

Original Research Article

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## Impact of Crop Establishment, Weed and Nutrient Management Practices on Microbial Population and Grain Yield of Transplanted Rice

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### ABSTRACT

The field experiments were carried out in clay loam soil of wetland farms of Tamil Nadu Agricultural University, Coimbatore during *Samba* 2009 and 2010 to elucidate the effect of rice establishment, weed and nutrient management practices on microbial population in the rhizosphere and yield of transplanted rice. The experiments were laid out in split plot design with rice establishment and weed management methods (M<sub>1</sub>: Conventional planting + hand weeding, M<sub>2</sub>: Conventional planting + one way rotary weeding, M<sub>3</sub>: SRI planting + hand weeding, M<sub>4</sub>: SRI planting + two way rotary weeding) in main plots and nutrient management practices [S<sub>1</sub>: Absolute control, S<sub>2</sub>: 150:50:50 kg NPK ha<sup>-1</sup>, S<sub>3</sub>: S<sub>2</sub> + 12.5 t FYM ha<sup>-1</sup>, S<sub>4</sub>: S<sub>3</sub> + *Azophosmet* (Seed treatment @ 2 g kg<sup>-1</sup> and soil application @ 2 kg ha<sup>-1</sup>) + pink pigmented facultative methylotroph (PPFM) (foliar spray @ 0.1% at active tillering, panicle initiation and at 50 per cent flowering stage)] in sub plots, replicated thrice. The SRI planting with two way rotary weeding thrice at weekly interval starting from 15 days after transplanting registered higher microbial population in the rhizosphere viz., bacteria, fungi, actinomycetes, *Azospirillum*, phosphobacteria and Pink pigmented facultative methylotroph (PPFM) at flowering stage and higher grain and straw yield. Microbial population and yield were higher with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha<sup>-1</sup>) along with 12.5 t ha<sup>-1</sup> FYM and biofertilizers viz., *Azophosmet* as soil and seed treatment and PPFM as foliar spray.

### Keywords

Transplanted rice, SRI, Microbial population and grain yield.

### Article Info

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## Introduction

Use of high energy agricultural inputs like fertilizers and pesticides cause environmental hazards, so it is desirable to develop a sustainable production system that give optimum productivity with minimum environmental pollution (Singh *et al.*, 2010). The System of Rice Intensification (SRI) is an alternative for conventional rice cultivation that saves the expensive external inputs, improves soil health/quality and protects the environment substantially (Ram *et al.*, 2014).

Microbes harbouring rhizosphere of crops provide benefits to crops through better nutrient availability by way of atmospheric N<sub>2</sub> fixation or solubilizing fixed mineral forms of nutrients (Pandey *et al.*, 2010). Use of integrated nutrient management yields maximum counts and establishment of microbes in soil rather than sole application of chemical fertilizer treatments (Kumar *et al.*, 2014). Keeping foresaid points in view, the field experiments with different crop

establishment, weed and nutrient management methods were conducted in clay loam soil of Tamil Nadu Agricultural University, Coimbatore during *rabi*, 2009 and 2010 to assess their effects on the microbial population and yield of transplanted lowland rice.

## Materials and Methods

The field experiments were conducted in clay loam soil of wetland farms, Department of Farm management, Tamil Nadu Agricultural University, Coimbatore during *rabi* 2009 and 2010 with the medium duration rice variety CO(R) 50. Field experiments were laid out in split plot design with rice establishment and weed management methods (M<sub>1</sub>: Conventional planting + hand weeding, M<sub>2</sub>: Conventional planting + one way rotary weeding, M<sub>3</sub>: SRI planting + hand weeding, M<sub>4</sub>: SRI planting + two way rotary weeding) in main plots and nutrient management practices [S<sub>1</sub>: Absolute control, S<sub>2</sub>: 150:50:50 kg NPK ha<sup>-1</sup>, S<sub>3</sub>: S<sub>2</sub> + 12.5 t FYM ha<sup>-1</sup>, S<sub>4</sub>: S<sub>3</sub> + *Azophosmet* (Seed treatment @ 2 g kg<sup>-1</sup> and soil application @ 2 kg ha<sup>-1</sup>) + pink pigmented facultative methylotroph (PPFM) (foliar spray @ 0.1% at active tillering, panicle initiation and at 50 per cent flowering stage)] in sub plots, replicated thrice. The soil samples collected from rhizosphere of rice at flowering stage were analyzed for microbial population by adopting standard methods. The grain yield was adjusted to 14 per cent moisture content. Data were subjected to an analysis of variance (F-test) as per the methods suggested by Gomez and Gomez (2010).

## Results and Discussion

### Microbial population

The crop establishment and weed management methods have significant

influence on the microbial population in the rhizosphere.

The SRI planting with two way rotary weeding thrice at weekly interval starting from 15 days after transplanting during both the years registered higher microbial population in the rhizosphere *viz.*, bacteria, fungi, actinomycetes, *Azospirillum*, phosphobacteria and Pink pigmented facultative methylotroph (PPFM) at flowering stage could be attributed to larger root volume along with favourable soil condition facilitated by the rotary weeding.

This is in corroboration with the findings of Kumar *et al.*, (2007) who have stated that larger canopies and root systems of SRI plants release more carbohydrates and amino acids into the soil as root exudates, enriching the rhizosphere and supporting greater microbial biomass and diversity.

The microbial population was significantly altered by the nutrient management practices. Population of bacteria, fungi, actinomycetes, *Azospirillum*, phosphobacteria and PPFM were higher with combined application of recommended dose of fertilizer (150:50:50 kg NPK ha<sup>-1</sup>) along with 12.5 t ha<sup>-1</sup> FYM and biofertilizers *viz.*, *Azophosmet* as soil and seed treatment and PPFM as foliar spray might be attributable to higher organic carbon content and external application of biofertilizers.

This finding is in line with the reports of Marschner *et al.*, (2003) who reported that organic and inorganic fertilizers affect the population, composition and function of soil micro organisms. In addition to that, according to Zhao *et al.*, (2010), close relations between microorganism growth and activity to organic matter content in the soil as this provided carbon and energy sources for the growth of microorganisms (Tables 1 and 2).

**Table.1** Effect of crop establishment and weed management methods and nutrient management practices on microbial population viz., bacteria, fungi and actinomycetes

| Treatments  | Colony forming units / gram of soil |             |                         |             |                                 |             |
|---|-------------------------------------|-------------|-------------------------|-------------|---------------------------------|-------------|
|   | Bacteria x 10 <sup>6</sup>          |             | Fungi x 10 <sup>5</sup> |             | Actinomycetes x 10 <sup>3</sup> |             |
|   | 2009                                | 2010        | 2009                    | 2010        | 2009                            | 2010        |
| <b>Crop establishment and weed management methods</b>           |                                     |             |                         |             |                                 |             |
| M <sub>1</sub> : Conventional planting + hand weeding           | 21.58                               | 21.08       | 5.00                    | 4.58        | 6.00                            | 5.17        |
| M <sub>2</sub> : Conventional planting + one way rotary weeding | 23.25                               | 22.75       | 6.00                    | 5.50        | 6.42                            | 5.33        |
| M <sub>3</sub> : SRI planting + hand weeding                    | 23.00                               | 22.67       | 5.25                    | 4.92        | 6.42                            | 5.33        |
| M <sub>4</sub> : SRI planting + two way rotary weeding          | 24.83                               | 24.17       | 6.67                    | 6.25        | 7.25                            | 6.17        |
| <b>SEd</b>  | 0.57                                | 0.49        | 0.27                    | 0.28        | 0.25                            | 0.29        |
| <b>CD at 5%</b>   | <b>1.40</b>                         | <b>1.20</b> | <b>0.66</b>             | <b>0.69</b> | <b>0.62</b>                     | <b>0.71</b> |
| <b>Nutrient management practices</b>                            |                                     |             |                         |             |                                 |             |
| S <sub>1</sub> : Absolute control                               | 15.08                               | 14.75       | 4.83                    | 4.42        | 5.25                            | 4.25        |
| S <sub>2</sub> : 150:50:50 kg NPK ha <sup>-1</sup>              | 21.67                               | 21.17       | 5.17                    | 4.83        | 5.92                            | 5.08        |
| S <sub>3</sub> : S <sub>2</sub> + 12.5 t FYM ha <sup>-1</sup>   | 26.08                               | 25.58       | 6.00                    | 5.58        | 7.08                            | 6.08        |
| S <sub>4</sub> : S <sub>3</sub> + Azophosmet +0.1% PPFM         | 29.83                               | 29.17       | 6.92                    | 6.42        | 7.83                            | 6.58        |
| <b>SEd</b>  | 0.52                                | 0.51        | 0.18                    | 0.18        | 0.19                            | 0.17        |
| <b>CD at 5%</b>   | <b>1.06</b>                         | <b>1.05</b> | <b>0.37</b>             | <b>0.36</b> | <b>0.38</b>                     | <b>0.35</b> |

**Table.2** Effect of crop establishment and weed management methods and nutrient management practices on microbial population viz., *Azospirillum*, Phosphobacteria and PPFM

| Treatments  | Colony forming units / gram of soil   |             |                                   |             |                        |             |
|---|---------------------------------------|-------------|-----------------------------------|-------------|------------------------|-------------|
|   | <i>Azospirillum</i> x 10 <sup>3</sup> |             | Phosphobacteria x 10 <sup>3</sup> |             | PPFM x 10 <sup>3</sup> |             |
|   | 2009                                  | 2010        | 2009                              | 2010        | 2009                   | 2010        |
| <b>Crop establishment and weed management methods</b>           |                                       |             |                                   |             |                        |             |
| M <sub>1</sub> : Conventional planting + hand weeding           | 7.58                                  | 7.25        | 17.75                             | 16.25       | 5.17                   | 5.58        |
| M <sub>2</sub> : Conventional planting + one way rotary weeding | 8.42                                  | 7.92        | 18.75                             | 17.33       | 5.42                   | 5.83        |
| M <sub>3</sub> : SRI planting + hand weeding                    | 8.42                                  | 7.83        | 18.50                             | 17.08       | 5.50                   | 5.67        |
| M <sub>4</sub> : SRI planting + two way rotary weeding          | 9.42                                  | 8.58        | 20.08                             | 18.67       | 6.58                   | 6.50        |
| <b>SEd</b>  | 0.26                                  | 0.20        | 0.60                              | 0.51        | 0.27                   | 0.25        |
| <b>CD at 5%</b>   | <b>0.64</b>                           | <b>0.49</b> | <b>1.47</b>                       | <b>1.24</b> | <b>0.67</b>            | <b>0.61</b> |
| <b>Nutrient management practices</b>                            |                                       |             |                                   |             |                        |             |
| S <sub>1</sub> : Absolute control                               | 6.58                                  | 6.33        | 14.42                             | 14.08       | 4.50                   | 4.92        |
| S <sub>2</sub> : 150:50:50 kg NPK ha <sup>-1</sup>              | 7.75                                  | 7.25        | 18.75                             | 17.00       | 5.17                   | 5.50        |
| S <sub>3</sub> : S <sub>2</sub> + 12.5 t FYM ha <sup>-1</sup>   | 9.25                                  | 8.67        | 19.50                             | 17.75       | 5.67                   | 6.00        |
| S <sub>4</sub> : S <sub>3</sub> + Azophosmet +0.1% PPFM         | 10.25                                 | 9.33        | 22.42                             | 20.50       | 7.33                   | 7.17        |
| <b>SEd</b>  | 0.22                                  | 0.17        | 0.51                              | 0.32        | 0.25                   | 0.17        |
| <b>CD at 5%</b>   | <b>0.46</b>                           | <b>0.34</b> | <b>1.05</b>                       | <b>0.66</b> | <b>0.51</b>            | <b>0.36</b> |

**Table.3** Effect of crop establishment and weed management methods and nutrient management practices on grain and straw yield of transplanted rice

| Treatments  | Grain yield (Kg ha <sup>-1</sup> ) |            | Straw yield (Kg ha <sup>-1</sup> ) |            |
|---|------------------------------------|------------|------------------------------------|------------|
|   | 2009                               | 2010       | 2009                               | 2010       |
| M <sub>1</sub> : Conventional planting + hand weeding           | 5286                               | 4912       | 7237                               | 6565       |
| M <sub>2</sub> : Conventional planting + one way rotary weeding | 5731                               | 5575       | 7608                               | 7229       |
| M <sub>3</sub> : SRI planting + hand weeding                    | 5472                               | 5170       | 7076                               | 6523       |
| M <sub>4</sub> : SRI planting + two way rotary weeding          | 6107                               | 5901       | 7761                               | 7526       |
| <b>SEd</b>  | 189                                | 194        | 281                                | 209        |
| <b>CD at 5%</b>   | <b>461</b>                         | <b>475</b> | <b>NS</b>                          | <b>512</b> |
| S <sub>1</sub> : Absolute control                               | 4675                               | 4379       | 6106                               | 5651       |
| S <sub>2</sub> : 150:50:50 kg NPK ha <sup>-1</sup>              | 5579                               | 5367       | 7718                               | 7178       |
| S <sub>3</sub> : S <sub>2</sub> + 12.5 t FYM ha <sup>-1</sup>   | 6052                               | 5762       | 7848                               | 7503       |
| S <sub>4</sub> : S <sub>3</sub> + <i>Azophosmet</i> +0.1% PPFM  | 6288                               | 6050       | 8010                               | 7510       |
| <b>SEd</b>  | 112                                | 100        | 170                                | 172        |
| <b>CD at 5%</b>   | <b>231</b>                         | <b>207</b> | <b>352</b>                         | <b>354</b> |

### Yield

The SRI planting with two way rotary weeding thrice at weekly interval starting from 15 days after transplanting registered significantly higher grain and straw yield during both the years might be attributable to larger root system and crop canopy and higher microbial population which facilitated the enhanced nutrient uptake, photosynthetic activity and remobilization of photosynthates. However, the straw yield was not significantly altered due to the crop establishment and weed management practices during 2009. This is in conformity with the findings of Sridevi and Chellamuthu (2012) and Revathi (2009) (Table 3).

Combined application of recommended dose of fertilizer (150:50:50 kg NPK ha<sup>-1</sup>) along with 12.5 t ha<sup>-1</sup> FYM and bio fertilizers *viz.*, *Azophosmet* as soil and seed treatment and PPFM as foliar spray registered higher grain and straw yield might be attributed to greater root development and activity, higher microbial population and increased nutrient

availability throughout the crop growth. This finding is in accordance with the findings of Virdia and Mehta (2010) and Sharma *et al.*, (2017)

In conclusion, the results of the present investigation revealed that SRI planting + two way rotary weeding along with recommended dose of fertilizer (150:50:50 kg NPK ha<sup>-1</sup>) + 12.5 t FYM ha<sup>-1</sup> + *Azophosmet* (seed and soil application) + PPFM (0.1% foliar spray) at active tillering, panicle initiation and at 50 per cent flowering stage registered higher microbial population *viz.*, bacteria, fungi, actinomycetes, *Azospirillum*, phosphobacteria and PPFM in the rhizosphere during flowering stage which in turn resulted in higher grain and straw yield of the medium duration rice variety CO (R) 50 during *rabi* in the clay loam soil of Coimbatore.

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