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**Jai Singh**
JNKVV, Krishi Vigyan Kendra, Singrauli, Madhya Pradesh, India

**AK Chaubey**
JNKVV, Krishi Vigyan Kendra, Singrauli, Madhya Pradesh, India

**SR Sharma**
JNKVV, Krishi Vigyan Kendra, Narsinghpur, Madhya Pradesh, India

**Mansi Mishra**
ICAR-Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh, India

**Corresponding Author:**
**Jai Singh**
JNKVV, Krishi Vigyan Kendra, Singrauli, Madhya Pradesh, India

# Integrated disease management modules for rice-bacterial leaf blight ecosystem under rice: Wheat cropping system

**Jai Singh, AK Chaubey, SR Sharma and Mansi Mishra**

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**Abstract**
Bacterial leaf blight (BLB), caused by *Xanthomonas oryzae* pv. *oryzae* is one of the crucial disease in rice ecosystem due to its wider distribution and destructiveness under the conducive environment. Considering the importance of this disease, experiment was conducted to assess integrated disease management (IDM) module with some antibiotics in rice through on field trials (OFT) against BLB in Singrauli district of M.P. during *kharif* 2018 and 2019. The experimental findings expressed superiority of all three IDM module over practices followed by farmers. The modules $T_3$involving seed treatment with Agrimycin-100 and copper sulphate, avoidance of seedling clipping during transplanting, split application of nitrogen, and foliar sprays of fresh cow dung extract, at 15 days interval on early onset of disease was found most effective in reduction of BLB disease severity with improvement in yield and cost benefit ratio followed by module $T_2$. IDM modules of current study can be used in controlling BLB of rice and sustaining higher yield in environmentally friendly manner.

**Keywords:** Rice, BLB, IDM and OFT

## Introduction
Rice (*Oryza sativa* L.) is the staple food crop, occupying about 63 percent of total area in food grain production in India. Globally, India stands at second position in rice production following china. In India acreage of rice is around 46.38 million ha with total production of 130.29 million tones and 2809 kg/ha yield productivity (Anonymous, 2023) [2]. In Madhya Pradesh the area production and productivity estimates are 2.016 lakh ha., 48149.0 M tones and 2085 kg/ha respectively (Anonymous, 2023) [2]. However, potential yield of rice is not gained under field condition due to various factors affecting the yield. Yield can still be improved by following various management tactics to control tee factors affecting yield. Rice crop exposed to several biotic and abiotic factors where biotic factors are predominant factor in fluctuating the yield. In cupboard of biotic stresses, it include several bacterial, fungal, viral and nematode pathogens which harbors rice ecosystem. Bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *Oryzae* (Xoo) is one of the most significant rice disease which causes economic yield loss. In India, the disease was first reported from Maharashtra (Srinivasan *et al.*, 1959) [19] and the losses had been estimated to vary from 6-74 percent (Gnanamanickam *et al.*, 1999 and Adhikari *et al.*, 1995) [7, 1]. BLB of rice lead epidemics in Northwestern part of India during 1979 and 1980 and in Southern part of India in 1998, 2010 and 2013 (Laha *et al.*, 2009; Yugander *et al.*, 2014) [10, 22], showing the destructive nature of the disease in tropical areas.

Various methods are followed for managing the BLB of rice with varying degree of success. Most widely used tactics include use of resistant varieties and chemical control. For the management of bacterial leaf blight of rice, number of control measures are being used but effective, economic and sustainable control measure for BLB is yet to be developed (Singh, 2009) [17]. Complete dependency on chemical control against bacterial plant diseases has restricted the availability of antibiotics due to development of antibiotic resistance and hazardous impact on environment. Keeping in consideration of all these issues, the current research was performed with the integration of several approaches to manage the BLB disease in

with boosting effect on yield of rice. Integration of management tactics could help in effective and successful management of BLB disease in rice. In the current study IDM modules consisting of antibiotics, Copper oxychloride, balance dose of nitrogenous fertilizer and cow dung extract were tested under field condition with the objective to establish an effective integrated disease management module against bacterial leaf blight of Rice.

## Materials and Methods

Krishi Vigyan Kendra, Singrauli, conducted on farm trials (OFTs) on integrated bacterial leaf blight management technology in rice at farmers' fields of Chitarwaikalan and Naugai villages of Singrauli district during *kharif* 2018 and 2019. The trials were laid out in completely randomized block design having four replications including farmers' practices as control in 10 different farmers' field representing 10 replications of plot. The experimental plot was prepared by furrowing threefold with cultivator and for fine tilt and smooth surface planking was done. Prior to 30 days of transplanting, FYM at the recommended rate of 1 t/ha was mixed and at the time of transplanting recommended dose of inorganic fertilizers (120:60:40 kg NPK/ha) was applied. Bispyribac-sodium 10% EC @ 250 ml/ha was used for weed management at 20 days after transplanting. To avoid the impact of cultivar variability high yielding hybrid variety of rice (US-312) was chosen for experimentation. Plot size was 50m x 10m with plant spacing of 30cm x 15cm and transplanting was conducted in second fortnight of July constantly.

**Table 1:** Details of Different Integrated Disease Management Modules (IDMs) for Bacterial leaf blight of Rice

| Treatments | Details |
|---|---|
| $T_0$ | Control |
| $T_1$ | After severe infection of bacterial leaf blight, spray once Streptocyclin at the rate of 250 ppm |
| $T_2$ | Soak the seeds in solution of Agrimycin-100 @ 0.025% and Copper sulphate @ 0.1% for 8 hours. Split doses of nitrogen applied as basal (50%), at tillering phase (25%) and at panicle initiation (25%). Clipping of seedling is avoided during transplanting. Foliar spray of Streptocyclin @ 0.05 g and Copper sulphate @ 1 g /lit. of water |
| $T_3$ | Soak the seeds in solution of Agrimycin-100 @ 0.025% and Copper sulphate @ 0.1% for 8 hours. Split doses of nitrogen applied as basal (50%), at tillering phase (25%) and at panicle initiation (25%). Clipping of seedling is avoided during transplanting. Two foliar spray of fresh cow dung extract (2%) at 15 days interval at early onset of bacterial leaf blight Fresh cow dung extract: one liter water + 20 g cow dung. Dissolve and allow settling then filtering. |

### Estimation of disease severity

As susceptible stage for BLB of rice is from seedling to early tillering stage. Therefore, percent disease severity of bacterial leaf blight was recorded from randomly selected 10 plants from each plot at fifteen days interval. Final observation was recorded at 75 days after transplanting (DAT), following the 0-9 scale of standard evaluation system (IRRI, 1996) for BLB. Observations on disease severity and yield recorded during investigation and data was analyzed statistically.

**Table 2:** Disease severity scale for bacterial leaf blight disease of rice

| Disease score | Lesion area (%) | Disease reaction |
|---|---|---|
| 0 | 0 | Highly Resistant (HR) |
| 1 | 1-10 | Resistant (R) |
| 3 | 11-30 | Moderately Resistant (MR) |
| 5 | 31-50 | Moderately Susceptible (MS) |
| 7 | 51-75 | Susceptible (S) |
| 9 | 76-100 | Highly Susceptible (HS) |

### Estimation of Cost-Benefit Ratio

Grain yield was noted from all ten farmers field separately. Yield was determined by cumulating the harvesting from respective field and calculated in quintal per hectare. The information was analyzed and positioned based on their yield performance. The cost-benefit ratio (CBR) of various treatments was determined by assessing different expense of cultivation and return from yield, then converting them to one hectare land. Average market cost of rice was supposed at rupees 20.0 per kg during test period. Benefit – cost ratio was calculated.

## Results and Discussions

The findings presented in Table 3 clearly indicate a significant reduction in bacterial leaf blight (BLB) severity in treatment $T_2$ and $T_3$compared to control ($T_0$). The lowest BLB severity, consistently observed over two years of trial, was in $T_3$, ranging from 9.05% to 10.50%.treatment combination 3 ($T_3$) exhibited a remarkable ability to reduce BLB infection by an average of 76.82% over two consecutive years. Treatment $T_3$, involving seed treatment with Agrimycin-100 and copper sulphate, avoidance of seedling clipping during transplanting, split application of nitrogen, and foliar sprays of fresh cow dung extract, proved to be the most effective in managing BLB in rice. The following best bundle of treatments was$T_2$, which included similar seed treatment and nitrogen application along with foliar sprays of streptocyclin and copper sulphate, also showed significant reduction in BLB severity from 18.90% to 19.50%. Treatment $T_1$ was having just a single spray of Streptocyclin @ 250 ppm after severe infection of BLB and has38.0 to 39.20 percent disease severity.

Furthermore, in terms of grain yield, the same treatment combinations that effectively managed BLB also resulted in the highest yields, with $T_3$ yielding 34.49 to 35.49 quintals per hectare and $T_2$ yielding 32.34 to 32.94 quintals per hectare, compared to 26.87 quintals per hectare in untreated control ($T_0$).

The economics of experiment was also calculated based on the expenditure incurred for different treatments under trial. The income data of rice yield in different treatments are presented in Table 4. Economic analysis revealed that $T_3$and $T_2$ treatments provided the highest net returns per hectare, significantly surpassing the usual practices of the area. On comparison of economics of all treatments, it was found that maximum net returns of rupees 36792.5 to 37531.5 per ha were obtained from $T_3$ followed by $T_2$ with rupees 33127.5 to 33852.5.0 per ha. Highest benefit–cost ratio that was 2.14:1 and to 2.12:1 in the year 2018-19 and 2019-20, respectively in the $T_3$ followed by $T_2$, where it was 2.04:1 and 2.06:1 in 2018-19 and 2019-20 respectively. Whereas the lowest benefit -cost ratio of 1.90:1 and 1.91:1 in above mentioned cropping season were recorded in control plot ($T_0$). Higher benefit-cost ratio for $T_3$and $T_2$, indicating their economic viability and profitability compared to the control ($T_0$).

In the same way Biswas *et al.* (2009) [6] and Patil *et al.* (2017) [15] advocated that Streptocycline (100ppm) is highly effective to managing BLB followed by Bacterinashak, Kasugamycin and Agrimycin 100. The results of present findings were coincide with the observations about great antibacterial property of Agrimycin-100 (Banerjee *et al.*, 1984 [5] and Sharma *et al.*, 2022) [16], Streptomycin Sulfate (Thimmegowda *et al*., 2012 and Naqvi *et al*., 2014) [21, 13] and Streptomycin sulfate + copper oxychloride (Kumar *et al.*, 2009) [9]. The prophylactic spraying of Streptocycline (500 ppm),Streptomycin + Oxytetracycline (1:9, 250 and 500 ppm), Bactrinol-100 (500 ppm) and Cow dung extract (20 g/liter) on rice was viewed as successful against bacterial leaf blight by Mary *et al*. (2001) [12], and Sreekumar and Nair, 1990 [18]. Mandal *et al*. (2017) [11], verified that the suggested portions of NPK (80:40:40) + higher dosages of potash (24 kg/ha) + three spraying of fresh cow dung slurry @1kg in 10 liter water at 10 days interval was acquired least bacterial leaf blight severity and higher yield in rice.

Sumit *et al*. (2020) [20] showed that rice seeds soaked in a 0.07 percent solution of Agrimycin and 0.025 percent Streptocycline for an hour and afterward sited for hot water treatment at 52°C to 54 °C for 30 minute, which resulted about 95-100 percent destruction of microorganism *Xanthomonas oryzae* pv. *oryzae* which decreased the occurrence of BLB in the rice field. Foliar spray comprising of 20 percent or 20 g fresh cow dung extract in one liter of water utilized two times has been accounted for to restrain the improvement of BLB in rice fields by spraying it just after the onset of disease symptoms in rice.

Consequently, shifting focus over to the disease management potential, grain yield gain, greatest insurance over yield losses due to disease, net return and ideal advantage in cost benefit ratio as well as sustainability, the Integrated disease management modules 3 ($T_3$), would be suggested for the management of BLB in rice crop.

**Table 3:** Effect of different IDM modules on bacterial leaf blight disease severity and yield in Rice

| Details of technology | Yield (qt./ ha) | | Increase in Yield (%) over farmers Practice | | Disease severity (%) at 75 DAT | | Reduction in Disease severity(%) over farmers practice | |
|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| $T_0$ | 26.75 | 27.0 | - | - | 41.25 | 43.0 | - | - |
| $T_1$ | 28.5 | 28.9 | 6.45 | 7.03 | 38.00 | 39.20 | 7.89 | 8.83 |
| $T_2$ | 32.34 | 32.94 | 20.89 | 22.0 | 19.50 | 18.90 | 52.72 | 56.04 |
| $T_3$ | 34.49 | 35.49 | 28.93 | 31.44 | 09.05 | 10.50 | 78.06 | 75.58 |
| CD at 0.05 | 3.97 | 4.06 | NA | NA | 8.88 | 9.27 | NA | NA |
| SE(m)± | 1.98 | 2.03 | NA | NA | 4.44 | 4.63 | NA | NA |

**Table 4:** Economic of different IDM modules of Bacterial leaf blight management practice in Rice.

| Details of technology | Cost of cultivation (Rs./ha) | | Average Gross Return (Rs/ha) | | Average Net Return (Rs/ha) | | B:C ratio | |
|---|---|---|---|---|---|---|---|---|
| | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 | 2018-19 | 2019-20 |
| $T_0$ | 28083.0 | 28289.80 | 53500.0 | 54000.0 | 25417 | 25710.2 | 1.90 | 1.91 |
| $T_1$ | 291009.50 | 292547.5 | 57000.0 | 57800.0 | 27890.5 | 28545.3 | 1.95 | 1.97 |
| $T_2$ | 34652.5 | 35027.5 | 64980.0 | 65880.0 | 33127.5 | 33852.5 | 2.04 | 2.06 |
| $T_3$ | 35187.5 | 36148.5 | 68980.0 | 70980.0 | 36792.5 | 37531.5 | 2.14 | 2.12 |

## Conclusions

The results of present investigation showed that considering the disease management potential, grain yield, economic returns, and sustainability, the integrated disease management module 3 ($T_3$: Soak the seeds in solution of Agrimycin-100 @ 0.025% and Copper sulphate @ 0.1% for 8 hours. Split doses of nitrogen applied as basal (50%), at tillering phase (25%) and at panicle initiation (25%). Clipping of seedling is avoided during transplanting. Two foliar spray of fresh cow dung extract (2%) at 15 days interval at early onset of bacterial leaf blight, fresh cow dung extract: one liter water + 20 g cow dung. Dissolve and allow to settle then filter) is recommended for the effective management of bacterial leaf blight in Rice.

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