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Use of customized leaf colour chart for input saving and disease occurrence in rice var. *Swarna* (MTU-7029)

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ABSTRACT

A field experiment was conducted in three villages of Cuttack district, during kharif 2014 and 2015, to study effects of application of nitrogenous fertilizer basing on use of customized leaf colour chart (CLCC) in transplanted rice var. *Swarna* on time of N application, incidence of disease and pest, grain yield, and economics. Nitrogen fertigation time differed from conventional time when CLCC was used by nearly 3-5 days along with saving of N fertilizer. Severity index for sheath blight was less in trial plots (0.6) than in farmer practice (1.8). The incidence of leaf folder also decreased by 57.49% in the trial plots as compared to farmers practice. However, the grain yield did not increase significantly in the CLCC based N applied plots as compared to farmers practice. These findings indicated that judicious use of nitrogenous fertilizer by using CLCC based recommendation could improve nitrogen use efficiency, saves N, reduces incidence of leaf folder and sheath blight without affecting the economical attributes in the farmers' fields.

Key words : Disease, leaf colour chart, nitrogen, pest, rice

INTRODUCTION

Among essential nutrients for plants, nitrogen (N) plays an important role in plant growth, seed quality and quantity. As farmyard manure availability is decreasing, use of nitrogenous fertilizer is increasing. If not used judiciously, urea or other N fertilizer use results in loss as plant has certain capacity to uptake the amount of N applied to the soil. The nitrogen use efficiency (NUE) reduces when N is not applied in proper time and quantity, mostly when used in excess amount. Traditionally, nitrogen is applied in rice as basal dose along with 2-4 splits at specified growth stages of rice (Sarangi et al., 2019). However, about less than 40% N supplied from applied fertilizer meets the crop demand due to large variations in crop N requirements, soil N supply and the lack of synchrony of plant demand and nutrient supply (Ladha et al., 2005; Yogendra et al., 2017; Subedi et al., 2018). Excess of nitrogen also leads to overgrowth of vegetative plant affecting grain production along with an increase in disease and pest incidence (Teng et al., 2016). In field conditions, site-specific nutrient management has been proved to be more efficient than the traditional farmers practice (Dobermann et al., 2002; Bhatia et al., 2012). Leaf colour chart (LCC) is an instant, easy and low-cost technique used for N diagnosis of a standing crop and N topdressing in crops particularly rice (Singh et al., 2007; Valynejad et al., 2010; Premalatha and Angadi, 2017). The customized leaf color chart (CLCC), developed by the National Rice Research Institute

(NRRI) for real-time N management in rice for Indian conditions. It enhances productivity, NUE, and farmer's profit (Singh et al., 2007; Moharana et al., 2017; Premalatha and Angadi, 2017) along with preventing fertilizer contamination of surface and ground water leading to nitrous oxide emission (Ladha et al., 2005; Bhatia et al., 2012). Thus, use of LCC may help to rationalize the use of urea and other nitrogenous fertilizer as per the need of the crop (Powlson et al., 2011). Considering all the above aspects, we tested the CLCC in transplanted rice as a resource conservation technology in farmers' fields in Tangi, Baramba and Nischintakoili blocks of Cuttack district for its effect on nitrogen fertilizer use, disease and pest incidence along with production performance in rice var. Swarna and compared the performance with existing farmers practice.

MATERIALS AND METHODS

A participatory rural appraisal was conducted to understand the farmers' practice of fertilizer application followed by a focused group discussion involving the farmers of Uchhapada (Tangi), Mangarajpur (Baramba) and Kulbadakshiri (Nischintakoili) village clusters of Cuttack district in 2014 and 2015 during pre-monsoon time. The farming situation was analyzed and 15 farmers were selected at random from each village cluster. They were trained to use CLCC and application of CLCC based N fertilizer. The rice var. Swarna was used for this trial. Rice cultivated with the existing agronomical practices was taken as control (T_1) and that with inclusion of CLCC based nitrogen use was treated as treatment group (T_2). In each cluster, every farmer used certain fields as their conventional practice, whereas in the test plots they followed the CLCC based application of nitrogenous fertilizer, particularly urea with total land holding of 6 ha for both the control and treatment groups. In control fields, farmers visually assessed the need for nitrogen and applied fertilizers as per their own assessment. In the control group, fertilizer dose of 60:30:30 was used by the farmers, whereas in the treatment group plots the nitrogen (N) dose was selected as per recommendations arising from using CLCC. Regular field visits were conducted to the treatment fields to technically assist the farmers under participatory trial and monitor the CLCC based N application. The data on time of application of N fertilizer and quantity of N along with diseases and pest incidence during the crop and final yield of paddy were recorded. In LCC based treatments, nitrogen was applied through urea based on average LCC readings taken from 21 days after sowing (DAS) to heading at every 10 days interval. In each reading, the plots with average LCC reading (taken from 10 randomly selected upper profile healthy leaves) below the critical value i.e. 4, received nitrogen at the rate of 30 kg ha^{-1} through urea topdressing (Devkota et al., 2013).

The customized leaf color chart (CLCC), developed by the National Rice Research Institute for real-time N management in rice for Indian conditions was used for this study. The disease and pest incidence, particularly sheath blight was recorded as per guidelines given by SES (2002) where disease severity index was calculated as sum of scores per number of samples, whereas for leaf folder the following method was used. To record the leaf infestation, 10 × 5 hills were selected randomly from each plot and the total leaves and leaf folder damaged leaves per 10 randomly selected hills were counted. Thereafter, percentage of infestation due to leaf folder was worked out by formula given below.

Leaf folder damage (%) = (Number of infested leaves per hill / Total number of leaves per hill) × 100

Number of pesticide spray done in the control and trial fields were also recorded. At the time of harvest the grain yield was recorded in 25 m^2 and expressed in quintals. The data generated were statistically analyzed by students' t-test as per Snedecor and Cochran (1994).

RESULTS AND DISCUSSION

In LCC, the color panels are designed to indicate whether rice plants are hungry or overfed by nitrogen fertilizer. It can be observed by matching the color of the rice leaf to the color on the LCC and proper time and amount of N fertilizer

for application can be decided ensuring need-based optimum use N (Shukla et al., 2004; Ladha et al., 2007; Ali et al., 2015; Kumar et al., 2018a,b). In practice, farmers apply N fertilizer basing on own instinct and experience along with comparison with nearby fields (Sarangi et al., 2019). Nitrogen application was differed from their normal practice in most of trial plots using CLCC (Table 1) and a difference of about 4-5 days was found from the normal farmers practice.

Table 1. Effect of using N fertilizer in rice using customized NRRI leaf colour chart

Parameters	Farmers practice	Trial Plots	Percent changes
Nitrogen used (kg ha^{-1})	71.3±4.5	58.6±2.5	18.3
Nitrogen application time	As per farmer perception	4-5 days delay to farmer practice	

The quantity of N fertilizer utilized in farmers practice was higher (13 kg N ha^{-1}) than the recommended practice indicating a saving in N fertilizer. As N was applied when the plants really needed it, this ensured optimal utilization of N and minimized water pollution (Guo et al., 2017). Saving of N fertilizer by the CLCC used group averaged at 13 kg N ha^{-1} (28 kg urea ha^{-1}) or 18.3% of the N applied previously with their own practice or N applied by the non-CLCC adopted farmers.

Table 2. Effect of using nitrogenous fertilizer in rice using customized NRRI leaf colour chart on incidence of pest and disease

Parameters	Farmers practice	Trial Plots	Per cent changes
Sheath blight (severity index)	1.8±0.2	0.6±0.1	-66.7%
Leaf folder (%)	4.14±0.54	2.38±0.36	-57.49
Spraying of insecticide (no.)	2.5	1.5	40

Excess use of N promotes more vegetative growth, making the plant more succulent and susceptible to pests and diseases (Teng et al., 2016). Sheath blight is of very common occurrence in our trial variety, i.e. Swarna. In our study, severity index for sheath blight was 66.7 per cent less in trial plots (0.6) where CLCC based N application was done than that of farmer practice (1.8)[Table 2]. Similarly, the incidence of leaf folder decreased by 57.49% in the trial plots as compared to farmers practice indicating the role of nitrogen synchrony in disease monitoring. The average number of spraying of insecticides done in trial plots were 1.5 per season as compared to control plots where about 2.5 sprays were done on an average per season resulting in reduction of spray (40%). In a similar study, Islam et al. (2007) observed 50% reduction in number of insecticide spray after adoption of LCC and also when compared with those who did not adopt the LCC.

Table 3. Effect of using CLCC for nitrogenous fertilizer application on yield and other parameters

Parameters	Farmers practice	Trial Plots	Per cent increase
Plant height (cm)	91.7±2.18	91.9±3.75	0.22
No. of effective tiller	10±1.24	11±1.41	10
Yield per hectare (q ha^{-1})	48.5±3.52	50.7±2.87	4.54

The plant height and effective tiller number were similar in both the groups indicating CLCC based N fertilizer application had no adverse effect on plant growth and other parameters influencing yield attributes. In a similar study, Kumar et al. (2018b) observed significant increase in tiller

number when recommended dose of nitrogen and CLCC were used. The yield also reflected a similar trend of yield in both the CLCC based N applied plots and farmers practice indicating minor role of CLCC in increasing the grain yield as it basically saves nitrogenous fertilizer by preventing its excess use. However, in some earlier studies higher grain yield and gain protein content were observed when recommended dose of nitrogen and CLCC were used (Kumar et al., 2018b). In a similar study, LCC based nitrogen management in dry direct seeded rice increased nitrogen use efficiency, total N uptake and grain yield (Subedi et al., 2018). The positive effect on tiller number and yield attributes may be attributed to the real time N uptake and utilization by the plant when N was applied with the help of CLCC (Thind et al., 2010). Economics Farmers practice is affected by economics of technological application. The economics of cost saving through less use of N fertilizer and less labour and chemical cost for pest control along with yield advantage has been summarized in Table 4.

Table 4. Economics of using CLCC for nitrogenous fertilizer application (Rs ha^{-1})

Parameters	Farmers practice	Trial Plots	Input saved/ extra income
N saving through urea saving (@13 kg^{-1} N) considering basal application same	13×13=169	-	169
Money saved in chemical and labor cost for spraying @Rs. 1550 per spray ha^{-1}	3875	2325	1550
Sale of rice @Rs. 1750 per q	84875	88725	3850
Total			5569

The price of urea in the trial year was Rs. 6 kg^{-1} or Rs 13 kg^{-1} N. Thus, the cost saving on nitrogen fertilizer in monetary terms is therefore estimated at Rs. 169 ha^{-1} in kharif season (Table 4). The cost saving on reduction of spray and use of pesticide in monetary terms is estimated at Rs. 1550 ha^{-1}. In terms of increase in yield, the extra grain will fetch about Rs. 3850 for the 2.2 q. So, the total saving due to CLCC based N application would be about Rs. 5569 ha^{-1}. Most of the studies indicated improvement in economic grain by use of CLCC (Kumar et al., 2018b; Subedi et al., 2018).

CONCLUSION

Use of customized leaf colour chart delayed the nitrogen fertilizer application day in almost all the cases in treatment groups as compared to control groups by nearly 4-5 days along with saving of N fertilizer. The incidence of leaf folder and severity index for sheath blight was less in trial plots than that of farmer practice indicating decrease in disease incidence. The grain yield and other yield parameters were not significantly influenced by CLCC based N applied plots as compared to farmers practice indicating no influence in yield attributes. However, the net benefit to farmers was improved by about Rs. 5569 ha^{-1} than that of the farmer practice indicating the usefulness of the technology.

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