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Demonstration of integrated pest and disease management package and its economic impact in rice

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Abstract

The Krishi Vigyan Kendra (KVK) in Bhadradri Kothagudem conducted Front Line Demonstrations (FLD) on integrated pest and disease management packages during the Kharif seasons of 2019, 2020, and 2021 within its operational area. These demonstrations compared the effectiveness of technology-demonstrated integrated pest and disease management packages with traditional farmer practices. The results showed that the technology-demonstrated plots had higher cost-benefit ratios (BC Ratio) of 2.3:1, 2.63:1, and 2.44:1 compared to the BC ratios of 2.1:1, 2.21:1, and 2.09:1 in the farmers' practice plots during the corresponding years. Additionally, farmers practiced plots typically sprayed pesticide mixtures after noticing pests.

Keywords: Rice, cultural methods, biological control, pesticides

Introduction

Rice holds significant importance as a primary cereal crop and a staple food for more than half of the global population, contributing up to 50% of the world's dietary caloric supply and a substantial portion of protein intake for many people worldwide. Its role in food security and political stability is closely intertwined. To meet the demand for increased rice production driven by population growth, intensive cultivation methods have been adopted, including high-yielding cultivars, increased plant density, and nitrogenous fertilizers. However, these practices have also led to heightened pest and disease pressures.

The warm and humid climates in many rice-growing regions are conducive to a range of pests and diseases, posing significant challenges to increasing production. Common threats include stem borers, leaf folders, brown plant hoppers, sheath blight, bacterial leaf blight, and blast disease (Kushwaha, 1990) [9]. In response, farmers often resort to excessive and indiscriminate use of costly pesticides, leading to issues such as pesticide resistance, residual toxicity, and ecological imbalance (Prajapati *el al*. 2013) [14].

To address these challenges, there is a need for location-specific integrated pest management strategies that are economically feasible, socially acceptable, and environmentally sustainable. Unfortunately, farmers often lack the necessary knowledge and guidance on implementing effective pest and disease management practices. In Bhadradri Kothagudem district, where rice cultivation is predominant, farmers face significant pest and disease pressures without adequate understanding of their impact or appropriate management strategies. Hence, Front Line Demonstrations (FLD) were organized to showcase the damage potential and effective management strategies for these agricultural threats.

Materials and Methods

The present study was undertaken at ten different farmers fields of Bhadradri Kothagudem district of Telangana with two treatments *viz.*, technology demonstration and check (farmers practice) (Table 1). The experiment was conducted consecutively for three years *i.e.* during *Kharif* season of 2019, 2020 and 2021.

Table 1: Details of treatments followed in farmers fields

Treatment 1 (Technology demonstration)	Treatment 2 (Farmers Practice)
1. Clipping of leaf tips before transplanting (to eliminate stem borer egg masses). 2. Erection of pheromone traps @ 4 per acre for monitoring and spraying only after 25-30 male moths/trap/week are observed. 3. Inundative release of egg parasitoid *Trichogramma japonicum* @ 4 egg cards per acre 4 times at an interval of 15 days starting from 25 days after transplanting. 4. Formation of alley ways of 20 cm width for every 2m. 5. Recommended dose of fertilizers (Optimum use of N fertilizers - only 25-30kg urea/acre/each time). 6. Alternate wetting and drying. 7. Application of chlorantraniliprole 0.4G granules @ 4kg/acre at 25 DAT. 8. Continuous monitoring of crop for BPH incidence based on set ETL levels i.e., 10-15 hoppers/hill during tillering stage and 20-25 hoppers/hill during panicle emergence stage. Need based spraying with pymetrozine 50%WG @ 0.6g against BPH. 9. Prophylactic spraying of cartap hydrochloride 50SP @ 2.0g/l at P.I to booting stage against stem borer. 10. Need based spraying of picoxystrobin + propiconazole 2ml/ for blast	1. Spraying of cartap hydrochloride 50SP after appearance of white ears 2. Spraying of insecticides after noticing hopper burn symptoms 3. Spraying of fungicides after noticing disease incidence

The methodology for the Front Line Demonstrations (FLD) followed guidelines outlined by Choudhary (1999) [5], including experimental design, site selection, farmer selection, demonstration layout, and farmer participation. Agronomic practices were rigorously applied, with the rice variety RNR-15048 (Telangana Sona) cultivated in plots sized at 0.4 hectares across ten locations for each treatment.The data was collected at fortnightly intervals on incidence of two major pests *i.e* rice yellow stem borer and brown planthopper and one major disease *i.e* leaf blast.

Yellow Stem Borer (YSB): The incidence of YSB was recorded in terms of percent damage by counting the damage done *i.e.*, white ears to total number of panicles per hill. For white ear head- Number of white ear plants in panicle stage and total number of panicles were recorded from ten hills in each plot and percent damage was calculated by using following formula.

$$\text{Percent damage (\%)} = \frac{\text{Number of white ears per hill}}{\text{Total number of panicles per hill}} \times 100$$

Brown plant hoppers (BPH): The number of nymphs and adults per hill were counted at panicle stage to record the abundance of BPH in the field and expressed as population per hill. The nymph/ adult population of brown plant hopper counted by randomly selecting 10 hills/ plot.

Leaf Blast

Leaf Blast incidence was recorded by assessing upper three leaves of random tiller from each of the ten random hills from each field and expressed as percent for each location. The disease in observed fields was expressed as

$$\text{Disease Incidence} = \frac{\text{Number of diseased leaves}}{\text{Total number of leaves assessed}} \times 100$$

Yield data were collected from both technology-assessed plots and farmers' practice plots. Using parameters such as extension gap, technology gap, yield gap, and technology index, as outlined by Rajashekhar *et al.* (2022) [15], Samui *et al.* (2000) [18], and Lakshmi Narayanamma *et al.* (2023) [10], the economic impact of treatments was assessed through benefit-cost ratio calculations.

Extension gap (Kg/ha) = Demonstrations yield –Yield under existing farmer's practice

Technology gap (Kg/ha) = Potential Yield – Demo Yield

Additional return = Demonstration return – farmer's practice return

$$\text{Yield gap (\%)} = \frac{\text{Extension gap}}{\text{Yield under farmers practice}} \times 100$$

$$\text{Technology gap (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

$$\text{Technology index (\%)} = \frac{\text{Potential yield - Demonstration yield}}{\text{Potential yield}} \times 100$$

Results and Discussion

Based on the current findings and subsequent data analysis over three consecutive years, it was observed that overall pest and disease incidences were lower in the technology-demonstrated plots compared to farmers' practice plots. This reduction can be attributed to regular monitoring of pest and disease incidences and the judicious use of integrated pest management strategies, resulting in a reduced pest and disease load.

Specifically, the incidence of white ears was notably lower in the demonstrated plots, with values of 9.15, 8.01, and 7.88 during Kharif seasons 2019, 2020, and 2021, respectively. In contrast, higher percentages of white ears were observed in farmers' practice plots, with values of 13.23, 12.62, and 13.24 during the corresponding years.

Brown planthopper (BPH) incidences were also lower in technology-demonstrated plots, with 16.38 insects/hill during Kharif 2019 and lower infestations in subsequent years. In contrast, farmers' practice plots showed higher

BPH infestations, with values of 27.37, 25.83, and 26.33 insects/hill during Kharif seasons 2019, 2020, and 2021, respectively.

Leaf blast disease incidences were higher in farmers' practice plots, with percentages of 22.0, 16.6, and 14.8 during Kharif seasons 2019, 2020, and 2021, respectively, while technology-demonstrated plots had lower incidences of 11.6, 9.2, and 9.0 during the corresponding years.

Regarding yields, technology-demonstrated plots recorded higher yields (7044, 7200, and 6944 Kg/ha) compared to farmers' practice plots (6617, 6875, and 6522 Kg/ha) during Kharif seasons 2019, 2020, and 2021, respectively. This translated into higher net returns for technology-demonstrated plots (Rs 89,992/-, Rs 89,000/-, and Rs 86,800/ha) compared to farmers' practice plots (Rs 86,675/-, Rs 77,500/-, and Rs 81,525/-) during the same periods. Overall, the benefit-cost ratio was higher in the treatment plots compared to the control plots throughout the experimentation period, indicating the effectiveness of the technology in reducing pest and disease incidences, increasing yields, and improving economic returns.

Table 2: Percent YSB incidence (White ears) at different locations

		Percent white ear incidence due to YSB/ locations										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
2019	Farmers Practice	12	16.2	12.3	12.5	12.8	12.4	15.1	12.5	13	13.5	13.23
	Demo	9.2	9.1	8.5	11.2	8.9	10.6	7.5	8.8	9.5	8.2	9.15
2020	Farmers Practice	12.7	14.1	12.5	10.1	11.4	12.7	12.4	12.4	15.8	12.1	12.62
	Demo	10.1	8.4	5.7	7.2	5.5	8.2	10.3	7.6	9.9	7.2	8.01
2021	Farmers Practice	13.1	14.2	12.1	14.5	12.5	11.7	13.5	10.8	13.5	16.5	13.24
	Demo	9.1	6.7	6.6	7.8	7.1	9.5	9.2	7.5	8.1	7.2	7.88

Table 3: Brown planthopper incidence in different locations at panicle stage

		BPH / hill / locations										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
2019-20	Farmers Practice	28.1	30.2	26.2	27.5	28.1	27.3	29.3	21.2	25.3	30.5	27.37
	Demo	19.2	16.3	14.6	15.6	14.9	19.2	16.3	14.6	14.9	18.2	16.38
2020-21	Farmers Practice	30.1	27.2	22.2	26.5	28.2	28.6	28.5	25.4	22.1	19.5	25.83
	Demo	17.9	14.2	15.6	12.6	17.3	18.9	14.7	11.9	17.6	19.1	15.98
2021-22	Farmers Practice	22.3	24.6	25.6	30.5	28.3	30.5	28.3	23.3	24.6	25.3	26.33
	Demo	12.4	12.2	12.5	14.7	12.5	15.2	12.6	10.2	13.2	11.9	12.74

Table 4: Percent leaf blast incidence at different locations

		Percent incidence / locations										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
2019-20	Farmers Practice	21.3	27.0	12.7	16.9	30.0	23.3	24.0	26.7	17.1	21.0	22.0
	Demo	10.3	14.0	11.7	12.0	11.7	12.3	13.3	10.8	8.3	12.0	11.6
2020-21	Farmers Practice	18.0	17.8	16.2	10.0	15.7	14.7	20.0	18.7	18.0	16.7	16.6
	Demo	9.0	9.0	6.0	6.7	8.1	10.7	9.3	11.7	10.3	11.1	9.2
2021-22	Farmers Practice	15.0	15.3	14.9	14.7	16.0	13.9	15.0	16.0	14.0	13.3	14.8
	Demo	9.9	8.8	9.6	10.7	10.0	6.7	8.3	9.2	8.0	8.8	9.0

Table 5: Economic impact of experiment

Year	Yield (Kg/ha)		Net returns (Rs. /ha)		B:C Ratio	
	Demo	**Farmers Practice**	**Demo**	**Farmers Practice**	**Demo**	**Farmers Practice**
2019-20	7044	6617	89,992	86,675	2.30:1	2.10:1
2020-21	7200	6875	89,000	77,500	2.63:1	2.21:1
2021-22	6944	6522	86,800	81,525	2.44:1	2.09:1

The findings align with prior studies, showing higher incidences of pests and diseases in farmers' practice plots compared to those implementing an Integrated Pest Management (IPM) module, resulting in a lower benefit-cost ratio (BC Ratio) for the former. Ratnakar *et al*. (2022) [16] also reported similar results, with technology-demonstrated plots showing higher BC Ratios of 2.1:1 and 2.2:1 in Rabi seasons 2018-19 and 2019-20, respectively, compared to 1.85:1 and 1.88:1 in farmers' practice plots during the corresponding periods. This could be attributed to practices such as regular leaf tip clipping before transplanting, pheromone trap installation for monitoring, and judicious insecticide application.

The implementation of alleyways (20 cm wide for every 2 meters), recommended fertilizer doses, alternate wetting and drying, and targeted spraying of pymetrozine 50 WG @ 0.6g against brown planthoppers (BPH) contributed to reduced BPH infestations in technology-demonstrated plots. Ratnakar *et al*. (2020) [17] observed higher BPH infestations in farmers' practice plots, with 20.9 adults/hill during Kharif 2018 and 29.8 adults/hill during Kharif 2019. Additionally, studies by Adhikari *et al*. (2019) [1], Deekshita *et al*. (2018) [6], Lakshmi *et al*. (2010) [11], and Liu *et al*. (2013) [12] support the efficacy of pymetrozine against BPH, inhibiting their feeding behavior.

Fungicide applications are commonly used to mitigate fungal diseases in rice cultivation due to their ease of use and effectiveness. The results are consistent with previous research, demonstrating that fungicide application, particularly picoxystrobin + propiconazole at 600 ml/ha, reduces leaf blast incidence by 16.5%, as evidenced by studies by Bag *et al*. (2016) [2], Bhuvaneswari (2012) [4], Naik *et al*. (2012) [13], and Balol *et al*. (2022) [3].

Conclusion
Based on the findings of this study, it can be inferred that location-specific Integrated Pest Management (IPM) modules have become crucial due to the dynamic pest patterns across seasons and agro-ecosystems. The noticeable yield disparity between farmers' practices and technology-demonstrated plots underscores the urgent necessity for robust extension services to educate farmers on adopting improved technologies. Furthermore, the lower yield levels observed in local practices indicate room for improvement through the adoption of recommended IPM strategies.
The Front Line Demonstration (FLD) intervention has proven highly effective in enhancing net returns among farmers. The positive outcomes observed in technology-demonstrated plots warrant wider implementation across the Bhadradri Kothagudem district. These results can be leveraged to encourage farmers to adopt these practices, thereby reducing unnecessary and unwarranted usage of insecticides and fungicides.

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Authors' contributions
Regarding author contributions, this work was a collaborative effort involving all authors. Each author thoroughly reviewed and approved the final manuscript.

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