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Integrated Disease Management Practices for Resilient Rice Production in Dakshina Kannada District of Coastal Karnataka

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ABSTRACT

The study was conducted during *kharif* (June, 2022 to November, 2022 and June, 2023 to November, 2023) in farmers' fields at Ichlampady village of Puttur taluk and Kella Puttige of Moodbidre taluk, Dakshina Kannada district, Karnataka. The present study aimed to demonstrate the integrated disease management practices such as summer deep ploughing followed by soil application of agriculture lime at 200 kg acre^{-1} before 15 days of transplantation; application of farm yard manure at 4 t acre^{-1} 7 days before transplanting; recommended dose of fertiliser application; seed treatment with carbendazim 63%+mancozeb 12% 75wp at 4 g kg^{-1} seeds; foliar application of carbendazim 50% wp at 1 g l^{-1} of water during 25th and 40th days after transplanting; application of tricyclazole 75% wp at 0.6 g l^{-1} of water during flowering were demonstrated against blast and brown spot diseases under natural infection. The integrated disease management practices showed most effective in controlling leaf blast, panicle blast and brown spot diseases, leading to 76.38%, 67.73% and 67.75% reduction respectively over farmers practice. The economic analysis revealed that integrated disease management practices achieved higher net return (₹ 61,675 ha^{-1}) with higher benefit cost ratio (1:2.88) as compared to farmer practice (1:1.55). The demonstration study recorded a technology gap of 1.09 t ha^{-1}, extension gap of 0.98 t ha^{-1} and a technology index of 21.74%. The present study highlighted that, IDM practices were feasible and economically viable over farmers practices, offering a superior option for controlling rice diseases.

KEYWORDS: Paddy, integrated disease management, blast, brown spot, yield

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1. INTRODUCTION

Rice (*Oryzae sativa* L.,) is the most widely cultivated crop worldwide, serving as a cornerstone of global food security and avital source of livelihood (Verma et al., 2021). Owing to its significance in global food security, rice ranks as the second most produced cereal crop worldwide. It is cultivated in an approximately 46.27 mha in India, producing 129.47 mt with a productivity of 27.98 q ha^{-1} (Anonymous, 2022). In Karnataka, rice is cultivated in 13.97 lakh hectares and yielding approximately 1.19 mt, rice exhibits a productivity level of 3.08 t ha^{-1} (Anonymous, 2022). Rice is a tropical and subtropical crop; it is highly adaptable to diverse growing environments and cropping conditions. The recognised rice ecosystems are irrigated low land, upland, and flood prone. Rice production significantly impacted by various biotic and abiotic stresses. Among the biotic stresses blast and brown spot diseases stands out as the most destructive threat to rice production in subtropical and temperate region of the world (Kumar et al., 2013; Sharma et al., 2021). In severe epidemic conditions, rice blast and brown spot diseases causes devastating yield losses with reductions of up to 80% (Koutroubas et al., 2009; Zhang et al., 2003). Blast disease (*Magnaporthe grisea*) is the most extensively studied fungus in the *Magnaporthales* order and ranks as the world's top fungal pathogen due to its immense scientific and economic impact (Dean et al., 2012). The pathogen infects rice at all developmental stages, manifesting distinct symptoms on the leaf, collar, neck, panicle and even the glumes. The severity of damage depends is favoured by multiple environmental factors, often leading to global rice yield losses ranging from 10% to 30% and upto 80–100% losses under substantial epidemics (Prabhu et al., 2009). Brown spot disease caused by fungus *Cochliobolus miyabeanus* is another most devastating disease threats to global rice production, tis diseases severely compromises seed germination and grain quality (Grish et al., 2024). From a commercial standpoint, it impacts the export value of milled rice by discolouring kernels and complicating the drying, processing, and milling stages. Furthermore, the infection leads to substantial weight loss and marked decline in overall seed viability (Shamshad et al., 2024). As primary constraints on global rice production, rice blast and brown spot diseases severely undermine crop yields and escalate production costs, posing a direct threat to the caloric stability of populations worldwide (Asibi et al., 2019; Shamshad et al., 2024). Consequently, there is an urgent imperative for globally coordinated mitigation strategies. To ensure long term food security, existing management techniques must integrate optimised agronomic practices with the strategic application of biological methods and chemical fungicides (Dethoup et al., 2022a; Sirikamonsathien et al., 2023). This includes the rotation of fungicide with diverse mode of action to circumvent the development of pathogen resistance (Kongcharoen et al., 2020). Furthermore, addressing soil health is critical, lime serves as a fundamental remedy for soil acidity, enhancing both plant health and productivity (Holland et al., 2018). When combined with organic amendments, liming effectively counters declining topsoil fertility in highland environments, ultimately boosting nutrient uptake and maximising crop output (Alam et al., 2017; Islam et al., 2021). In light of these concerns, the objective of the present study was to evaluate the effectiveness of integrated disease management (IDM) approaches for the ecofriendly management of blast and brown spot diseases. By prioritizing sustainable strategies, this front line demonstration study aims to enhance crop productivity while minimising environmental impact. helps in sustainable crop production.

2. MATERIALS AND METHODS

2.1. Experimental sites

The demonstrations were conducted during *kharif* (June, 2022 to November, 2022 and June, 2023 to November, 2023) in farmers' fields at Ichlampady village (12.61° N, 74.94° E) of Puttur taluk and Kella Puttige (13.13° N, 75.03° E) of Moodbidre taluk, Dakshina Kannada district, Karnataka. The field experiments conducted under natural infection conditions aimed to evaluate the effectiveness of integrated diseases management strategies in controlling blast and brown spot diseases in rice. Ten demonstrations were conducted across ten locations by selecting ten farmers from each adopted village within Puttur and Moodbidre taluks of Dakshina Kannada district during 2022–23 and 2023–24. The Bhadra (MO 4) rice variety was cultivated in all farmers' fields, with standard agronomic practices (except for disease management) followed consistently. During training sessions and diagnostic visits, farmers selected under demonstrations were guided in executing key field operations such as sowing, operating plant protection measures, weeding and harvesting. The demonstrations were laid out in an area of 0.4 ha and adjacent fields were treated as farmers practices. Total of 10 demonstrations were conducted in different farmers fields with recent scientific package of practices in rice during both the years of *kharif* (June, 2022 to November, 2022 and June, 2023 to November, 2023). Details on demonstrations and farmers practices were presented in Table 1.

2.2. Details of the treatments

Fungicides applications in all demonstrations were conducted using a knapsack sprayer equipped with a hollow cone nozzle, calibrated to deliver a spray volume of 500 l ha^{-1} to ensure uniform coverage.

2.3. Per cent disease index (PDI)

The leaf blast and panicle blast disease severity were analysed

Table 1: Efficacy of technology interventions and farmers practices under FLD on integrated management of blast and brown spot diseases in paddy

Sl. No.	Particulars	Technological interventions in FLD	Farmers Practice	Gap
1.	Variety	Bhadra (MO 4)	Bhadra (MO 4)	No gap
2.	Spacing (Rows×Plants)	20×12	20×12	No gap
3.	Seed rate (acre)	25 kg	25 kg	No gap
4.	Summer deep ploughing	Yes	No	Full gap
5.	Application of lime	Soil application of agriculture lime at 200 kg $acre^{-1}$ before 15 DAT	No application	Full gap
6.	Seed treatment	Seed treatment with carbendazim 63%+ mancozeb 12% 75wp at 4 g kg^{-1} seeds	No seed treatment	Full gap
7.	Farm yard manure	4 t $acre^{-1}$	2 t $acre^{-1}$	Partial gap
8.	Fertilizer dose	N:P:K (24::12:24 kg $acre^{-1}$	One time application fertilizers	Partial gap
9.	Micronutrients application	Application of ZnSo4 at 8 kg $acre^{-1}$	No	Full gap
10.	Plant protection	Deployment of IPM strategies based on local needs followed by foliar application of carbendazim 50% wp at 1 g l^{-1} of water during 25th and 40th days after transplanting; application of tricyclazole 75% wp at 0.6 g l^{-1} of water during flowering	Non-adoption of IPM practices and need based application of carbendazim 50% wp at 1 g l^{-1} of water	Partial gap

at 45 and 90 days after transplantation respectively. Disease severity assessed visually using disease rating scale used for screening of blast diseases developed by (Anonymous, 2013). Disease severity scoring for leaf blast and panicle blast was presented in the Table 2 and Table 3 respectively.

Table 2: 0–9 grade disease rating scale used for screening of leaf blast disease in paddy

Score	Lesion size
0	No lesion observed
1	Small brown specks of pinpoint size
3	Small, round to slightly elongated necrotic sporulating lesion, measuring approximately 1–2 mm in diameter with a distinct brown margin
5	Narrow or slightly elliptical, 1–2 mm in breadth, more than 3 mm long with a brown margin
7	Broad spindle-shaped lesion with a yellow, brown, or purple margin
9	Rapidly coalescing small, whitish, greyish, or bluish lesions without distinct margins

The brown spot disease severity was analysed at 45 days after transplantation. Per cent disease index visually analysed and calculated based on disease severity scale (1–9 scale) given by (Annonymous, 2013). Details for blast disease scoring was presented in Table 4.

Table 3: Standard disease scoring system for panicle blast based on the appearance of the symptoms (Anonymous, 2013)

Score	Based on incidence
0	No incidence
1	<5% incidence
3	5–10% incidence
5	11–25% incidence
7	26–50% incidence
9	>50% incidence

Table 4: Standard disease scoring system for brown spot based on the appearance of the symptoms (Anonymous, 2013)

Score	Affected leaf area
1	No incidence
2	Less than 1% incidence
3	1–3% incidence
4	4–10% incidence
5	11–15% incidence
6	16–25% incidence
7	26–50% incidence
8	51–75% incidence
9	75–100% incidence

The per cent disease index was calculated by using the following formula of Wheeler, 1969.

PDI=(Sum of all the numerical disease rating/(Total number of veins observed×Maximu disease rating)×100

2.4. Yields and economics

The yield data was recorded by the random crop cutting method and increase in yield over the farmers practices was analysed as per standard statistical procedures through paired t-test. A comprehensive economic analysis was undertaken to evaluate the financial feasibility of the proposed treatment interventions. Cultivation costs, encompassing inputs such as labour, fertilizers, pesticides, and irrigation, were meticulously accounted for. Gross returns were calculated based on the prevailing market prices for rice. Net returns were determined by subtracting total cultivation costs from gross returns.

Outputs data were systematically collected from both frontline demonstration plots and farmers practices plots. Subsequently, technology gap, extension gap, and technology index were estimated in accordance with the methodology outlined by Samui et al. (2000).

Technology gap=Pi(Potential yield)-Di(Demonstration yield)

Extension gap=Di(Demonstration Yield)-Fi (Farmers Yield)

Technology index=(Pi(Potential yield)- Di(Demonstration Yield))/Potential yield)×100

Benefit cost ratio and per cent increase in yield were calculated by using the formula given below

% increase in yield =(Demonstration yield- Farmers practice yield/Farmers practice yield)×100

Benefit cost ratio=Gross income/Cost of cultivation

3. RESULTS AND DISCUSSION

The effectiveness of integrated disease management (IDM) technologies in managing blast and brown spot diseases in paddy carried out during *kharif* (June, 2022 to November, 2022 and June 2023 to November 2023) under farmers' fields presented in Table 5 and Table 6. The results showed that application of IDM practices significantly reduced the leaf blast (75.75%), panicle blast (68.90%) and brown spot (66.80%) disease over farmer's practice. In 2022–23, significantly higher per cent disease index (PDI) of leaf blast (18.57) and brown spot (11.71) were recorded as compared to 2023–24. The disease severity and spread of the diseases mainly dependent mainly both on micro and macro-climatic condition of crops. Pannu et al. (2005) reported that the incidence of disease was varied by 8.8 and 9.2% when the annual rainfall was 410.5 mm (during 2001) and 502 mm (2003) respectively. Carvalho et al. (2010) reported that deficiency of nitrogen or potash influence in the disease's development. Walters and Bingham (2007) found that the increased or decreased per cent of disease severity was mainly dependent on fertiliser application. A balanced nutrition application was the best approaches to reduce the incidence of many diseases (Carvalho et al., 2010). Rice blast and brown spot were considered as the most devastating diseases due to their worldwide distribution and causes severe yield loss (Zhang et al., 2003). Various research studies have sought new effective approaches to control these diseases by developing new

Table 5: Impact of IDM practices on leaf and panicle blast disease severity during 2022–23 and 2023–24

Treatments	Leaf blast PDI (45 DAT)				Panicle blast PDI (90 DAT)			
	2022–23	2023–24	Mean	Mean % disease control over farmers practice	2022–23	2023–24	Mean	Mean % disease control over farmers practice
Farmers practice	18.57	15.39	16.98		8.29	12.86	10.58	
Demonstration practice	5.71	2.53	4.12	75.75	3.14	3.43	3.29	68.90
T value (0.05)	2.26	2.26	-	-	2.26	2.26	-	-

* PDI: Per cent disease index; IDM: Integrated disease management

Table 6: Impact of IDM practices on brown spot disease severity during 2022–23 and 2023–24

Treatments	Brown leaf spot PDI (60 DAT)			
	2022–23	2023–24	Mean	Mean % disease control over farmers practice
Farmers practice	11.71	7.56	9.64	-
Demonstration practice	4.29	2.11	3.20	66.80
T value (0.05)	2.26	2.26	-	-

* PDI: Per cent disease index; IDM: Integrated disease management

fungicide molecules or by biocontrol agents or by applying integrated disease management practices (Dethoup et al., 2022a; Sirikamonsathien et al., 2023). Froyd et al. (1978) reported that tricyclazole was a highly efficacious fungicide for control of blast disease on rice. Fungicides (Tricyclazole) were effective if applied frequently and at proper times in relation to infection periods. It helped to reduce cultivation cost and enhanced the socio-economic conditions of the farmers. The fungicidal applications provided an effective control of brown spot disease in a short time span and it was the most widely used control measures (Biswas et al., 2008).

Soil acidity was an important constraint in agriculture. Soil acidity was a natural occurring process due to heavy rainfall and removal of cations like calcium, potassium and magnesium by leaching and consequent accumulation of Fe^{2+}, Al^{3+}, and Mn^{2+} resulting in micronutrient poisoning (Sureshkumar et al., 2018). Acidic condition of the soil was one of the major limiting factors for plant growth and development (Adams, 1986). Application of lime was one of the most fundamental and successful management technique for decreasing soil acidity and beneficial for soil health and improved the crop yields (Holland et al., 2018). Top soil fertility and organic matter content have declined over time under high land (normal flood level) conditions (Alam et al., 2017). Combining lime and organic amendments substantially increased each crops overall output and nutrient absorption (Islam et al., 2021)

Rice crop yield was significantly higher in crop exposed to IDM technologies (3.91 t ha^{-1}) as compared to farmers practices (2.93 t ha^{-1}) (Table 7). The present technologies demonstration results has given a good impact over the farming community of Dakshina Kannada as they were found motivated by the integrated disease management practices applied in the FLD plots. The disease severity and yield of rice varied in both the years, which might be due to the weather and climatic aberrations, as well as change in the location of trials in each year.

Both organic and inorganic pest management practices were equally effective under integrated disease management practices. Singh (2005) reported that leaching of nutrients like iron, manganese, potash and zinc from soil makes even though resistant cultivars become susceptible to *H. oryzae*. Use of fungicides for application provides an effective management of plant diseases in short time span and it's the most widely used control practice (Biswas et al., 2008). Kongcharoen et al. (2020) reported fungicides should be applied in rotation and in combination with other groups possessing different mode of action helped in the prevention of the accumulation of resistance in pathogen population. The application of IDM practices resulted in decreased the rice diseases and enhanced rice yields as compared to farmers practices. The results from the present study clearly demonstrated that the tested integrated diseases management practices outperformed traditional farming practices under identical environmental conditions. Farmers were motivated by increased productivity and have begun adopting these technologies. Potential yield comparisons between IDM demonstrations and farmers practices highlighted the yield gaps, which were further analysed in terms of the technology index and technology gap.

The technology gap, indicating the difference between the potential yield (5.0 t ha^{-1}) and the demonstration yield, was recorded at 1.08 ha^{-1} (Table 7). Front line demonstration conducted in supervision of Krishi Vigyan Kendra (Dakshina Kannada) Mangaluru scientists revealed that technology gap was likely due to variations in soil fertility and weather conditions. These results highlighted the need for location specific recommendations to bridge the yield gap (Kedarnath et al., 2024; Kedarnath et al., 2025; Rai et al., 2020; Chaitanya et al., 2020) in case of rice, groundnut and watermelon, respectively.

The extension gap of 0.98 t ha^{-1} highlighted the necessity of educating farmers and supporting them in enhancing yields through the adoption of improved scientific management practices (Table 7). Increased use of scientific IDM technologies by farmers was expected to reduce the existing extension gap over time. The technology index, which indicated the feasibility of a technology at the farmers level was observed at a low value of 21.74 (Table 7), suggesting that the technology was well suited for the Dakshina Kannada district in Coastal Karnataka. These finding aligned with the results of Khajuria et al., 2022 in rice crop.

Table 7: Effect of IDM practices on productivity, technology gap, extension gap, technology index and cost benefit ratio under FLDs

Years	Area (ha)	Grain yield (t ha^{-1})			% increase over FP	Technology gap (t ha^{-1})	Extension gap (t ha^{-1})	Technology index (%)	B:C ratio	
		Potential	FLD	FP					FLDs	FP
2022–23	2	5.0	3.89	2.85	36.63	1.11	1.04	22.12	2.18	1.48
2023–24	2	5.0	3.93	3.02	30.19	1.07	0.91	21.36	2.37	1.61
Average	2	5.0	3.91	2.93	33.41	1.08	0.98	21.74	2.28	1.55

The economic analysis of rice production revealed that the higher net return of ₹ 61,675/- received from the IDM demonstration plots with higher benefit cost ration (1:2.88) as compared to farmer practice (Table 8). Present findings confirmed with the findings of Shankar et al. (2022) and Khajuria et al. (2022), found that higher net returns and benefit cost ration in technologies demonstrated field as compared farmers practices.

Table 8: Economics (Average of two years) of rice production under FLDs

Technology options	No. of trials year^{-1}	Mean yield (t ha^{-1}) of *kharif,* 2022 and 2023	Mean net return ₹ ha^{-1}	B:C ratio
Farmers practice	10	2.93	41,103	1.55
Demonstration practice	10	3.91	61,675	2.28

4. CONCLUSION

The adoption of IDM practices for the management of rice blast and brown spot diseases reduced the leaf blast (76.38%), panicle blast (67.73%) and brown spot (67.75%) over farmer's practice. Also, achieved higher net return (₹ 61,675 ha^{-1}) with higher benefit cost ratio (1:2.88) as compared to farmer practice (1:1.55). Therefore, the IDM practices with scientific intervention had proven to be effective under the real farming situation.

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