RESEARCH ARTICLE

COMPATIBILITY OF ENTOMOPATHOGENIC FUNGI WITH IMIDACLOPRID FOR MANAGEMENT OF BROWN PLANTHOPPER, *NILAPARVATA LUGENS* STAL. (DELPHACIDAE: HEMIPTERA) IN RICE

B. Nagendra Reddy[1]*, V. Jhansi Lakshmi[2], G.S. Laha[2] and T. Uma Maheswari[1]

[1]College of Agriculture, Rajendranagar, PJTSAU, Hyderabad; [2] Indian Institute of Rice Research, Rajendranagar, Hyderabad

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Abstract: Compatibility between imidacloprid and entomopathogenic fungi studies were conducted at IIRR (Indian Institute of Rice Research), Hyderabad. Imidacloprid was tested at three concentrations viz., recommended concentration (RC), sub lethal concentration (0.5 RC) and more than recommended concentration (1.5 RC) against three entomopathogenic fungi viz., *Beauveria bassiana*, *Metarhizium anisopliae* and *Lecanicillium lecanii* (*Verticillium lecani*) by using poison food technique under laboratory conditions. Imidacloprid was harmless to *B. bassiana* and *L. lecanii* at three tested concentrations and slightly harmful to *M. anisopliae* at 1.5 RC. Combined use of imidacloprid with entomopathogenic fungi at recommended concentrations against BPH under glasshouse conditions indicating increased mortality of BPH compared to imidacloprid alone spray.

Keywords: Compatibility, Entomopathogenic fungi, *Beauveria*, *Metarhizium*, *Lecanicillium*, Planthopper

INTRODUCTION

Rice is one of the important staple food crop in the world. It is attack by number of insect pests. Among these pests brown planthopper, *Nilaparvata lugens* is a one of the destructive pest. BPH is cause direct damage by suck the sap from plant and cause yellowing and wilting (Hopper burn symptom) and indirectly by spreading two important plant viruses like rice ragged stunt virus and rice grassy stunt virus. Insecticides are the major means of managing the BPH. However, continuous use of these insecticides causing health hazards and environmental pollution, besides this it cause development of insecticide resistance in the insects. BIPM **(**Bio-intensive Integrated Pest Management) include combined use of chemical pesticides with bio pesticides such as bacteria, fungi and viruses. Therefore, the present investigation has been planned with combined use of fungal formulations and imidacloprid for managing BPH.

MATERIAL AND METHOD

Experiment was carried out to evaluate compatibility between insecticides and pathogenic fungi both in the laboratory and glasshouse.

Inhibitory studies in the laboratory (Poison food technique)

Standard poison food technique was followed to assess compatibility of the entomopathogenic fungi with various insecticides (Moorhouse *et al.*, 1992). Desired quantity of insecticide based on field application rate (recommended concentration, half recommended concentration and 1.5 recommended concentration) was added to the PDA medium (200 ml), autoclaved at 121°C (15 Psi) for 15-20 minutes in the conical flask before solidification (medium temperature 48°C) to get desired concentration and later was mixed thoroughly. The medium was then poured equally into the petriplates. Each treatment was replicated four times. Small disc (5 mm dia.) of young fungal mycelium was cut with sterile cork borer and placed aseptically in the centre of plate containing the poisoned medium. Petri plates were incubated at 27±1°C, 80±5% relative humidity. Suitable check without poison was kept for comparison under the same conditions. Diameter of the fungal colony was measured at 2, 4, 6, 8 and 10 days after inoculation (DAI) and compared with standard check. The data were expressed as percentage growth inhibition of fungi by insecticide treated PDA (Hokkanen and Kotiluoto, 1992) and calculated by the formula

$$X = \frac{Y-Z}{Y} \times 100$$

Where X, Y, Z stand for percentage growth inhibition, radial growth of the fungus in untreated check and radial growth of the fungus in poisoned medium, respectively. The pesticides were further classified in evaluation categories of 1- 4 scoring index. 1 = harmless (<20% reduction), 2 = slightly harmful (20-35% reduction), 3 = moderately harmful (35- 50% reduction), 4 = harmful (>50% reuction) in toxicity tests *in vitro* according to Hassan's classification scheme (Hassan, 1989).

Inhibitory studies under glasshouse conditions

The recommended dose of insecticides was mixed with the effective fungal commercial formulations and sprayed on to the rice plants. BPH were released on the sprayed plants and mortality was recorded at 24 hrs interval up to five days after spraying. The results were compared with those of insecticides and fungal pathogens alone by recording data on per cent mortality.

*Corresponding Author

RESULT AND DISCUSSION

Effect of Imidacloprid 17.8 SL on growth of entomopathogenic fungi

Among the three concentrations tested, 0.5 RC of imidacloprid showed least effect by recording 5.06 to 15.16 per cent reduction in growth over control. Mycelial growth of the fungal pathogens was reduced by about 5.06 – 23.36 per cent (Table. 1). Otherwise, when the concentration of insecticide was increased, it caused more reduction of mycelial growth. Present results corroborate the findings of Sahoo and Dangar (2014) who reported that the mycelial growth of *B. bassiana* and *M. anisopliae* was reduced by 12.0 and 10.4 per cent over control, respectively when treated with 0.04% imidacloprid. Among three entomopathogenic fungi, *M. anisopliae* was most affected by imidacloprid which recorded 15.16 per cent, 19.26 per cent and 23.36 per cent reduction over control at 0.5 RC, RC and 1.5 RC, respectively followed by *L. lecanii* recording 10.40 per cent, 11.88 per cent and 19.80 per cent reduction over control at 0.5 RC, RC and 1.5 RC respectively. Among the three fungi, *B. bassiana* was least affected by imidacloprid by recording 5.06 per cent, 11.24 per cent and 15.17 per cent reduction in mycelia growth over control at 0.5 RC, RC and 1.5 RC, respectively. Our findings are in conformity with the findings of Rachappa *et al.* (2007) who stated that imidacloprid was found to be safe to the fungus, *M. anisopliae* inhibiting only 11.10 per cent growth at field recommended dose. Similarly Kim and Kim (2007) reported that imidacloprid had no effect on spore germination and mycelial growth of *L. attenuatum*. Singh *et al.* (2014) also studied compatibility of *B. bassiana* with imidacloprid and reported that imidacloprid was non-toxic, moderately toxic and toxic to *B. bassiana* at 0.5 RC, RC and 2 RC, respectively. Khan *et al.* (2012) supported that imidacloprid (0.005%) was compatible with *B. bassiana* and *M. anisopliae*. According to Hassan's classification (1989), present results indicated that imidacloprid at higher dose than recommended dose was found to be slightly harmful (23.36% reduction) to *M. anisoplia.* However, imidacloprid at three concentrations was harmless (<20% reduction) against three entomopathogenic fungi.

Effect of imidacloprid 17.8 SL + entomopathogenic fungi on BPH

Imidacloprid is said to be the most effective chemical extensively used for managing brown planthopper because of which the insect has developed resistance to imidacloprid since 2003 (Matsumura *et al*. 2008, Jhansi Lakshmi *et al.,* 2010). In the present investigation, an attempt was made to study efficacy of imidacloprid alone and in combination with commercial formulations of entomopathogenic fungi, *B. bassiana*, *M. anisopliae* and *L. lecanii* at recommended dose by spraying on rice plants. The results indicate that all treatments were found significantly superior over control in reducing the pest population. One day after spraying, imidacloprid alone has recorded 22.50 per cent mortality which was on par with other combination treatments like imidacloprid + *B. bassiana* (18.75 per cent), imidacloprid + *M. anisopliae* (18.75 per cent) and imidacloprid + *L. lecanii* (18.75 per cent). Similar results were found at two days after spraying where imidacloprid alone caused 30.00 per cent mortality which was on par with imidacloprid + *B. bassiana*, imidacloprid + *M. anisopliae* and imidacloprid + *L. lecanii*, which recorded 25.00, 23.75 and 22.50 per cent mortality respectively (Table. 2). Similar trend was observed at three days after spraying recording 38.75, 36.25, 40.00 and 35.00 per cent mortality by imidacloprid, imidacloprid + *B. bassiana*, imidacloprid + *M. anisopliae* and imidacloprid + *L. lecanii*, respectively which were on par with each other and significantly superior over control. However, four days after spraying, fungal infection was observed on insects sprayed with imidacloprid + fungal pathogen which has recorded high per cent mortality (67.50 per cent) over imidacloprid alone (51.25 per cent) and control (0.0 per cent). Among the treatments, imidacloprid + *B. bassiana* has recorded maximum per cent mortality of 67.50 per cent followed by imidacloprid + *M. anisopliae* (66.25 per cent mortality) that remained on par with each other and significantly superior over imidacloprid + *L. lecanii* (55.00 per cent mortality). In combination treatments, mortality increased over time and at five days after spraying, imidacloprid + *B. bassiana* combination was found to be best with highest per cent mortality of 80.00 per cent followed by imidacloprid + *M. anisopliae* (77.50 per cent) and imidacloprid + *L. lecanii* (70.00 per cent) which were on par with each other. Imidacloprid alone has recorded 55.00 per cent mortality that was on par with imidacloprid + *L. lecanii* (70.00 per cent mortality). In the present investigation, at five days after spraying imidacloprid + *B. bassiana* (80.00 per cent), imidacloprid + *M. anisopliae* (77.50 per cent) and imidacloprid + *L. lecanii* (70.00 per cent) treatments have recorded highest per cent mortality compared to imidacloprid alone spray which recorded 55.00 per cent mortality only.

Based on prior laboratory results obtained (Table. 1) on harmless nature of imidacloprid and glasshouse results (Table. 2), it could be suggested that under field conditions, imidacloprid at recommended dose could be mixed with *B. bassiana*, *M. anisopliae* and *L. lecanii* and mortalities ranging from 70.0 to 80.0 per cent could be expected after five days of spraying.

Table 1. Effect of imidacloprid 17.8SL on growth of entomopathogenic fungi

Fungus	0.5 Recommended Concentration		Recommended Concentration		1.5 Recommended Concentration		Untreated Control Radial growth (cm)	Mean
	Radial growth (cm)	Inhibition (%)	Radial growth (cm)	Inhibition (%)	Radial growth (cm)	Inhibition (%)		
B. bassiana	4.23	5.06	3.95	11.24	3.78	15.17	4.45	4.10[c]
M. anisopliae	5.18	15.16	4.93	19.26	4.68	23.36	6.10	5.22[a]
L. lecanii	4.53	10.40	4.45	11.88	4.05	19.80	5.05	4.52[b]
Mean	4.64[b]		4.44[b]		4.17[c]		5.20[a]	
CV (%)	5.35							
LSD (5%)								
Fungus	0.17							
Concentration	0.21							

Means with same letter are not significantly different at 5% level by DMRT
RC- Recommended Concentration

Table 2. Effect of imidacloprid 17.8 SL in combination with entomopathogenic fungi on BPH

Treatment	Mortality (%)				
	1 DAS	**2 DAS**	**3 DAS**	**4 DAS**	**5 DAS**
Imidacloprid 17.8SL @ 0.4 ml/l	22.50 (28.31)[a]	30.00 (33.20)[a]	38.75 (38.48)[a]	51.25 (45.70)[b]	55.00 (47.85)[b]
Imidacloprid 17.8SL @ 0.4 ml/l + *B. bassiana* @ 5g/l	18.75 (25.65)[a]	25.00 (29.99)[a]	36.25 (37.00)[a]	67.50 (55.22)[a]	80.00 (63.41)[a]
Imidacloprid 17.8SL @ 0.4 ml/l + *M. anisopliae* @ 5g/l	18.75 (25.65)[a]	23.75 (29.15)[a]	40.00 (39.21)[a]	66.25 (54.46)[a]	77.50 (61.66)[a]
Imidacloprid 17.8SL @ 0.4 ml/l + *L. lecanii* @ 5g/l	18.75 (25.65)[a]	22.50 (28.31)[a]	35.00 (36.21)[a]	55.00 (47.89)[b]	70.00 (56.77)[ab]
Control	0.00 (0.00)[b]	0.00 (0.00)[b]	0.00 (0.00)[b]	0.00 (0.00)[c]	1.25 (6.42)[c]
CD (0.05%)	**4.7**	**5.21**	**4.87**	**6.15**	**9.63**
SE(m)	**1.54**	**1.71**	**1.6**	**2.02**	**3.17**

Means with same letter are not significantly different at 5% level by DMRT
DAS- Days after spraying

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REFERENCES

Hassan, S.A. (1989). Testing methodology and the concept of the IOBC/WPRS working group. Pp. 1-8. In: Jepson, P.C.(Ed.). Pesticides and Non-target invertebrates. Intercept, Wimborne, Dorset.

Hokkanen, H.M.T and Kotiluoto, R. (1992). Bioassay of the side effects of pesticides on *Beauveria bassiana* and *Metarhizium anisopliae*: standardized sequential testing procedure. *IOBC/WPRS Bull*. 11(3): 148-151.

Jhansi Lakshmi, V., Krishnaiah, N.V and Katti, G.R., Pasalu, I.C and Vasanthabhanu, K. (2010c). Development of insecticide resistance in rice brown planthopper and whitebacked planthopper in Godavari delta of Andhra Pradesh. *Indian Journal of Plant protection*. 38(1): 35-40.

Kim, J.J and Kim, K.C. (2007). Compatibility of Entomopathogenic fungus *Lecanicillium attenuatum* and Pesticides to control Cotton Aphid, *Aphis gossypii*. *International Journal of Industrial Entomology*. 14(2): 143-146.

Matsumura, M., Hiroaki, T., Satoh, M., Morimura, S.S., Otuka, A., Tomonari, W and Thanh, D.V. (2008a). Current status of insecticide resistance in rice planthoppers in Asia. Paper presented at international Planthopper conference organized by International Rice Research Institute, Los Banos, Philippines, June, 23-25, 2008.

Moorhouse, E.R., Gillsepie, A.T., Sellers, E.K and Charnley, A.K. (1992). Influence of fungicides and insecticides on the entomogenous fungus, *Metarhizium anisopliae*, a pathogen of the vine weevil, *Otiorhynchus sulcatus*. *Biocontrol Science and Technolnology*, 82: 404 – 407.

Rachappa, V. Lingappa, S and Patil, R.K. (2007b). Effect of agrochemicals on growth and sporulation of *Metarhizium anisopliae* (Metschnikoff) Sorokin. *Karnataka Journal of Agricultural Sciences*. 20(2): 410-413.

Sahoo, B and Dangar, T. K. (2014). Compatibility of some fungal entomopathogens of rice leaf folder (*Cnaphalocrocis medinalis* Guinee) with selected chemical insecticides. *Journal of Microbiology and Biotechnology Research*. 4 (4):1-7.

Singh, R.K., Vats, S., Singh, B and Singh, R.K. (2014). Compatibility analysis of entomopathogenic fungi *Beauveria bassiana* (NCIM No-1300) with several pesticides. *Research Journal of Pharmaceutical, Biological and Chemical Sciences*. 5(1): 837- 844.