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Field Evaluation of Forte Plus F1 (0.5% Matrine) Against Key Insect Pests in Rice (*Oryza sativa* L.)[1]

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Abstract: ***This study evaluated the bio-efficacy of Forte Plus F1 (0.5% matrine), a natural bio-insecticide, against four key rice pests: Green Leafhopper, Rice Bug, Rice Leaf Folder, and Yellow Stem Borer. Field trials were conducted in Sta. Lucia and Lomboy, Philippines, from December 2023 to April 2024. Four treatment levels were tested using RCBD with four replications. The highest concentration (T4: 400ml/300L) consistently showed superior control of GLH and RLF populations and damage, indicating a strong dose-response relationship. However, results for Yellow Stem Borer larval counts were statistically non-significant, though incidence reduction was noted. Forte Plus F1 demonstrated promising potential for ecofriendly rice pest management.***

Keywords: rice pests, Forte Plus F1, Green Leafhopper, bio-insecticide, Yellow Stem Borer

1. Introduction

Rice suffers from wide range of insect infestation that seriously affect its yield, these insects include Green Leafhopper (Nephotettix viriscens), Rice Bug (Leptocorisa acuta), Leaffolder (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 Leaffolder 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. Leaffolder). 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 causes 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 F1 (0.5% matrine), a safe, environmentally friendly and effective bio-insecticide based on traditional Chinese herbal medicine science is in our hand. This product is a totally natural organic insecticide extracted from a number of herbs by advanced technology and facilities. With the same active ingredient with that of the invention of Xi'an Shengwei Technology Industry Ltd. (2004), it has an effect on different systems of pests by inhibiting or destroying its anti-pesticidal properties. It is a contact poison firstly and stomach secondly. It paralyzes the nerve centers of insects, then solidifies the albumen and blocks the air vents of insects' body. Finally, makes the insects die by suffocation. Also, it suppresses food absorption of insects and reduce larvae livability and then hinder its growth to prevent insects from laying eggs; Moreover, it suppresses microsomal monooxygenase, enhance the toxicity of active ingredient to insects. After application, insects will stop eating immediately thereby avoiding damage to the crops. It will take twenty-four to forty-eight hours for the target pests to die. Moreover, from plant source, the active ingredients can be light -resolved completely, thus, no residue was left behind in the plant tissues. Due to its high efficacy, lack of residue, and absence of phytotoxicity, it is a favorable option for organic agriculture and its sustained development. Also, because of its high dilution rate and low dosage it is an economical product (Beijing Multigrass Formulation Co. Ltd., 2023).

The statement made by Beijing Multigrass Formulation Co., Ltd. is in conjunction with the result of the study conducted by Zanardi, O.Z. et. al. (2015). They further stated that the matrine-based biopesticide caused lethal and sublethal effects on all the studied pest species. They concluded that matrine-based biopesticide is a useful component for crop protection where the studied pest species occur, mainly in ecological systems of food production, which need efficient tools for pest management.

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Furthermore, according to Celiz, RJ R. 2018, one of these new broadspectrum biological insecticides for the management of wide range of pests is Matrine. It is a medicinal plant which is widely used in various pharmaceutical formulations and traditional medicinal remedies in Korea. Of these bioactive components, matrine and oxymatrine, which are quinolozidine alkaloids, are known as bioactive materials against various insect pests, pathogenic fungi, bacteria, and nematodes.

In the Philippines, no records of its efficacy against these insect pests of rice are yet available, hence this research.

This research is significant as it provides the first empirical data on the efficacy of Forte Plus F1 in Philippine rice fields, contributing valuable insights for organic pest management strategies.

2. Objectives

1) To evaluate the bio efficacy of Forte Plus F1 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 F1 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 F1 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 on December 4 for Site 2. The experimental sites were laid out in RCBD with 4 replications (Figures 1 and 2).

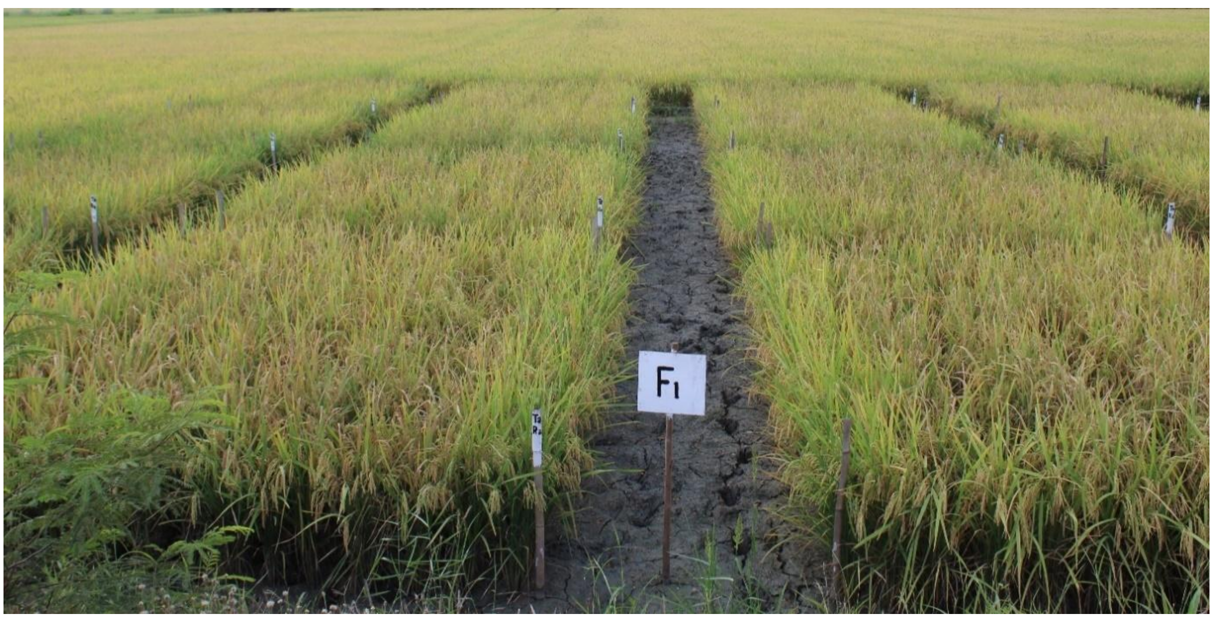

Figure 1: The experimental site in Sta Lucia Old, Zaragoza, Nueva Ecija

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).

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 bundled 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. Chemical insecticides and fungicides were not applied in order to eliminate additional factors that might affect the control of pests aside from Forteplus F1 as an organic pesticide.

Sampling Procedure

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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 out from the at t e 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 12m2 (4m x 4m) sampling area per plot was estimated using the formula below:

$$\%\ Incidence = \frac{\text{No. of damaged tillers per hill}}{\text{Total no. of tillers per hill}} \times 100$$

4. Results and Discussion

Green Leaf Hopper

Actual Population Counts

In Location 1, the actual population counts of green leaf hopper showed that the Untreated Control (T1) demonstrates a progressive increase in population over time, moving from non-significant initial counts to significantly higher counts by the 3rd application and maintaining high levels thereafter. This shows that GLH populations increase steadily without pest control. For the treated groups, T2, T3, and T4, each shows a decline in population counts over the applications. Over time, these treatments diverge significantly from T1, reflecting the impact of Forte Plus F1. T2 and T3 consistently exhibit a 'b' classification across the applications, suggesting effective control that is markedly better than T1 but less potent than T4. T4 by the 5th and 6th applications indicates the highest level of efficacy, with the most substantial population reductions (Table 1-Figure 3). This result indicates a strong dose-response relationship, where increased concentrations of Forte Plus F1 correlate with more significant pest control outcomes.

Table 1: Green Leaf Hopper (GLH) population counts at different levels of FORTE PLUS PLUS F1 (Dry Season, 2024)

TRT	39 DBTA	Treatment Application					
		1st Apln	2nd Apln	3rd Apln	4th Apln	5th Apln	6th Apln
T1	65ns	70ns	86a	95a	96a	110a	101a
T2	64	58	57b	51b	50b	47b	48b
T3	61	54	53b	47b	40b	36bc	32b
T4	57	52	41b	34b	32b	19c	13c

Figure 3: Rice plant treated with Forte Plus F1 (400ml/ha).

In Location, 2 the actual population counts showed that the Untreated Control (T1) exhibited an increase in population up to the 4th application resulted in poor crop stand (Figure 3), followed by a decrease at the 6th application as the plants grows towards maturity. Conversely, the treatments with Forte Plus F1 (T2, T3, T4) consistently exhibited a decreasing GLH population trend. Notably, by the 6th application, the population had significantly diminished, with the most marked reduction observed in T4, which received double the recommended rate of the product (Table 2). These results confirm the product's effectiveness in managing GLH populations, with its efficacy being enhanced at higher concentrations.

Table 2: Green Leaf Hopper (GLH) population counts at different levels of FORTE PLUS F1 (Dry Season, 2024)

GHS Population Counts							
TRT	39 DBTA	Treatment Application					
		1st Apln	2nd Apln	3rd Apln	4th Apln	5th Apln	6th Apln
T1	65ns	67ns	77a	86a	103a	81a	48ns
T2	66	64	53b	52	43b	32b	22
T3	63	60	51b	48bc	35b	23bc	16
T4	57	42	27c	36c	23b	12bc	12

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

Rice Leaf Folder

Actual Population Counts

The untreated control (T1) in Location 1 shows a consistent reduction in RLF population. This trend suggests that even without treatment, RLF population may naturally decrease over time as the plant grows towards maturity. Treatments T2, T3, and T4 each show more significant population reductions, with T4 demonstrating the most substantial decline, reaching zero by 60 DATA and maintaining that through 80 DATA showing the increasing effectiveness with higher concentrations of Forte Plus F1 (Table 3).

Table 3: Rice Leaf Folder population counts at different levels of FORTE PLUS F1. (Dry Season, 2024)

TRT	Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80 DATA
T1	8.75a	8.25a	7.0a	7.00a	5.5a
T2	4.0bc	3.0b	0.00	2.25b	2.00b
T3	5.75b	3.5b	1.0bc	0.5bc	0.25c
T4	3.25c	3.0b	0.25c	0.00c	0.00c

In Location 2, data collected from 40 to 80 days after treatment applications revealed a downward trend in RLF population counts in treated plots when compared to the untreated control. The control showed an initial increase in population, peaking at 60 DATA, and showed minimal population decline in damage over time (Table 4). Treatments with Forte Plus F1, at increasing concentrations, demonstrated significant reductions in RLF populations, with the most substantial control observed at the highest concentration (T4).

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	80 DATA
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

In Location 1, at 80 DATA, T1 shows the highest percentage of RLF damage (1.72%), while T2 shows considerable damage reduction (0.62%). T3 and T4 are the most effective treatments, with T3 reducing damage to 0.07% and T4 completely preventing RLF damage (Table 5). The results indicate that Forte Plus F1 is capable of significantly reducing RLF populations and damage to crops, with greater concentrations yielding more pronounced effects.

Table 5: Rice Leaf Folder damage at different levels of FORTE PLUS F1. (Dry Season, 2024)

TRT	Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80 DATA
T1	2.73a	2.57a	7.00a	1.56a	1.71a
T2	1.25bc	0.93b	0.62b	0.23b	0.62b
T3	1.79b	1.09b	0.31bc	0.07b	0.07c
T4	1.01c	0.93b	0.07c	0.00b	0.00c

Data showed a downward trend in RLF damage in Location 2 treated plots when compared to the untreated control. Then a minimal reduction in damage over time. Treatments with Forte Plus F1, at increasing concentrations, demonstrated significant reductions in RLF percentage damage, with the most substantial control observed at the highest concentration (T4). By 80 DATA, the RLF damage percentage in T4 was notably the lowest among the treatments (Table 6).

Table 6: Rice Leaf Folder damage at different levels of FORTE PLUS F1. (Dry Season, 2024)

TRT	Days after Treatment Application				
	39 DBTA	40 DATA	50 DATA	60 DATA	80 DATA
T1	2.73ns	3.04ns	3.43a	2.74a	3.28a
T2	2.58	2.03	1.48b	0.86b	0.70b
T3	2.97	1.95	0.93bc	0.62b	0.46bc
T4	3.13	1.48	0.70c	0.23b	0.15c

Yellow Stem Borer

Actual Population Counts (Number of Larva).

In Location 1, this study evaluates the impact of Forte Plus F1 on stem borer larval populations across multiple treatments and applications. Despite observed reductions in larva counts, particularly with the highest concentration (T4), the results across all treatments and time points remained statistically non-significant. This suggests that at current dosages, Forte Plus F1 did not achieved statistically significant reduction in stem borer populations compared to untreated controls (Table7).

Table 7: Rice Yellow Stem Borer population counts at different levels of FORTE PLUS F1. (Dry Season, 2024).

TRT	ENT Application				
	2nd Apln	3rd Apln	4th Apln	5th Apln	6th Apln
T1	0.00ns	3.00ns	5.50ns	5.25ns	2.00ns
T2	0.00	1.25	4.50	3.75	0.75
T3	0.00	2.00	1.75	1.75	1.00
T4	0.00	1.75	2.25	2.50	0.25

Similar results were observed in Location 2 with 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 F1 did not achieve a statistically significant reduction in stem borer populations compared to untreated controls (Table 8).

Table 8: Rice Yellow Stem Borer population counts at different levels of FORTE PLUS F1. (Dry Season, 2024).

TRT	ENT Application				
	2nd Apln	3rd Apln	4th Apln	5th Apln	6th Apln
T1	0.00ns	12.5ns	28.0ns	8.75ns	4.00ns
T2	0.00	7.25	14.75	6.50	2.50
T3	0.00	9.50	8.75	2.25	2.25
T4	0.00	1.25	4.25	0.50	1.25

Percent (%) Incidence

The results indicate that over a series of six applications, the Untreated Control (T1) reached a peak in stem borer incidence (66.12%) by the 4th application and saw a decrease by the 6th application (13.44%). The treatments with Forte Plus F1 (T2, T3, and T4) all showed an increase in efficacy with higher concentrations. By the 6th application, the incidence rates had declined to 5.74%, 2.27%, and 1.56% respectively (Table 9), suggesting that Forte Plus F1 is effective in controlling stem borer incidence, with greater concentrations resulting in lower incidences of infestation and good crop stand (Figure 9). These findings highlight the potential of Forte Plus F1 as a viable organic management strategy against stem borers.

Table 9: Rice Yellow Stem Borer incidence at different levels of FORTE PLUS F1. (Dry Season, 2024).

TRT	Treatment Application				
	2nd Apln	3rd Apln	4th Apln	5th Apln	6th Apln
T1	0.00ns	19.36ns	66.12ns	35.09a	13.44a
T2	0.00	10.78	35.96	27.47ab	5.74b
T3	0.00	7.98	10.13	11.64c	2.27b
T4	0.00	8.27	18.59	20.58bc	1.56b

Figure 5: Rice plants treated with FORTE PLUS F1 (400ml/ha).

In Location 2, initially, none of the treatments showed a statistically significant incidence of stem borers, suggesting either the insecticide takes time to affect the population, or the population has not developed significantly to be impacted by the treatment. The untreated control (T1) showed a peak in stem borer incidence at the 4th application, highlighting the vulnerability of untreated crops to stem borer infestations. In contrast, treatments involving Forte Plus F1 exhibited a reduction in stem borer incidence over time, with the greatest reduction observed in plots treated with the highest concentrations of the insecticide (T3 and T4). The data from the 6th application clearly demonstrates that higher concentrations of Forte Plus F1 significantly mitigate the incidence of stem borers, with T4 achieving the lowest incidence rate (Table 10).

Table 10: Rice Yellow Stem Borer incidence at different levels of FORTE PLUS F1. (Dry Season, 2024).

TRT	Treatment Application				
	2nd Apln	3rd Apln	4th Apln	5th Apls	6th Apln
T1	0.00	25.35ns	128.52ns	62.34a	64.17a
T2	0.00	22.82	81.44	40.62ab	21.49b
T3	0.00	18.97	56.4	28.06bc	13.98b
T4	0.00	10.28	34.17	27.77c	12.80b

5. Conclusion

Green Leaf Hopper Actual Population Counts. The comparison between the two data sets from Sta. Lucia and Lomboy sites demonstrates that Forte Plus F1 consistently reduces GLH populations across various concentrations and is most effective at higher application rates. The treatment shows a clear dose-response relationship, with T4 consistently performing the best in reducing pest populations. Despite the slight variations in population peaks, the overall trend confirms the efficacy of Forte Plus F1 in GLH population management.

Rice Leaf Folder Actual Population Counts. The consistent reduction in RLF populations across both Sta. Lucia and Lomboy sites indicates the effectiveness of Forte Plus F1 as an organic insecticide, with a clear dose-response effect observed. T4, the treatment with the highest concentration of Forte Plus F1, generally results in the lowest RLF populations at the end of the treatment period in both localities. However, the eradication of RLF is more thoroughly achieved in Sta. Lucia as compared to Lomboy, suggesting potential environmental or biological factors that may influence treatment efficacy.

Rice Leaf Folder Damage. The comparative analysis indicates that Forte Plus F1 is effective in reducing RLF damage in rice crop. There is a clear trend across both localities showing that higher concentrations of the insecticide correspond to lower percentages of damage, with the most concentrated treatment (T4) achieving near or complete control of RLF damage. Notably, while the overall trend of decreasing damage percentages is consistent, the extent of control varies between locations, which may be influenced by environmental or agronomic factors.

Yellow Stem Borer Percent (%) Incidence. These findings suggest, it's clear that Forte Plus F1 displays effectiveness in reducing stem borer incidence over time. The more pronounced decrease in the latter treatments suggests an accumulative effect of the insecticide, indicating its potential as a management strategy for the pest. However, the initial increase in Lomboy highlights the potential for varied responses in different environments or under different pest pressures, which warrants further investigation.

6. Recommendation

Green Leaf Hopper Actual Population Counts. Given the evidence of efficacy, it is recommended to incorporate Forte Plus F1 into integrated pest management strategies for rice crops. The recommended rate of application (200ml/300 li water) should be adhered to, balancing pest control with environmental stewardship. Continuous monitoring of GLH populations post-treatment is essential to ensure sustained control and prevent the development of pest resistance.

Rice Leaf Folder Actual Population Counts. It is advised to employ Forte Plus F1 at the recommended rate for economic and environmental reasons, as it provides effective control against RLF. However, the highest rate should be reserved for severe infestations or less responsive ecological settings, as seen in Lomboy. Continuous monitoring and integrated pest management strategies should be adopted to tailor treatment applications specifically to current field conditions, pest pressure, and to mitigate resistance development.

Rice Leaf Folder Damage. For optimal control of RLF, the use of Forte Plus F1 at the recommended rate is advised, with careful monitoring for any signs of resistance. Considering environmental stewardship, the lowest effective dose should be utilized. Additionally, integrating this treatment with other pest management strategies may enhance results.

Yellow Stem Borer Percent Incidence. Based on these findings, it is recommended to continue the use of Forte Plus F1 as part of an integrated pest management (IPM) strategy. It may be beneficial to investigate the cause of the initial increase in pest numbers at Lomboy to optimize application timing and rates. Furthermore, combining chemical control with other IPM practices, such as biological control and cultural methods, could enhance overall efficacy and sustainability.

References

[1] Pathak, M. D., Khan, Z. R.. 1994. Insect Pest for Rice.
[2] Shepard, B. M. 1995. Rice-Feeding Insects of Tropical Asia.
[3] IRRI, 2023. Insects - IRRI Rice Knowledge Bank. Green leaf hopper. http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/green-leafhopper
[4] IRRI, 2023. Insects - IRRI Rice Knowledge Bank. Rice bug. http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/rice-bug
[5] IRRI, 2023. Insects - IRRI Rice Knowledge Bank. Leaffolder.
[6] http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/rice-leaffolder
[7] IRRI, 2023. Insects - IRRI Rice Knowledge Bank. Stem borer.
[8] http://www.knowledgebank.irri.org/training/fact-sheets/pest-management/insects/item/stem-borer
[9] Xi'an Shengwei Technology Industry Ltd. Patent Application CNB2004100258221A and Publication of CN1299579C. https://patents.google.com/patent/CN1299579C/en
[10] Celiz, RJ R. 2018. Insecticidal Effects of Matrine Against Flower Thrips, Thrips hawaiiensis
[11] Morgan on ‘Cavendish’ banana. Journal of South Pacific Agriculture, Volume 21.
[12] Zanardi, O.Z., et. al., 2015. Bioactivity of a Matrine-based Biopesticide Against Four Pest Species of Agricultural Importance. Crop Protection. Volume 67, January 2015, Pages 160-167.
[13] Beijing Multigrass Formulation Co. Ltd. http://www.chinabaicao.com