

# Effect of integrated plant nutrient management (IPNM) practices on grain yield and qualities of medium slender rice (*Oryza sativa*) under rice – rice cropping system in Southern India

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## ABSTRACT

A field experiment was carried out at Agricultural College and Research Institute, Madurai during *rabi* seasons of 2001 and 2002 to study the effect of cotton crop residue management practices and levels of inorganic fertilizer N and K on rice [*Oryza sativa* (L.)] - rice cropping system. The results revealed that incorporation of cotton stalks @ 5 t ha<sup>-1</sup> with *Trichoderma viride* in rice crop significantly improved yield attributes (number of panicles and number of grains) and yield of rice. Similar yield trend was seen by increasing levels of N and K and also significantly increased the grain qualities of medium slender rice in organics and bio-inoculants applied plots.

**Key words :** Cotton residues incorporation, IPNM, Bio-inoculants, Levels of fertilizer N and K, Grain yield and qualities.

## INTRODUCTION

In recent years, rice has emerged as the principal food crop in Southern India. In Tamil Nadu, rice [*Oryza sativa* (L.)] - rice cropping system is mostly followed. Growing two or more crops per year involves heavy removal of plants nutrients, nitrogen being the key input limiting rice production. To sustain rice productivity at present levels, the plants nutrients removed in harvested produce or lost from the system must be replaced by fertilizers or must be obtained from organic manures. Addition of N through organic manures exhibited better replenishment of losses of N through crop harvest and other mechanisms, creating a dynamic equilibrium (Satheesh and Balasubramanian, 2003), this equilibrium needed to be sustained for increasing the rice production and high yielding rice varieties ability to use additional nutrient inputs which were thus developed. Moreover, use of organic manure not only acts as a source of N and other nutrients but also increase the efficiency of applied nitrogen (Zhu *et al.*, 1987). Bhudhar and Palaniappan (1994) opined that the addition of organic waste increased the microbial population during the decomposition process. In places like Srivilliputhur, Rajapalayam, Tenkasi tracts of Southern districts of Tamil Nadu (India), *rabi* rice is grown after summer cotton. Similarly in Thanjavur district rice is grown after rice fallow cotton. Disposal of cotton residues is a major problem in these areas. Cotton stalks

of about 10 – 15 t ha<sup>-1</sup> after the final picking, are normally uprooted and used as fuel. About 15 t ha<sup>-1</sup> of cotton stalks can supply 180 kg N ha<sup>-1</sup> (Bhudhar and Palaniappan, 1994). Even though *hirsutum* cotton stalks have sufficient nutrient value either it is wasted or used as fuel, in spite of poor calorific value of stalks. Burning results in huge wastage of plant nutrients and creates an environmental pollution. The nutrients present in organic materials (cotton residue) can be recycled into field either by direct incorporation or by composting with some bio-inoculants. It is the easy way to utilize the cotton stalks efficiently by integrating with biological sources. Integrated plant nutrient approach to crops by the combination of organics, bio-inoculants along with synthetic fertilizers has numerous apparent agronomical and environmental benefits over inorganic fertilizers alone. Hence, a field trial was conducted to study the effect of cotton residue management practices and levels of inorganic fertilizer N and K on grain yield and qualities of *rabi* rice.

## MATERIALS AND METHODS

A field experiment was carried out at Agricultural College and Research Institute, Madurai during *rabi* seasons (September- December) of 2001 and 2002. The experimental soil was sandy clay loam with pH of 8.05, which was medium in organic carbon (0.52 %), low in available nitrogen (186.3 kg ha<sup>-1</sup>), medium in phosphorus

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(17.80 kg ha<sup>-1</sup>) and high in potassium (285.80 kg ha<sup>-1</sup>). The field experiment was laid out in split-plot design with three replications. The experiment in main plots consisted of five treatment combinations on incorporation of cotton stalks @ 5 t ha<sup>-1</sup> alone or with bio-inoculants *viz.*, control - without cotton stalks incorporation (M<sub>1</sub>), cotton stalks incorporation @ 5 t ha<sup>-1</sup> (M<sub>2</sub>), cotton stalks incorporation @ 5 t ha<sup>-1</sup> + *Trichoderma viride* (M<sub>3</sub>), cotton stalks incorporation @ 5 t ha<sup>-1</sup> + *Pleurotus sajor caju* (M<sub>4</sub>) and cotton stalks incorporation @ 5 t ha<sup>-1</sup> + *Trichoderma viride* + *Pleurotus sajor caju* (M<sub>5</sub>). In subplots, however, four (S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub> and S<sub>4</sub>) inorganic fertilizers levels, *i.e.* 125, 100, 75, and 50 % of the recommended dose of inorganic fertilizer N and K were kept, respectively. The full dose of phosphorus fertilizer was applied as basal and the inorganic fertilizers N and K were applied in three splits *viz.*, at basal, active tillering and flowering stages of rice crop. Five tones of cotton stalks ha<sup>-1</sup> was incorporated manually in the concerned treatments. Medium slender rice cv. CO 43 was sown in the first week of September in wet land area. Other management practices were adopted as per recommendations of the crops. The total rain fall received during the *rabi* season was 538 and 547 mm during 2001 and 2002, respectively.

## RESULTS AND DISCUSSION

### *Yield of rice:*

The incorporation of cotton stalks @ 5 t ha<sup>-1</sup> with or without bio-inoculants in rice significantly increased rice grain yield (Table 1). The increase in grain yield in treatment receiving cotton stalks incorporation @ 5 t ha<sup>-1</sup> plus *Trichoderma viride* and cotton stalks incorporation @ 5 t ha<sup>-1</sup> + *Trichoderma viride* + *Pleurotus sajor caju* was 1967, 1893 kg ha<sup>-1</sup>, respectively resulting in 44.45, 42.78 per cent over no cotton stalks incorporation treatment (Table 1). This increment may be due to steady and adequate supply of nutrients from crop residues incorporated resulting in better absorption of nutrients and subsequent utilization in partitioning the assimilates from the source to sink. Similar finding was reported by Gururajan *et al.* (2001) and Babou *et al.* (2001).

Higher fertility level (125 per cent of the recommended dose of N and K) enhanced the yield (5923 kg ha<sup>-1</sup>) of rice over the lower dose (50 per cent of the recommended dose of N and K) and it was at par with application of 100 per cent of the recommended dose of inorganic N and K (Table 1).

### *Effect of IPNM on grain qualities of rice:*

Incorporation of cotton stalks with or without bio-

inoculants and levels of N and K increased the quality parameters of rice such as optimum cooking time, total amylose content, crude protein content and reduce the percentage of gruel loss as compared to control (Table 1).

### *Optimum cooking time:*

The optimal cooking time was prolonged in rice obtained from the treatment in which the incorporation of cotton stalks was done during both the years (Table 1). This prolonged time might be due to the increased hardness of grain affected through incorporation of organic and high levels of nitrogen (Sardana, 2000). The prolonged cooking time (17.55 minutes) was significantly influenced by the treatment receiving cotton stalks incorporation @ 5t ha<sup>-1</sup> with *Trichoderma viride* (M<sub>3</sub>). This cooking time was at par with cotton stalks incorporation @ 5t ha<sup>-1</sup> with *Trichoderma viride* and *Pleurotus sajor-caju* (M<sub>5</sub>). The optimum cooking time was shortened (14.05 minutes) in case of the produce obtained in control plot (M<sub>1</sub>).

Application of 125 % of recommended dose of inorganic N and K (S<sub>1</sub>) prolonged the cooking time. This cooking time was at par with the treatment, which received 100 % of recommended dose of inorganic N and K (S<sub>2</sub>), which was at par with 75 % of recommended dose of inorganic N and K (S<sub>3</sub>). Interaction effect was not significant.

### *Total amylose content:*

Application of organic manures enhanced the total amylose content of rice grain due to ensured supply of nutrients. Total amylose content in rice was significantly influenced by the incorporation of cotton stalks with or without bio-inoculants and levels of inorganic fertilizers N and K (Table 1). The highest total amylose content (29.32 %) was recorded in the treatment consisting of the incorporation of cotton stalks @ 5 t ha<sup>-1</sup> with *Trichoderma viride* (M<sub>3</sub>) and it was at par with Cotton stalks incorporation @ 5 t ha<sup>-1</sup> with *Trichoderma viride* and *Pleurotus sajor caju* (M<sub>5</sub>) which was 20.31 and 17.02 % higher than that of control (M<sub>1</sub>). Lesser amylose content was observed with control plot (M<sub>1</sub>).

Application of 125 % of recommended dose of inorganic N and K (S<sub>1</sub>) recorded highest total amylose content (29.52 %). It was at par with the treatment, which received 100 % of recommended dose of inorganic N, and K (S<sub>2</sub>). Total amylose content in the treatment consisting of recommended dose of fertilizer was at par with 75 % of recommended dose of inorganic N and K (S<sub>3</sub>). Lesser amylose content was observed in 50 per cent of recommended dose of inorganic N and K (S<sub>4</sub>).

**Table 1 : Grain yield and qualities of rice as influenced by IPNM (pooled data of 2 years)**

Treatments	Grain yield (kg ha <sup>-1</sup> )	Optimum cooking time (min)	Total amylose content (%)	Crude protein content (%)	Gruel loss (%)	Elongation ratio
<b>Organics and bio-inoculants</b>						
M <sub>1</sub>	4425	14.05	24.37	8.02	3.91	1.43
M <sub>2</sub>	5745	14.95	26.42	8.52	3.51	1.44
M <sub>3</sub>	6392	17.55	29.32	9.50	3.05	1.47
M <sub>4</sub>	5885	15.95	27.52	8.92	3.32	1.45
M <sub>5</sub>	6318	16.85	28.52	9.30	3.14	1.46
C.D. (P=0.05)	89.38	0.8	0.90	0.30	0.15	NS
<b>Inorganic fertilizers</b>						
S <sub>1</sub>	5923	18.1	29.52	9.44	2.85	1.46
S <sub>2</sub>	5809	17.5	28.97	9.24	2.93	1.46
S <sub>3</sub>	5730	16.85	28.45	9.05	3.02	1.45
S <sub>4</sub>	5548	15.75	27.43	8.74	3.26	1.44
C.D. (P=0.05)	119.3	0.73	0.65	0.23	0.12	NS
Interaction	NS	NS	NS	NS	NS	NS

NS: Non-significant

**Crude protein content:**

Crude protein content in rice was significantly influenced by the incorporation of cotton stalks with or without bio-inoculants and levels of inorganic fertilizer N and K (Table 1). The similar trend was also observed in total amylose content. The highest crude protein content (9.50 %) was recorded in the treatment consisting of the incorporation of cotton stalks @ 5 t ha<sup>-1</sup> with *Trichoderma viride* (M<sub>3</sub>) and it was at par with cotton stalks incorporation @ 5 t ha<sup>-1</sup> with *Trichoderma viride* and *Pleurotus sajor caju* (M<sub>5</sub>) which was 18.45 and 15.96 % higher than that of control (M<sub>1</sub>). Crude protein content of rice increase with organic and increased levels of N and K may be due to the desired quantity of N supplied at appropriate times through right sources which would have influenced positively the crude protein content (Poonam *et al.*, 2000).

Application of 125 % of recommended dose of inorganic N and K (S<sub>1</sub>) recorded highest (9.44 %) crude protein content in rice. It was at par with the treatment, which received 100 % of recommended dose of inorganic N and K (S<sub>2</sub>), which again was at par with 75 % of recommended dose of inorganic N and K (S<sub>3</sub>). Lesser crude protein content in rice was observed in 50 per cent of recommended dose of inorganic N and K (S<sub>4</sub>).

**Gruel loss:**

The percentage gruel loss was significantly influenced by the incorporation of cotton stalks with or without bio-inoculants and levels of inorganic fertilizer N and K (Table 1). The highest gruel loss (3.91 %) was observed with control plot (M<sub>1</sub>) and the lowest gruel loss (3.05 %) was

recorded in rice obtained in the treatment consisting of the incorporation of cotton stalks @ 5t ha<sup>-1</sup> with *Trichoderma viride* (M<sub>3</sub>). It was inferred that, proper N nutrition and favorable soil condition maintained by organic and inorganic N combination reduced the gruel loss from the grain (Virender Sardana, 2000). The percentage of gruel loss was at par with the treatment consisting of cotton stalks incorporation @ 5t ha<sup>-1</sup> with *Trichoderma viride* and *Pleurotus sajor caju* (M<sub>5</sub>).

Application of 125 % of recommended dose of inorganic N and K (S<sub>1</sub>) recorded lowest gruel loss in rice. It was at par with the treatment, which received 100 per cent of recommended dose of inorganic N and K (S<sub>2</sub>). This treatment was at par with 75 % of recommended dose of inorganic N and K (S<sub>3</sub>).

**Elongation ratio:**

Elongation ratio of cooked rice was neither influenced by the incorporation of cotton stalks with or without bio-inoculants nor by levels of inorganic fertilizers N and K.

**Conclusion :**

It can be concluded from the study that incorporation of cotton stalks @ 5 t ha<sup>-1</sup> and *Trichoderma viride* with 100 % recommended fertilizer level to *rabi* rice is the best IPNM practice for getting eco-friendly sustainable and improved grain yield and qualities in rice crop.

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