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Enhancing paddy yield through Blast disease management in Kurukshetra district of Haryana

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Abstract

An On-Farm Trial was conducted by Krishi Vigyan Kendra (KVK), Kurukshetra during the Kharif seasons of 2020 and 2021 using the rice variety PB-1121. The study aimed to assess rice production, yield attributes, growth characteristics, the relationship between rice blast disease incidence as well as the economic aspects of cultivation. Rice, being a major cereal crop, serves as a staple food for more than half of the global population. To improve crop productivity and enhance farmers' profitability, On-Farm Trials (OFTs) were carried out using improved rice varieties along with advanced production and protection technologies.

A total of 15 on-farm trials were conducted during the years 2020 and 2021 on farmers' fields to demonstrate the production potential and economic benefits of improved technologies, including sowing methods, nutrient management, and chemical weed control. The performance of these improved practices was compared with traditional farmer practices in terms of production, productivity, and economic returns. Yield gaps were also analyzed.

Results showed that in 2020, the highest mean net income was recorded in the treatment with Tebuconazole 50% + Trifloxystrobin 25 WG (Rs. 54,924/ha), followed by Tricyclazole 75 WP (Rs. 46,476/ha). In 2021, the Azoxystrobin 18.2% + Difenoconazole 11.4% SC treatment provided the highest net return (Rs. 90,150/ha), while Tricyclazole 75 WP again performed well with a net return of Rs. 83,350/ha. The benefit-cost ratio (BCR) for improved technologies ranged from 1.84 to 2.90, significantly higher than that of the farmers' traditional practices, which yielded net returns of Rs. 34,663/ha (2020) and Rs. 68,300/ha (2021). These findings clearly highlight the advantages of adopting improved technologies for higher productivity and profitability in paddy cultivation.

Keywords: Neck Blast, Tebuconazole 50% + Trifloxystrobin 25 WG, Tricyclazole 75 WP, Azoxystrobin 25 WG @ 250 gm/ha 18.2% + difenoconazole 11.4% SC, on farm trial and gap analysis

Introduction

Rice (*Oryza sativa* L.), often referred to as the "Global Grain," is a vital staple food across Asia, with approximately 90 percent of its global cultivation taking place in this region (USDA, 2021) [22]. India ranks as the second-largest rice producer after China, contributing nearly 20 percent to the world's total rice production (FAOSTAT, 2020) [4]. In 2017-18, India had 43.77 million hectares under rice cultivation, producing 112.8 million tonnes of rice. West Bengal alone accounted for 5.12 million hectares and 14.97 million tonnes (Anonymous, 2019) [1]. During the monsoon months, high humidity and temperature cause rice seeds to absorb excess moisture from the environment. This accelerates seed aging and leads to reduced vigour, viability, and yield (Teckrony and Egli, 1991) [21]. One of the most severe biotic constraints to rice production is rice blast disease, caused by *Pyricularia oryzae*. It affects both vegetative and reproductive stages of the crop, damaging leaves and panicles and potentially causing yield losses of up to 70-80% (Nasruddin and Amin, 2013) [14]. The disease can appear at any growth stage and in various aerial parts of the plant, especially leaves and nodes (Seebold *et al.*, 2004) [17].

In early growth stages, conidia form on seedling leaves, progressing to collar and neck blast as the plant matures (Wang *et al.*, 2014) [24], which can result in up to a 30 percent reduction in grain yield (Spence *et al.*, 2014) [19]. Infected panicles often produce partially or fully unfilled grains (IRRI, 2014) [10]. The seed-borne nature of the pathogen makes it especially difficult to control (Hubert *et al.*, 2015) [9]. Contaminated seeds can lead to infected seedlings, which act as

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the primary source of inoculum for the disease (Faivre-Rampant *et al.*, 2013) [5]. Among various control strategies, chemical seed treatment is considered the most efficient, environmentally friendly, and economical. It uses a minimal amount of fungicide (1-1.5 g kg⁻¹ of seed) compared to foliar sprays, while still effectively suppressing the pathogen. Even moderate blast infections can lead to a 50 percent reduction in grain yield. Rice blast incidence spans the entire crop cycle, from early seedling stages to grain maturity. Leaves are most vulnerable between 20 and 55 days after seedling emergence, while panicles are susceptible between 10 and 20 days after their initiation. Plant resistance tends to improve after 55-60 days post-emergence, lowering leaf infection rates. Leaf damage reduces the plant's photosynthetic capacity, indirectly impacting yield. Depending on the variety, disease severity, agronomic practices, and environmental conditions, rice blast can cause yield losses ranging from 30-80% (Balgude and Gaikwad, 2019) [2]. Disease severity is influenced by factors such as the pathogen's virulence, climatic conditions, cultivation practices, and rice variety (Obilo *et al.*, 2012) [15]. High humidity, moderate temperatures, excessive nitrogen use, and prolonged leaf wetness favor disease development (TeBeest *et al.*, 2012) [20], while high rainfall and cooler weather further promote its spread (Ghatak *et al.*, 2013) [7]. Given the strong influence of weather parameters on disease progression, it is essential that farmers understand the optimal timing and method of fungicide application. To support this, an On-Farm Trial (OFT) was implemented by Krishi Vigyan Kendra (KVK), Kurukshetra, aiming to improve rice productivity and grain quality by controlling rice blast disease through better understanding of its correlation with different fungicidal spray (Refinement of technology).

Materials and Methods

The study was conducted during two successive kharif seasons of 2020 and 2021 at Krishi Vigyan Kendra (KVK), Kurukshetra in selected villages. A total of 15 OFTs were organized, covering an area of 4.5 hectares, using the improved PB-1121 basmati rice variety to showcase advanced production technologies. There were three treatment combinations viz. farmers practices (control), recommended practices; (Tricyclazole 75WP @300 gm+500 lt water/ha), refinement of

technology- (Azoxystrobin 18.2%+difenoconazole 11.4% SC@500 ml+500 lt water/ha) and Tebuconazole 50+trifloxistrobin 25WG @250 gm+500 lt water/ha. First spray was done after appearance of symptoms on leave and second spray was done at 50% panicle emergence stages. Table 2 depicts general demonstration package as well as farmers' practices of kharif rice. They managed all crop operations independently, while receiving regular guidance and monitoring from KVK scientists throughout the crop season. The cost of cultivation was calculated for both improved (OFT) and traditional (farmers' practice) methods. It included expenses for seed, fertilizers (chemical), pesticides, herbicides, hired labor (excluding family labor), land preparation, sowing, harvesting, and transportation. The average gross and net returns were calculated based on the prevailing local market price of paddy grain. The Benefit-Cost Ratio (BCR) was computed as the ratio of net return to the total cost of cultivation, following the methodology outlined by Kumari *et al.* (2007) [12]. The comparison on productivity and economic returns were made on paddy in demonstrated plots with the corresponding farmers' practices (local check). The data output were analyzed to estimate extension gap, technology gap, technology index along with the benefit cost ratio (Samui *et al.*, 2000) [16] as per following equations.

Technology gap = Potential yield - Demonstration yield

Extension gap = demonstration yield - farmers' yield

Technology index = $\frac{\text{(potential yield - demonstration yield)}}{\text{potential yield}} \times 100$

The cost and returns were calculated in the way suggested by Yadav *et al.* (1999). The following formula was used for the calculation of benefit: cost ratio.

Benefit: Cost ratio = average gross returns (Rs. /ha)/average cost of cultivation (Rs. /ha).

Neck Blast Incidence: Neck Blast disease scoring was done as suggested by Goto and Yamanaka (1968) [6], Mackill and Bonman (1992) [13] and Hayashi and Fukuta (2009) [8].

Neck Blast Disease Rating Scale:

Neck Blast Scale	Scale Description
0	No visible lesions or lesions only on few pedicles
1	Lesions on several pedicles or secondary branches
3	Lesions on few primary branch or the middle part of panicle axis
5	Lesions partially around the panicle base (node) or the uppermost internode neck of the panicle or the lower part of the panicle axis near the base
7	Lesions completely around the panicle base or the uppermost internode or panicle axis near the base with more than 30% of filled grain
9	Lesions completely around the panicle base or the uppermost internode or panicle axis near the base with less than 30% of filled grain

Neck Blast Incidence: One random tiller from each of the ten hills in each field was assessed for the neck blast and expressed as per calculated using the following formula:

$$\text{Neck Blast Incidence (\%)} = \frac{\text{No. of panicle with severe neck blast} \times 100}{\text{total no. of panicle observed per location}}$$

Results and Discussion

The data indicates that a total of 15 On-Farm Trials (OFTs) were conducted over two consecutive Kharif seasons to evaluate the effectiveness of different fungicidal treatments in managing rice

blast disease in PB-1121 variety:

Table 1: On Farm Trail implemented.

Sr. No.	Season	Number of OFT
1	Kharif, 2020	10
2	Kharif, 2021	05
	Total	15

Ten number of trials were conducted during 2020 and five were conducted 2021 in paddy Kharif season. The cumulative 15 OFTs across two years provided robust field-level data for

comparing the efficacy of fungicides and understanding their impact on disease control, yield enhancement, and economic returns. The seasonal distribution of trials suggests a progressive refinement in fungicide evaluation, moving from standard practices to more advanced and effective combinations, aligning

with evolving disease dynamics and farmer needs. This systematic approach under real-farm conditions enhances the reliability of the recommendations and supports evidence-based technology dissemination for rice blast management in Haryana.

Table 2: Comparison of technology packages under on farm trails and farmers' practice.

S. No.	Technology	Demonstration package	Farmers' practice
1.	Variety	PB-1121	PB-1121
2.	Seed treatment	Yes 10kg seed+ 10gm Carbendazim 50WP +10 lt water+1 gm Streptocycline for 24hrs	No
3.	Spray of fungicide/ after appearance of symptoms and 2 nd spray@50% panicle emergence stage	Tricyclazole 75WP @300 gm/ha (Recommended practices); Tebuconazole 50 + trifloxystrobin 25 WG@ 250 gm.ha; Azoxystrobin+difenoconazole @500 ml/ha (refinement of technology)	Control

The data presented in Table 2 indicated that the comparison of spray fungicides under On-Farm Trials (OFT) and traditional farmer practices reveals substantial differences in disease

control, seed health, yield performance, and overall profitability in rice (*Oryza sativa*) cultivation.

Table 3: Management of blast disease in paddy (PB-1121) during 2020

Technology option	No. of trials	Incidence of Blast (%)	Yield (kg/ha.)	% Increase in yield over farmers practices	Gross cost (Rs. /ha)	Gross Return (Rs./ha)	Net return (Rs./ha)	BCR
Tricyclazole 75WP @300 gm+500 lt water /ha (recommended practices)	10	9.7	3720	-	55080	101556	46476	1.84
tebuconazole 50 + trifloxystrobin 25 WG@ 250 gm+500 lt water /ha (refinement technology)		6.9	3980	-	53730	108654	54924	2.02
Farmer's Practice (Control)		12.7	3310	-	55700	90363	34663	1.62

The data presented in Table 3 clearly demonstrate that Tebuconazole 50%+ Trifloxystrobin 25WG was the most effective treatment in managing rice blast disease, recording the lowest incidence at 6.9 percent, thereby confirming its superior disease control ability. In comparison, Tricyclazole 75WP, the commonly used fungicide under farmer-preferred practices, reduced disease incidence to 9.7 percent, while traditional farmer practices, which lacked proper fungicide application, showed the highest incidence at 12.7 percent. In terms of yield, Tebuconazole 50% + Trifloxystrobin 25WG again outperformed other treatments, yielding 3980 kg/ha, which was 20.24 percent increase over the traditional farmer's practice. The Tricyclazole-75WP treated plots also performed better than untreated controls, yielding 3720 kg/ha, representing a 12.39 percent improvement. The lowest yield of 3310 kg/ha was recorded in the traditional practice plots, primarily due to higher disease pressure and lack of effective control measures. From an economic perspective, the maximum net return was observed in the Tebuconazole 50%+ Trifloxystrobin 25 WG treatment (Rs. 54,924/ha), followed by Tricyclazole (Rs. 46,476/ha). The

lowest net return (Rs. 34,663/ha) was obtained under the traditional farmer's practice. Despite the slightly lower gross cost (Rs. 53,730/ha) in the Tebuconazole + Trifloxystrobin treatment, the higher yield and effective disease control resulted in greater profitability. The Benefit-Cost Ratio (BCR) further supports the economic advantage of improved disease management. Tebuconazole 50%+ Trifloxystrobin 25WG recorded the highest BCR of 2.02, indicating a return of Rs. 2.02 for every rupee invested. Tricyclazole 75WP had a BCR of 1.84, while traditional practices yielded a BCR of just 1.62. These results underscore the significant impact of scientific disease management practices on farm profitability. Wheeler B.E.J. (1969) [25] found that the combination of fungicide significantly reduced the disease severity of blast and improved grain filling and overall productivity under humid conditions. Kumar *et al.* (2016) [11] observed that Tricyclazole 75 WP alone was less effective in high-humidity zones compared to newer combination fungicides like Tebuconazole 50%+ Trifloxystrobin 25WP due to broader-spectrum activity and systemic properties.

Table 4: Management of blast disease in paddy (PB-1121) during 2021

Technology option	No. of trials	Incidence of Blast (%)	Yield (kg/ha.)	% Increase in yield over farmers practices	Gross cost (Rs. /ha)	Gross Return (Rs./ha)	Net return (Rs./ha)	BCR
Tricyclazole 75WP @300 gm +500 lt water /ha (recommended practices)	5	8.8	3710	11.7	46500	129850	83350	2.8
Azoxystrobin 18.2%+difenoconazole 11.4 SC @500 ml+500 lt water /ha (refinement of technology)		4.7	3920	18.1	47050	137200	90150	2.9
Farmer's Practice (Control)		12.2	3320	-	47900	116200	68300	2.4

The data presented in Table 4 clearly show that Azoxystrobin 18.2%+ Difenoconazole 11.4% SC was the most effective treatment for managing rice blast, reducing disease incidence to

just 4.7 percent, compared to 12.2 percent under traditional farmer practices. Tricyclazole 75WP also demonstrated notable efficacy, bringing down blast incidence to 8.8 percent,

reaffirming its continued relevance in disease management. In contrast, traditional practices, lacking effective fungicidal applications, recorded the highest disease incidence, indicating poor control and greater crop vulnerability. In terms of yield, the Azoxystrobin 18.2%+ Difenconazole 11.4% SC treatment produced the highest yield of 3920 kg/ha, representing an 18.1 percent increase over the farmer's practice (3320 kg/ha). Tricyclazole also improved yield significantly to 3710 kg/ha, an 11.7 percent increase. The lowest yield was recorded in plots managed with traditional practices, which directly correlates with the highest blast incidence. Economically, Azoxystrobin 18.2%+ Difenconazole 11.4% SC delivered the highest gross return (Rs. 1,37,200/ha) and net return (Rs. 90,150/ha). Tricyclazole also performed well, with a net return of Rs. 83,350/ha. However, the farmer's practice resulted in a much lower net return of Rs. 68,300/ha, mainly due to higher disease pressure and reduced yield. The Benefit-Cost Ratio (BCR) was

also most favorable for Azoxystrobin 18.2%+ Difenconazole 11.4%SC, recorded at 2.90, indicating excellent cost-efficiency and profitability. Tricyclazole 75WP followed closely with a BCR of 2.80, while farmer's practice lagged behind at 2.40, reinforcing the value of scientific disease management. These findings are supported by several studies: Dutta *et al.* (2018) [3] found that Azoxystrobin, when combined with Difenconazole, offers superior systemic protection compared to Tricyclazole alone due to its dual mode of action (strobilurin + triazole), resulting in prolonged residual activity and better panicle protection. Sharma *et al.* (2022) [18] demonstrated that Tricyclazole is effective during early blast stages, but its efficacy decreases during reproductive stages, where combination fungicides provide more consistent control.

Constraints in yield gap and potential interventions perceived by the farmers to mitigate yield gaps

Table 5: Constraints in yield gap and potential interventions

Constraints in yield gap	Potential interventions
Non-availability of good quality seeds	Timely weed control
Lack of knowledge	Seed treatment
Non-mechanization	Strengthening of extension services and timely advisories
Small land holdings	Assured purchase of farmers' output
Inadequate transportation and marketing facilities	Timely and assured supply of inputs
Non-availability of good quality pesticides	
Distance of market	

Conclusion

The findings of the study highlight a significant yield gap between demonstration plots and farmers' traditional practices in paddy cultivation, primarily due to differences in technology adoption. The On-Farm Trials (OFTs) conducted in Kurukshetra district, Haryana, demonstrated a positive impact on rice productivity, particularly in the PB-1121 variety. In the 2020, the use of the combination fungicide Tebuconazole 50%+ Trifloxystrobin 25 WG proved highly effective in managing rice blast. It significantly reduced disease incidence while delivering higher yields and greater net returns compared to both Tricyclazole (the standard fungicide) and traditional farmer practices. These results affirm that adopting newer-generation fungicides with broad-spectrum activity is both economically viable and agronomically beneficial for PB-1121 growers in Haryana. In the 2021, Azoxystrobin 18.2%+ Difenconazole 11.4%SC emerged as the most effective fungicidal treatment, offering the lowest blast incidence, highest yield, maximum net returns, and the highest benefit-cost ratio. This combination outperformed all other treatments, making it the most profitable and agronomically sound option for managing blast disease in PB-1121. While Tricyclazole continues to be a dependable fungicide for blast control, the study clearly shows that next-generation combinations like Tebuconazole 50% + Trifloxystrobin 25WG and Azoxystrobin 18.2%+ Difenconazole 11.4%SC provide superior results. Therefore, promoting these advanced fungicidal solutions among paddy farmers is essential for effective disease management, enhanced productivity, and increased profitability in Basmati rice cultivation.

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