 | 7.78 | | 6.40 | 4.18 | 7.24 | |

## Conclusion

From the above discussion it is clear that organic fertilizer have a significant influence on yield and residual status of soil fertility after harvest of rice. Transplanting conventional method showed maximum yield while SRI recorded maximum residual soil nutrient.

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