

Evaluating the Bio-Efficacy of Forte Plus F2 (0.3% Matrine) for Insect Pest Management in Rice Cultivation¹

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Abstract: This study investigates the efficacy of Forte Plus F2, a 0.3% matrine-based bio-insecticide, against four major rice pests- Green Leafhopper (GLH), Rice Bug (RB), Rice Leaf Folder (RLF), and Yellow Stem Borer (YSB)-under field conditions in two locations in the Philippines. The experimental design followed a randomized complete block structure with four treatment concentrations. Results showed that Forte Plus F2 significantly reduced GLH and RLF populations and associated crop damage, especially at higher concentrations. Although the impact on YSB larval counts was not statistically significant, a marked decline in pest incidence was observed. The study concludes that Forte Plus F2 is a viable component of integrated pest management for rice, particularly in organic and sustainable farming contexts.

Keywords: matrine, bio-insecticide, rice pests, integrated pest management, sustainable agriculture

1.Introduction

Philippines as tropical country is fully dependent on rice as staple food of the Filipinos. Due to the favorable climate, rice is cultivated year-round. The favorable climate for rice production, however, also becomes favorable for occurrence of pests and diseases, most notably of the pests are the insect pests that seriously affect its growth and yield, these insects include Green Leafhopper (*Nephotettix viridescens*), Rice Bug (*Leptocoris acuta*), Leaf folder (*Cnaphalocrosis medinalis*), Stem borers (*Scirpophaga* spp.) to name a few (Pathak, M. D., et. al., 1994 and Shepard, B. M., 1995). The Green leafhoppers (GLH) are the most common leafhoppers in rice fields and are primarily critical because they spread the viral disease tungro. (IRRI, 2023. GLH). Both nymphs and adults feed by extracting plant sap with their needle-shaped mouthparts. The rice bugs damage rice by sucking out the contents of developing grains from pre-flowering spikelets to soft dough stage, therefore causing unfilled or empty grains and discoloration. Immature and adult rice bugs both feed on rice grains. (IRRI, 2023. Rice Bug). The Rice Leaf folder caterpillars fold a rice leaf around themselves and attach the leaf margins together with silk strands. They feed inside the folded leaf creating longitudinal white and transparent streaks on the blade. (IRRI, 2023. Leaf folder). During severe infestation the whole field exhibits whitish scorched appearance. The Stem Borers can destroy rice at any stage of the plant from seedling to maturity. They feed upon tillers and cause deadhearts or drying of the central tiller, during vegetative stage; and causes whiteheads at reproductive stage. (IRRI, 2023. Stem borer). High population density of these insect pests in the field can cause tremendous damage to rice plants which could lead to low yield. Therefore, a sound effective and ecofriendly management approaches be instituted to put these insect pests at bay.

A published patent by Xi'an Shengwei Technology Industry Ltd. (2004), a 0.3% matrine solution revealed a significant findings and advantages to control insect pests.

According to the invention, the matrine solution is fast, efficient, broad-spectrum activity to control insect pests. Moreover, the inventions present to control of tens kinds of insects such as cotton bollworm, cabbage caterpillar, diamond-back moth, aphid, two spotted spider mite, its efficient 86-99% that reaches, the time of tagging killed off the insect pests in 3-5 minute. To date, Forte Plus F2 (0.3% matrine solution), a safe, environmentally friendly and effective bio-insecticide based on traditional herbal medicine science is on our hand. This product is a totally organic insecticide extracted from a number of herbs by advanced technology and facilities. It contains plenty of trace elements and natural PGRs which can promote plant growth. It has the advantages of fast-acting, broad-spectrum activity, high prevention and cure effective rate of crop pests, short time of contact poisoning by killing the insect pests in 3-5 minutes, high safety or no toxicity to people and animals, no residue characteristics, thus, no pollution to the environments. Its mode of action disrupts various physiological systems in insect pests by neutralizing their natural defenses. Contact poison firstly and suffocation secondly. It makes insect nerve center paralysis, thereby, polypide protein coagulating pore are stopped up, suffocates leading to death of the target pests (). With its high effective rate, short time of contact poisoning, non-residue and no toxicity to people and animals, it is therefore a favorable option for organic agriculture. The study aims to assess the field-level bio-efficacy of Forte Plus F2, a matrine based organic insecticide, in controlling common rice pests to support its potential registration and integration into eco-friendly pest management strategies.

Also, because of its high dilution rate and low dosage it is an economical product. In the Philippines, this product was previously tested on the major insect pests of beans, but not on insect pests of rice, hence this research.

This research is significant as it addresses the growing need for sustainable pest control solutions in rice cultivation, reducing reliance on synthetic insecticides and

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contributing to environmental safety and crop productivity.

2.Objectives

1. To evaluate the bio efficacy of Forte Plus F2 against Green Leafhopper, Rice Leaf Folder, Rice Bug and Yellow Stem Borer in rice.
2. To determine the best application rate of the Forte Plus F2 that will provide the most effective management of Green Leafhopper, Rice Leaf Folder, Rice Bug and Yellow Stem Borer in rice.
3. To generate bio-efficacy data of the fungicide as support in application for full registration of Forte Plus F2 in rice with BAFS.

3.Materials and Methods

Efficacy trial design and layout-The experimental area was divided into four (4) blocks and each block was subdivided into four (4) plots with a dimension of 4m x 5m representing the four (4) treatments. Both Sites 1 and 2, were planted with rice variety SL 22. Transplanting was carried out in Site 1 on December 9, 2023 and in Site 2 on December 4, 2023. The Analysis of Variance (ANOVA) with 5% LSD was used following the RCBD Experimental Design. The experimental sites were laid in 4 replications. (Figures 1 and 2).



Figure 1: The experimental site in Sta Lucia Old, Zaragoza, Nueva Ecija



Figure 2: The experimental site in Lomboy, La Paz, Tarlac

Treatment protocols: T1-Untreated Control; T2-Test Product-Product's Recommended Rate (200ml/300 li water); T3- Test product not more than 2xRR (300ml/300 li water); T4-Test product 2x RR (400ml/300 li water).

Land Preparation. Seedbed was prepared following the standard protocol for rice seedbed preparation. The standard field preparation for rice i.e. clearing and weeding the field, pre-irrigation, first ploughing or tilling, harrowing, flooding and levelling were carried out to prepare the study site.

Cultural Management Practices

Land preparation. Seedbed was prepared following the standard protocol for rice seedbed preparation. The standard field preparation for rice i.e. clearing and weeding

the field, pre-irrigation, first ploughing or tilling, harrowing, flooding and levelling were carried out to prepare the study site.

Seedling bag/plant/material preparation. Seedlings were pulled and tight and transferred to the experimental sites prior to transplanting.

Transplanting. Twenty-one (21) to twenty-eight (28) days old rice seedlings (SL 22) were transplanted manually in both sites with a distance of 25 x 25 cm (between hills and between rows).

Fertilizer management. Application of 1 bag of 14-14-14 at 0-14 DAT or 1-14 days after sowing (DAS) and 1 bag Urea and 0.5 bag 0-0-60 at 28-32 DAT

Water management. Irrigation water levels were maintained at around 3 cm initially and gradually increases to 5-10 cm (with increasing plant height) and remaining there until the field is drained 7-10 days before harvest. In Site 1, irrigation water was sourced out from the

community irrigation canal. In Site 2, irrigation water comes from deep well pump.

Pest Management. Molluscicide was applied right after transplanting. Weeds were controlled through hand weeding. Insecticide and fungicide were not applied.

Sampling Procedure

Green Leaf Hopper (GLH)	
Actual Population Counts	
Using an insect net, 10 sweeps were executed per plot and the number of adults and nymphs caught were recorded. This was done one (1) day before treatment application (DBTA), and 1, 3 and 7 days after treatment application (DATA) for 6 consecutive weeks	
Actual Count of Tungro Virus Infection (TVI)	
No tungro infected plants were counted as tungro infected plants were absent	
Rice Leaf Folder	
Actual Population Count	
Rice Leaf Folder was monitored at 40 to 50 and 61 to 82 DAT when leaf folders are generally abundant in the field. Folded leaves were opened on 10 randomly tagged sample plants and recorded the number of larvae present	
Estimate of Leaf Folder Damage (LFD)	
Percent LFD was computed using the formula below:	
$\%LFD = \frac{\text{No. of plants with LFD tillers}}{\text{Total no. plants}} \times 100$	
Rice Bug (RB)	
Actual Population Counts	
Number of eggs, nymphs or adults from each 10 randomly tagged sample plants/plot were counted and recorded. This was carried out 1 DBTA, and 1, 3 and 7 DATA, as appropriate.	
Deadheart Incidence	
To differentiate from stem borer damage, deadhearts caused by RBB cannot be pulled at the bases. RBBs also cause reddish brown discoloration on the plant and chlorotic lesions on the leaves.	
Stem Borer	
Actual Population Counts	
This was done through destructive sampling of plants within the plots. Tillers were dissected and the number of larvae present were counted in at least 20 tillers per plot for 6 consecutive weeks every after treatment application.	
Estimate of Damage	
Percent incidence in a 12m ² (4m x 4m) sampling area per plot was estimated using the formula below:	
$\% \text{ Incidence} = \frac{\text{No. of damaged tillers per hill}}{\text{Total no. of tillers per hill}} \times 100$	

4.Results and Discussion

Green Leaf Hopper

Actual Population Counts

The evaluation was conducted in Location 1 to determine the effectiveness of Forte Plus F2 in managing Green Leaf Hopper populations across six sequential applications. The untreated control (T1) showed a peak in population by the 4th application and a subsequent decline, illustrating the

natural population dynamics in the absence of treatment. In contrast, the treated groups exhibited a consistent decrease in population numbers, with the most significant reduction observed in T4, which utilized double the recommended rate of Forte Plus F2. By the 6th application, T4 had reduced the population to the lowest level among all treatments, confirming the high efficacy of the insecticide at higher concentrations (Table 1-Figure 3). These results demonstrate the potential of Forte Plus F2 as an effective organic insecticide for GLH control, suggesting that appropriate dosing is critical for achieving optimal pest management in agricultural practices.

Table 1: Green Leaf Hopper (GLH) population counts at different levels of FORTE PLUS F2 (Dry Season, 2024).

TRT	39 DBTA	Treatment Application					
		1 st Appln	2 nd Appln	3 rd Appln	4 th Appln	5 th Appln	6 th Appln
T1	65ns	66a	70a	79a	82a	70a	49a
T2	64	59a	57ab	54ab	44b	28b	16a
T3	62	52ab	51b	49b	39bc	18bc	7b
T4	57	39b	30c	28b	25c	11c	3b



Figure 3: Rice plant treated with Forte Plus F2 (400ml/ha)

In Location 2, the untreated control (T1) experienced a peak in GLH population by the 4th application associated with unthrifty growth of the plants (Figure 4), followed by a reduction, indicative of natural population dynamics. Conversely, the treated plots exhibited a consistent decrease in population numbers. Notably, the plot treated

with the highest concentration of the insecticide (T4) recorded the most significant reduction, with GLH numbers reduced to a mere 1 by the 6th application resulting to good stand of the crop (Table 2). These results demonstrate the high efficacy of Forte Plus F2, particularly at higher concentrations, in reducing GLH populations.

Table 2: Green Leaf Hopper (GLH) population counts at different levels of FORTE PLUS F2 (Dry Season, 2024).

TRT	39 DBTA	Treatment Application					
		1 st Appln	2 nd Appln	3 rd Appln	4 th Appln	5 th Appln	6 th Appln
T1	65ns	76a	85a	94a	100a	72a	39a
T2	58	52b	32b	29b	27b	21b	14b
T3	58	36c	22b	13b	12c	10c	9bc
T4	57	30c	24b	1b2	11c	5c	1c



Figure 4: Unthrifty looking plants in the Untreated plots prior to harvest

Rice Leaf Folder

Actual Population Counts

In Location 1, the analysis of Rice Leaf Folder (RLF) population after the application of Forte Plus F2 insecticide reveals critical insights into the product's effectiveness. The comparison of RLF population counts over time,

particularly from 40 to 80 days after treatment application, demonstrates a consistent decline in populations across all treatments, with the untreated control (T1) showing a slight reduction from 11.5 to 11.0 indicating some natural population decline. However, the treated groups (T2, T3, T4) exhibit a more substantial decrease, with T4 reaching zero by 80 days, reflecting the highest efficacy among the treatments.

Table 3: Rice Leaf Folder population counts at different levels of FORTE PLUS F2. (Dry Season, 2024).

TRT	Days After Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80DATA
T1	76a	85a	94a	100a	72a
T2	52b	32b	29b	27b	21b
T3	36c	22b	13b	12c	10c
T4	30c	24b	1b2	11c	5c

Over the course of the treatment period, the untreated control (T1) in Location 2 showed a slight increase in RLF

population from 9.75 to a peak of 12.50 at 60 DATA, before slightly declining to 10.50 by 80 DATA. RLF

populations remained relatively stable without treatment, with minor fluctuations likely influenced by environmental conditions. In contrast, T2, which was treated with the recommended rate of Forte Plus F2, demonstrated a more consistent and significant reduction in RLF counts, from 8.25 initially down to 2.25 by 80 DATA. This trend was

even more pronounced in T3 and T4, where the initial counts of 6.25 and 4.75 reduced to 1.00 and 0.00, respectively, by the end of the period. T4, receiving double the recommended rate, effectively eradicated the RLF population by 80 DATA (Table 4).

Table 4: Rice Leaf Folder population counts at different levels of FORTE PLUS F1. (Dry Season, 2024)

TRT	Days After Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80DATA
T1	8.75ns	9.75ns	11a	12.5a	10.5a
T2	8.25	6.50	4.75b	4b	2.25b
T3	9.50	6.25	3bc	2.75bc	1.5bc
T4	10.00	4.75	2.25c	1.5c	0.5c

Rice Leaf Folder Damage

Regarding the percentage of RLF damage in Location 1, similar trends were observed. T1's damage percentage showed slight fluctuations but ultimately increased to 2.11% at 40 DATA to 1.88% at 80 DATA. In contrast, T2

significantly reduced damage from 1.01% at 40 DATA to 0.31% at 80 DATA. The more concentrated treatments, T3 and T4, effectively minimized the damage to crops, with T3 reducing it to 0.00% by 60 DATA and T4 maintaining no damage from 50 DATA onwards (Table 5).

Table 5: Rice Leaf Folder damage at different levels of FORTE PLUS F2. (Dry Season, 2024)

TRT	Days After Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80DATA
T1	2.03ns	2.11a	1.95a	1.33a	1.87a
T2	1.48	1.01b	0.78b	0.15b	0.31b
T3	1.41	1.01b	0.23c	0.07b	0.00b
T4	1.48	0.07c	0.00c	0.07b	0.00b

Damage assessment followed a similar pattern in Location 2. T1's damage percentage saw an increase, particularly by 80 DATA, where it spiked to 6.01%, indicating worsening conditions without control measures. T2 and T3 both

managed to control damage, reducing it to 1.64% and 1.32%, respectively, by 80 DATA. However, T4 stood out by reducing damage to a mere 0.47% by 80 DATA, significantly lower than T1's figures (Table 6).

Table 6: Rice Leaf Folder damage at different levels of FORTE PLUS F2. (Dry Season, 2024)

TRT	Days After Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80DATA
T1	2.73a	3.12a	3.75a	2.51a	6.01a
T2	1.64bc	1.40b	1.17b	0.54b	1.64b
T3	1.95bc	1.32bc	0.78bc	0.47b	1.32b
T4	1.32c	0.70c	0.39c	0.15b	0.47b

Yellow Stem Borer

Actual Population Counts (Number of Larva).

Despite observed reductions in larva counts, particularly with the highest concentration (T4), the results in Location

1 across all treatments and time points remained statistically non-significant. This indicates that under the conditions and concentrations tested, Forte Plus F2 did not achieved a statistically significant reduction in stem borer populations compared to untreated controls (Table 7).

Table 7: Rice Yellow Stem Borer population counts at different levels of FORTE PLUS F2. (Dry Season, 2024)

TRT	Treatment Application				
	2 nd Appln	3 rd Appln	4 th Appln	5 th Appln	6 th Appln
T1	0.00ns	1.75a	4.75ns	6.25a	5.00ns
T2	0.00	0.75b	2.50	2.75ab	2.50
T3	0.00	0.50b	1.50	0.25b	1.50
T4	0.40	0.00b	1.00	1.00b	0.25

Results are similar to those observed in Location 1 in which observed reductions in larva counts, particularly with the highest concentration (T4), the results across all treatments and time points remained statistically non-

significant. This indicates that under the conditions and concentrations tested, Forte Plus F2 did not achieved a statistically significant reduction in stem borer populations compared to untreated control (Table 8).

Table 8: Rice Yellow Stem Borer population counts at different levels of FORTE PLUS F2. (Dry Season, 2024)

TRT	Treatment Application				
	2 nd Appln	3 rd Appln	4 th Appln	5 th Appln	6 th Appln
T1	0.00ns	13.00ns	30.00a	8.00ns	3.00ns
T2	0.00	6.50	9.50b	3.75	1.75
T3	0.00	3.00	12.00b	4.50	1.50
T4	0.40	3.00	4.75b	3.00	0.50

Percent (%) Incidence

From the 2nd to the 4th application, all treatments in Location 1, including the untreated control (T1), displayed no significant differences, indicating that up to this point, there were no detectable differences in stem borer incidence due to the insecticide treatment. However, from the 5th application onwards, a differentiation begins to emerge, with the untreated control (T1) showing a significant level of stem borer incidence, suggesting that

by this time, stem borer incidence has become noticeable and impactful. In the 6th application, the results showed a graded response to increasing concentrations of Forte Plus F2. While T1 maintains a higher incidence of stem borers, treatments T2 and T3 showed a reduction in stem borer incidence. Treatment T4, with twice the recommended rate, shows the greatest reduction in stem borer incidence, suggesting a strong insecticidal effect at this concentration (Table 9-Figure 5).

Table 9: Rice Yellow Stem Borer incidence at different levels of FORTE PLUS F2. (Dry Season, 2024)

TRT	Treatment Application				
	2 nd Appln	3 rd Appln	4 th Appln	5 th Appln	6 th Appln
T1	0.00ns	7.35ns	43.16ns	52.48a	25.63a
T2	1.56	3.13	36.65	19.04ab	14.86ab
T3	0.00	3.98	11.41	2.17b	8.50bc
T4	0.40	0.00	19.80	6.74b	1.66c

**Figure 5:** Rice plants treated with FORTE PLUS F2 (400ml/ha)

In Location 2, the study also evaluated the effectiveness of Forte Plus F2 at various concentrations against Yellow Stem Borer incidence over multiple applications. The untreated control (T1) experienced a significant spike in stem borer incidence by the 4th application, suggesting a severe infestation, followed by a notable decrease, which might be attributed to natural population dynamics. In

contrast, the treated groups showed a progressive and significant control of the pest. The recommended rate (T2) effectively reduced the pest incidence, demonstrating the product's capability. Higher concentrations in T3 and T4 were even more effective, with T4 achieving the lowest incidence by the 6th application, underscoring the increased efficacy of higher doses (Table 10).

Table 10: Rice Yellow Stem Borer incidence at different levels of FORTE PLUS F2. (Dry Season, 2024)

TRT	Treatment Application				
	2 nd Appln	3 rd Appln	4 th Appln	5 th Appln	6 th Appln
T1	0.00ns	58.66ns	199.06a	65.18ns	50.81a
T2	0.00	40.19	65.27b	32.46	22.93b
T3	0.00	13.13	53.41b	41.32	20.41b
T4	0.00	18.00	25.37b	27.62	11.30

5. Conclusion

Green Leaf Hopper Actual Population Counts. The data implied that Forte Plus F2 is effective in managing GLH populations, with more pronounced results in Lomboy. The variability in efficacy between Sta Lucia and Lomboy suggests that environmental factors, application timing, or

inherent biological differences in GLH populations may influence the outcome. This underlines the importance of localized assessments when implementing pest management strategies.

Rice Leaf Folder Actual Population Counts. The results conclusively suggest that Forte Plus F2 is highly effective

in managing RLF populations, with greater efficacy noted at higher concentrations. Over the course of the treatments, the RLF populations decreased significantly, demonstrating the sustained effectiveness of Forte Plus F2. It's critical to note that such a decrease in pest populations contributes to improved crop health and potential yield. However, the presence of larvae at 80 DATA even in treated plots suggests the potential for resistance development or incomplete control, necessitating ongoing monitoring.

Rice Leaf Folder Damage. The evidence suggests that Forte Plus F2 effectively reduces the damage caused by RLF, with a pronounced dose-response relationship. While both locales showed a reduction in RLF damage over time across treatments, Sta. Lucia demonstrated a potentially more efficacious outcome with two treatments achieving zero percent damage by the end of the study period.

Yellow Stem Borer Percent (%) Incidence. Forte Plus F2 has demonstrated significant impact on the reduction of stem borer incidence, with the data showing a dose-dependent effect in both Sta. Lucia and Lomboy sites. Despite regional differences in peak incidences, the trend suggests that higher concentrations of the insecticide correlate with a greater reduction in pest incidence. The variability may be attributed to local environmental conditions which reflects differences in average prevailing temperature i.e. 25.92oC in Sta Lucia Old and 22.35oC in Lomboy or differing initial pest population densities.

6.Recommendation

Green Leaf Hopper Actual Population Counts. Given the observed efficacy of Forte Plus F2, it is recommended to include this insecticide as a strategic component of an integrated pest management (IPM) for controlling GLH populations in rice cultivation. T4, the highest concentration treatment, should be considered for use in areas with significant GLH pressure, based on its superior performance. However, it is essential to monitor for signs of pest resistance and to consider environmental stewardship by potentially rotating with different modes of action or integrating additional non-chemical pest management strategies

Rice Leaf Folder Actual Population Counts. It is recommended to consider the context of insecticide application carefully. For similar agricultural settings as in Lomboy, using Forte Plus F2 according to the study's treatment schedule appears beneficial. For environments akin to Sta Lucia, a review of application timing and possible integration with other pest management practices may be warranted to optimize GLH control. Additionally, further studies could elucidate the factors contributing to the differing responses, to tailor pest management strategies more precisely.

Rice Leaf Folder Damage. It is recommended that Forte Plus F2 be employed as an integral component in managing RLF within rice cultivation, particularly at the higher treatment concentrations which have demonstrated substantial efficacy. Given the variability observed

between different regions, it would be advisable to tailor the concentration of Forte Plus F2 to local conditions, possibly informed by a localized field trial or past pest management records

Yellow Stem Borer Percent Incidence. It is recommended to adopt Forte Plus F2 for the management of stem borer populations, tailoring the application rate to balance pest control efficacy with environmental sustainability. For more conservative pest management, the recommended rate (T2) shows substantial efficacy. However, for severe infestations, a higher rate (T4) could be considered. It is also advised to implement an integrated pest management strategy, combining chemical control with other practices to maintain long-term pest suppression. It is recommended to adopt Forte Plus F2 for the management of stem borer populations, tailoring the application rate to balance pest control efficacy with environmental sustainability.

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