Nutrient Management in Different Rice (Oryza sativa L.) Establishment Methods under Black Clay Soils of Tungabhadra Command

B. G. Masthana Reddy*, K. Mahantashivayogayya, Sujay Hurali and S. B. Gowdar

All India Co-ordinated Rice Improvement Programme, Agricultural Research Station, Gangavathi-583 227, University of Agricultural Sciences, Raichur, Karnataka (India)

*Corresponding author

Abstract

Field experiment was conducted at Agricultural Research Station, Gangavathi, Karnataka during the rainy season of 2015 and 2016 to evaluate nutrient practices for different rice establishment methods in comparison with puddle transplanting with recommended nutrient practice. Three establishment methods as main treatments and five nutrient practices as sub treatments were tried in split-plot design with three replications. Among establishment methods puddle transplanting recorded higher grain yield and among nutrient practices application of 200:100:100 kg N, P₂O₅ & K₂O/ha, 150%RDF and LCC based N application resulted in higher grain yields. The interaction revealed that a combination of puddle transplanting with either 200:100:100 kg N, P₂O₅ & K₂O/ha or 150%RDF and wet direct seeding with LCC based N management proved superior to puddle transplanting with recommended nutrient practice. However, LCC based N application in addition to maintaining on par yield with location specific practice also resulted in 31.5, 25 and 25% saving in N, P and K respectively and 10% saving in N against recommended practice and can be adopted by the farmers.

Keywords

Nutrient management, LCC, Dry direct seeded rice

Introduction

Rice is an important food crop of India, grown over an area of 43.44 mha with a production of 112.4mt and with a productivity of 2.7t/ha (Anon 2016). In order to feed the growing population India need to produce 130mt of rice by the year 2030 according to projections by Indian Institute of Rice Research, Hyderabad. Rice is grown under different establishment methods under various agro ecological conditions. In irrigated low land system it is traditionally established by manual transplanting with continuous ponding of water in the field. Due to non availability and high cost of labour, urbanization, mechanization and shortage of water availability a shift in the planting
methods has been observed in recent years in many farmers fields and farmers are adopting many methods of establishment like mechanical transplanting, dry direct seeding and broadcasting of seeds on unpuddle soils. Though lot of work on nutrient management practices in transplanted rice has been carried out in the past, such work on other methods is very much lacking. Hence in the present investigation an attempt was made to evaluate different nutrient management practices for different establishment methods in comparison with traditional transplanting.

Materials and Methods

Field experiment was conducted on black clay soil during the rainy season of 2015 and 2016 at the Agricultural Research Station, Gangavati, coming under Tungabhadra command of Karnataka. The soil of the experimental site was medium deep black clay in texture, neutral to alkaline in reaction (pH 8.1 to 8.3) and low in electrical conductivity (0.50 to 0.75 dS/m). The soil was low in alkaline KMnO4-N (210 kg ha⁻¹), high in Olsen’s-P2O5 (74.5 kg ha⁻¹) and high in NH₄OAc extractable K₂O (410 kg ha⁻¹) in the surface 0-20cm depth. The treatments consisted of three establishment methods viz., M₁: normal manual transplanting, M₂: wet direct seeding on puddle soil through drum seeding and M₃: dry direct seeding on unpuddle soil as main plot treatments and five nutrient practices viz., S₁: 100% recommended NPK (150:75:75 kg N, P₂O₅ and K₂O/ha), S₂: 75% inorganic+25%organic on N equivalent basis of recommended NPK, S₃: 150% of recommended NPK, S₄: LCC based N application with recommended P and K and S₅: Location specific NPK (200:100:100 kg N, P₂O₅ and K₂O/ha) were tried in split-plot design with three replications. Gangavathi sona (GGV-05-01) a medium duration rice variety maturing in 135 days was used. Direct seeding was done on 12th August and 4th August during 2015 and 2016 respectively. While transplanting was done on 11th September and 3rd September during 2015 and 2016 respectively. In the case of transplanting 30 days aged seedlings (at a seed rate of 62.5 kg/ha) were transplanted at 20x10cm spacing. While sprouted seeds at the rate of 45 kg/ha were sown using a drum seeder in wet direct seeding on puddle soil and in the case of dry direct seeding seeds were sown at 22.5cm spacing using a seed rate of 30 kg/ha. Recommended herbicides and need based plant protection measures were followed. Observations on grain yield and yield parameters were recorded and economics worked out.

Results and Discussion

Effect on grain yield

Among the establishment methods puddle transplanting recorded significantly higher grain yield during both years and in the mean data (57.58, 44.82 and 50.93 q/ha respectively during 2015, 2016 and in the mean) as compared to wet seeding and dry direct seeding. The treatment recorded 11.1 and 14.2% higher grain yield respectively over direct wet seeding and direct dry seeding. Among the nutrient practices 150% NPK and location specific NPK (200:100:100 kg N, P₂O₅ and K₂O/ha) recorded significantly higher grain yield of 54.18 and 54.02 q/ha respectively than recommended dose of 150:75:75 kg N, P₂O₅ and K₂O/ha (49.29 q/ha) during 2015. However, during 2016 LCC based NPK application and 150% RDF recorded significantly higher grain yield of 46.64 and 45.97 q/ha than recommended dose. The two year mean data revealed that application of 200:100:100 kg N, P₂O₅ and K₂O/ha recorded 9.6% higher grain yield than recommended NPK which however remained on par with 150% NPK and LCC based N application. The interaction effect revealed that a
combination of puddle transplanting x 200:100:100 kg N, P₂O₅ and K₂O/ha(M₁S₅) recorded significantly higher grain yield of 61.81 and 52.17 q/ha respectively during 2015 and 2016 which however remained on par with puddle transplanting x 150%RDF and puddle transplanting x LCC based N application. Earlier Srinivasagam Krishnakumar and Stefan Haefele (2013), Shantappa Duttarganvi et al., (2014), Ahmad Ali et al., (2015), Ashrabani Moharana et al., (2017), Tauseef A Bhatt et al., (2017) and Yogendra et al., (2017) reported higher grain yield of rice with less N application in the case of LCC based N application as compared to blanket application. The mean interaction was non significant.

Economics

The economics (Table 2) revealed that puddle transplanting recorded 11.43 and 14.93 % higher mean net returns over wet and dry direct seeding respectively. Among the nutrient practices, application of 200:100:100 kg N, P₂O₅ and K₂O/ha recorded higher net returns during 2015. However, LCC based N application proved superior during 2016 and in the mean data representing 24 and 17 % higher net returns than recommended practice. The interaction revealed that a combination of puddle transplanting x 200:100:100 kg N, P₂O₅ and K₂O/ha recorded higher net returns during 2015 which however remained on par with puddle transplanting x 150%RDF and direct wet seeding x LCC based N application. However, during 2016 wet direct seeding x LCC based N application recorded higher net returns than recommended practice and 150% RDF. The mean data revealed that puddle transplanting x 200:100:100 kg N, P₂O₅ and K₂O/ha recorded higher net returns but remained on par with puddle transplanting x 150%RDF and direct wet seeding x LCC based N application. The results are in line with [9] who reported higher additional income due to LCC based N application in rice.
Among the establishment methods the BC ratio was significant only during 2016 with direct wet seeding recording higher BC ratio of 2.11. Among nutrient practices LCC based N application recorded higher BC ratio during both years and in the mean indicating economic profitability of LCC based N application. The interaction revealed that BC ratio was non significant during 2015.

Table 1 Grain yield and yield parameters as influenced by establishment methods and nutrient practices in rice

| Establishment methods | Grain yield (q/ha) Mean | Panicles/sqm Mean | Panicle weight (g) Mean | Grains/panicle Mean |
|-----------------------|-------------------------|-------------------|-------------------------|---------------------|
| M1                    | 57.58 | 44.28 | 50.93 | 393 | 2.74 | 165.2 |
| M2                    | 48.68 | 41.46 | 45.27 | 401 | 2.57 | 150.3 |
| M3                    | 49.79 | 40.26 | 43.70 | 445 | 2.32 | 137.8 |
| SEM                   | 1.25 | 0.65 | 1.20 | 7.50 | 0.06 | 3.43 |
| CD (p=0.05)            | 5.03 | 2.55 | 4.70 | 29.6 | 0.24 | 13.48 |
| Nutrient practices     |             |                   |                   |                   |                   |
| S1                    | 49.29 | 40.13 | 44.71 | 380 | 2.48 | 147.8 |
| S2                    | 49.74 | 32.36 | 41.38 | 410 | 2.53 | 145.7 |
| S3                    | 54.18 | 45.97 | 48.96 | 432 | 2.56 | 158.3 |
| S4                    | 52.88 | 46.64 | 48.65 | 417 | 2.51 | 142.00 |
| S5                    | 54.02 | 44.91 | 49.47 | 422 | 2.62 | 161.7 |
| SEM                   | 0.78 | 1.06 | 1.04 | 11.4 | 0.05 | 2.85 |
| CD (p=0.05)            | 2.29 | 3.09 | 3.02 | 33.2 | NS | 8.73 |
| Interaction            |             |                   |                   |                   |                   |
| M1S1                  | 55.67 | 43.02 | 49.34 | 373 | 2.81 | 157.3 |
| M1S2                  | 53.10 | 32.92 | 43.01 | 377 | 2.60 | 172.7 |
| M1S3                  | 60.84 | 47.42 | 54.13 | 390 | 2.73 | 176.3 |
| M1S4                  | 56.70 | 47.50 | 52.10 | 422 | 2.57 | 148.7 |
| M1S5                  | 61.81 | 52.17 | 56.99 | 395 | 2.98 | 171.0 |
| M2S1                  | 43.48 | 36.72 | 40.10 | 373 | 2.48 | 145.0 |
| M2S2                  | 50.67 | 33.47 | 42.07 | 362 | 2.61 | 147.0 |
| M2S3                  | 51.57 | 43.77 | 47.67 | 440 | 2.64 | 156.3 |
| M2S4                  | 48.80 | 49.52 | 49.16 | 391 | 2.53 | 133.3 |
| M2S5                  | 48.87 | 43.83 | 46.35 | 371 | 2.57 | 169.7 |
| M3S1                  | 48.71 | 40.65 | 44.68 | 395 | 2.17 | 141.3 |
| M3S2                  | 45.43 | 30.70 | 38.06 | 425 | 2.37 | 117.3 |
| M3S3                  | 50.12 | 46.72 | 48.42 | 466 | 2.31 | 142.3 |
| M3S4                  | 53.33 | 44.52 | 48.93 | 438 | 2.43 | 144.0 |
| M3S5                  | 51.39 | 38.72 | 45.05 | 498 | 2.30 | 144.3 |
| SEM                   | 1.76 | 1.76 | 2.00 | 19.2 | 0.09 | 5.59 |
| CD (p=0.05)            | 5.15 | 5.14 | NS | NS | NS | 16.34 |
Table 2 Economics of rice as influenced by establishment methods and nutrient practices

| Establishment methods | Net returns (Rs/ha) | Benefit-cost ratio |
|-----------------------|--------------------|--------------------|
|                       | 2015 | 2016 | Mean  | 2015 | 2016 | Mean  |
| M1                    | 75276 | 49806 | 62541  | 2.52 | 2.00 | 2.26  |
| M2                    | 61969 | 48816 | 55392  | 2.41 | 2.11 | 2.26  |
| M3                    | 62149 | 44257 | 53203  | 2.41 | 1.95 | 2.15  |
| SEm                   | 2716  | 1381  | 1661   | 0.05 | 0.03 | 0.05  |
| CD (p=0.05)           | 10665 | NS    | 6521   | NS   | 0.11 | NS    |

| Nutrient practices    | Net returns (Rs/ha) | Benefit-cost ratio |
|-----------------------|--------------------|--------------------|
|                       | 2015 | 2016 | Mean  | 2015 | 2016 | Mean  |
| S1                    | 62068 | 44731 | 53400  | 2.36 | 1.98 | 2.17  |
| S2                    | 60705 | 25414 | 43060  | 2.39 | 1.54 | 1.91  |
| S3                    | 69197 | 54807 | 62002  | 2.42 | 2.13 | 2.27  |
| S4                    | 69903 | 59277 | 64590  | 2.55 | 2.32 | 2.44  |
| S5                    | 70449 | 53901 | 62175  | 2.50 | 2.15 | 2.32  |
| SEm                   | 1681  | 2316  | 1709   | 0.05 | 0.05 | 0.04  |
| CD (p=0.05)           | 4908  | 6762  | 4989   | NS   | 0.15 | 0.11  |

| Interaction           | Net returns (Rs/ha) | Benefit-cost ratio |
|-----------------------|--------------------|--------------------|
|                       | 2015 | 2016 | Mean  | 2015 | 2016 | Mean  |
| M1S1                  | 72845 | 48735 | 60790  | 2.51 | 2.01 | 2.26  |
| M1S2                  | 64717 | 24052 | 44385  | 2.28 | 1.48 | 1.88  |
| M1S3                  | 80375 | 54770 | 67572  | 2.57 | 2.06 | 2.31  |
| M1S4                  | 74564 | 54729 | 64647  | 2.55 | 2.14 | 2.34  |
| M1S5                  | 83880 | 66745 | 75312  | 2.69 | 2.34 | 2.51  |
| M2S1                  | 52224 | 39446 | 45835  | 2.22 | 1.92 | 2.07  |
| M2S2                  | 65380 | 30250 | 47815  | 2.46 | 1.67 | 2.06  |
| M2S3                  | 66199 | 52301 | 59250  | 2.44 | 2.14 | 2.29  |
| M2S4                  | 64982 | 67796 | 66389  | 2.50 | 2.60 | 2.55  |
| M2S5                  | 62296 | 54286 | 58291  | 2.41 | 2.23 | 2.32  |
| M3S1                  | 61136 | 46012 | 53574  | 2.36 | 2.02 | 2.19  |
| M3S2                  | 52019 | 21942 | 36981  | 2.10 | 1.46 | 1.78  |
| M3S3                  | 61016 | 57353 | 59184  | 2.26 | 2.18 | 2.22  |
| M3S4                  | 71399 | 55307 | 63353  | 2.59 | 2.23 | 2.41  |
| M3S5                  | 65173 | 40673 | 52923  | 2.40 | 1.87 | 2.14  |
| SEm                   | 3763  | 3845  | 3125   | 0.10 | 0.08 | 0.07  |
| CD (p=0.05)           | 10985 | 11224 | 9123   | NS   | 0.24 | 2.00  |

However during 2016 and in the mean data a combination of wet direct seeding x LCC based N application recorded higher BC ratio of 2.6 and 2.55 respectively and proved significantly superior to puddle transplanting x recommended practice and puddle transplanting x 150% RDF.

The two year data indicated that puddle transplanting in combination with either location specific recommendation of 200:100:100 kg N, P2O5 and K2O/ha or
150% RDF or LCC based N application proved superior than puddle transplanting x recommended practice in terms of grain yield. However based on economic analysis of net returns and BC ratio it can be concluded that puddle transplanting in combination with either 200:100:100 kg N,P₂O₅ and K₂O/ha or 150% RDF and direct wet seeding with LCC based N application performed better and can be recommended for farmers adoption.

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