Original Research Article

Efficacy of newer insecticide molecules for the management of emerging pests of Rice in Cauvery delta zone of Tamil Nadu, India

ABSTRACT

Seven insecticides including Azadirachtin and untreated control were evaluated in field condition against emerging pests of Rice *viz*., Rice hispa, *Dicladispa armigera*, (Oliver), (Chrysomelidae: Coleoptera), Whorl maggot, *Hydrellia sasakii* Yuasa and Isitani (Diptera: Ephydridae) and Rice black bug, *Scotinophara lurida (*Burmeister*)*,(Pentatomidae: Hemiptera) during 2019 and 2020 at Tamil Nadu Rice Research Institute, Aduthurai. All the tested newer insecticide molecules were effective against the above mentioned emerging pests of Rice. Two sprays at 35 and 75 days after transplating (DAT) of Chlorantraniliprole 18.5 % SC @ 150ml/ha reduced highest incidence of hispa, whorl maggot and black bug (91.80, 92.25, 84.51 per cent reduction over control) followed by Clothianidin 50 WDG @ 40g/ha (88.46, 89.60 and 83.39 per cent reduction over control). Higher yield was recorded from Chlorantraniliprole 18.5 % SC (6075 kg/ha) treated plots followed by Clothianidin 50 WDG @ 40ml/ha (5950 kg/ha). Cost benefit analysis showed that Chlorantraniliprole 18.5 % SC @ 150ml/ha spray was the most viable treatment by recording the highest cost benefit ratio of 1: 3.17. Chlorantraniliprole 18.5 % SC @ 150ml/ha recorded more number of spiders and coccinellids (1.51 and 1.75 no./plant) followed by Carbosulfan 25% EC @ 1000ml/ ha (1.40 and 1.75 no./plant) which was onpar with control (2.98 and 2.88 no./plant).

Key words: Rice hispa, *Dicladispa armigera*, Whorl maggot, *Hydrellia sasakii,* Rice black bug, *Scotinophara lurida*, Chlorantraniliprole 18.5 % SC, Rice, *Oryza sativa*

1. Introduction

Rice, *Oryza sativa* (Linnaeus) is the principle cereal crop and being the staple food for more than 65 per cent of the world population, (Mathur, 1999). It is cultivated in almost all the tropical, subtropical and temperate countries of the world. Rice is the staple food for more than two thirds of the Indian population contributing to 40 % of the total food grain production. In India it is grown in about 43million hectares (m ha) and produced a record of 127.93 million tones of rice during 2021-22 (https://www.icar-iirr.org/index.php/en/). Sudden occurrence of pest and diseases at different stages of the crop growth is the one of the major constraints of rice production and low productivity in India. The rice plant is subject to attack by more than 100 species of insects and 20 of them can cause economic damage (Pathak and Khan, 1994). Among the minor pests, Rice hispa, *Dicladispa armigera*, (Oliver), Chrysomelidae: Coleoptera, a coleopteran pest, is problem in specific rice ecologies *viz*., irrigated paddy fields as well as lowland rice cultivation in Tamil Nadu (Fig 1), West Bengal, Assam and North-East Indian states (Partha Pratim Bhattacharjee and Ray, 2012). This pest causes extensive damage to the vegetative stage of plant resulting 35-65% loss in yield throughout Assam (Dutta and Hazarika, 1992).

The reasons for the outbreak of the minor pests are extensive cultivation of high yielding varieties, growing of susceptible varieties, monocropping which is providing constant niches for pest multiplication, indiscriminate use of fertilizers, particularly application of high levels of nitrogen, non-judicious use of insecticides resulting in pest resistance to insecticides, and resurgence of pests and out breaks of minor pests (Sain and Prakash, 2008; Prakash *et al*., 2014). Major pests such as plant hoppers, stem borer and leaf folders have consistently posed serious challenges in rice cultivation. Some less significant pests such as Rice hispa, Whorl maggot and Black bug *etc*. due to their suddenness of occurrence and spread, have resulted in panic actions by rice farmers to protect their crops at any cost.

Loss due to Whorl maggot, *Hydrellia sasakii* Yuasa and Isitani (Diptera: Ephydridae) is of 30% and resulted in stunted root growth which results in poor nutrient uptake and reduced photosynthesis interfering with carbohydrate metabolism (Shepard *et al*. 1990 and Ramamurthy *et al*. 1977). Past few years, the farmers of Cauvery delta zone (Rice bowl of Tamil Nadu) are facing the problem of whorl maggot and they are loading the field with many chemicals to control this emerging pest (Fig 3).

Rice black bug, *Scotinophara lurida* (Burmeister), (Pentatomidae: Hemiptera) damages rice plants by sucking the sap from stem. The heavily infested field plants turn yellowish brown and death of plants causing characteristic ‘bug burned’ areas. In Tamil Nadu sporadic but severe outbreak of the pest was reported by Sundarababu *et al*., (1984), Uthamasamy and Mariappan (1985) and Anandhi and Pillai, (2008). Rice black bug is an emerging insect pest on rice in Cauvery Delta region from 2013 to 2018. *S. lurida* was monitored using light trap at Aduthurai during kharif 2013-2021 indicated that their peak populations (nos/trap/week) was as high as 60083, 23808, 6564, 9023, 15946, 14791, 15633, 29161 and 6049 in respect of 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020 and 2021. The peak abundance of *S. lurida* was higher whenever pre-kharif abundance was high (Fig 2). The farmers of this region got annoyed due to the sudden incidence of Black bug and applying many pesticides to control this emerging pest (AICRIP Rice Annual Report, 2015- 17).

Sparks (2013) opined that the need for more selective insecticides was one of the key themes during the evolution of poison free management of insect-pests. The use of selective chemical insecticides, in combination with an effective natural enemy provided more comprehensive prophylactic and remedial treatment than single approach (Gentz *et al.*, 2010). For the management of the above pests more chemical insecticides have been used since many years back by the local farmers of the Cauvery delta zone of Tamil Nadu, though no literature is available from the delta zone so far. Hence, the newer chemicals for the above emerging pests, economics and safer to natural enemies are to be tested and published.

2. Materials and Methods

Field experiments were conducted at Tamil Nadu Rice Research Institute, Aduthurai during 2019 and 2020 to evaluate the efficacy of newer insecticides (Clothianidin 50 WDG @ 40g/ha; Thiamethoxam 25 WG @ 100g/ha; Carbosulfan 25% EC @ 1000ml/ha; Chlorantraniliprole 18.5% SC @ 150ml/ha, Diafenthiuron 50 WP@ 600g/ha Azadirachtin 10000ppm @ 1000ml/ha; Untreated check) against emerging pests and its impact on natural enemies in rice. The trial was laid out in a randomized block design with three replications. ADT 49 was used as a test variety and transplanted at a spacing of 20 x 15 cm. Treatments were imposed at 35 and 75 days after transplanting. Observations on the emerging pests were taken at ten randomly selected plants per plot from each replication at 50 and 90 days after transplanting. Spider and coccinellid population also calculated from each plant randomly after first and second spray of the insecticides. Grain yield was recorded in each plot after harvest and converted into kg/ha. The per cent incidence of Rice hispa, whorl maggot and black bug damage was calculated and transformed into arc sine for statistical analysis.

3. Results and Discussion

The results revealed that all the treatments were significantly reduced the per cent infestation of the Rice hispa, whorl maggot and black bug damage when compared to control and at the same time significant increase in grain yield also recorded due to application of insecticides. Two spray of Chlorantraniliprole 18.5 % SC @ 150ml/ha reduced the incidence of hispa, whorl maggot and black bug (91.80, 92.25, 84.51 per cent reduction over control) followed by Clothianidin 50 WDG @ 40g/ha (88.46, 89.60 and 83.39 per cent reduction over control). Azadirachtin 10000ppm @ 1000 ml/ha recorded 66.48, 62.23 and 61.95 per cent reduction over control of hispa, whorl maggot and black bug (Table 1).

Highest yield was recorded from Chlorantraniliprole 18.5 % SC (6075 kg/ha) treated plots followed by Clothianidin 50 WDG @ 40ml/ha (5950 kg/ha). Cost benefit analysis of the different newer insecticides revealed that the application of Chlorantraniliprole 18.5 % SC @ 150ml/ha was the most economically viable treatment by recording the highest cost benefit ratio of 1: 3.17 followed by Thiamethoxam 25 WG @ 100 g/ ha (1: 3.14). The reasons for the highest cost benefit ratio (CBR) was the fact that the treatment Chlorantraniliprole 18.5 % SC @ 150ml/ha recorded the maximum yield and treatment Thiamethoxam 25 WG @ 100 g/ ha recorded not only the maximum yield but also low cost as compared to others. The CBR in descending order was Diafenthiuron 50 WP @ 600 g/ ha (3.12) followed by Carbosulfan 25% EC @ 1000ml/ ha (3.03), Azadirachtin 10000ppm @ 1000 ml/ha (2.89) and Clothianidin 50 WDG @ 40 g/ ha (2.77) (Table 2).

All the tested new chemicals were on par in reduction of the above emerging pests. Impact of the above chemicals on natural enemies *viz*., coccinellids and spiders were identified (Table 3). Chlorantraniliprole 18.5 % SC @ 150ml/ha recorded more number of spiders and coccinellids (1.51 and 1.75 no./plant) followed by Carbosulfan 25% EC @ 1000ml/ ha (1.40 and 1.75 no./plant) which was onpar to control (2.98 and 2.88 no./plant). Minimum reduction over control of coccinellids (49.32) and spiders (39.23) were recorded from Chlorantraniliprole 18.5 % SC and Carbosulfan 25% EC treated plots. Singh *et al.* (1992) reported that fenvalerate, cypermethrin and monocrotophos reduced the rice hispa effectively and increased the grain yield over untreated control. However the reported chemicals synthetic pyrethroids and organochlorines, which are very toxic and causing resurgence in rice field. Litsinger *et al*., (2022) reported excellent control of rice whorl maggot lasted up to 28 days after treatment with carbosulfan 25 EC, benfuracarb 40 F, carbofuran 12 F, and furathiocarb 40 EC. Carbosulfan 25 EC effectiveness against rice whorl maggot is corroborated with our findings. Ovicidal effect of some insecticides against rice black bug was reported by Anandhi and Pillai, (2006) also reported the same finding.

4. Conclusions

Many years pesticides have proved to be a boon for the rice growing delta farmers of Tamil Nadu as well as throughout the world by increasing yield and by innumerable benefits to the society directly. Hence, the eco- friendly effective chemicals identified from this study can be recommended to manage the emerging pests of Rice.

Table 1 Effect of newer insecticide molecules on emerging pests in Rice (Pooled observations 2019 & 2020)
(Mean of three replications)

Treatments	Damaged Leaves_50 DAT (after first application) (% incidence)						Damaged Leaves_90 DAT (after second application) (% incidence)				% reduction over control		
	5 DAT			14 DAT			5 DAT		14 DAT				
	Hispa	WM	Black bug	Hispa	WM	Black bug	WM	Black bug	WM	Black bug	Hispa	WM	Black bug
Clothianidin 50 WDG @ 40 g/ ha	3.50 (10.41)	4.25 (7.95)	6.50 (14.28)	7.00 (15.01)	6.50 (12.64)	8.39 (15.01)	3.00 (9.61)	6.10 (13.97)	5.25 (12.91)	8.83 (16.80)	88.46	89.60	83.39
Thiamethoxam 25 WG @ 100 g/ ha	8.25 (16.32)	7.5 (14.93)	4.09 (11.28)	10.25 (18.41	9.80 (15.55)	11.00 (12.64)	9.50 (17.49)	4.6 (11.70)	11.25 (19.29)	6.00 (13.68)	79.67	79.21	85.69
Carbosulfan 25% EC @ 1000ml/ ha	5.0 (12.547.5)	5.5 (12.96)	8.5 (15.14)	6.75 (13.60)	8.00 (15.01)	10.50 (18.96)	4.40 (11.50)	7.75 (15.37)	7.00 (14.94)	9.00 (18.56)	87.0	86.38	80.09
Chlorantraniliprole 18.5% SC @ 150 ml/ ha	2.08 (8.16)	3.77 (11.85)	6.46 (14.41)	5.39 (7.98)	5.89 (11.28)	7.50 (15.01)	2.25 (7.27)	6.60 (12.72)	2.27 (12.61)	7.25 (15.32)	91.80	92.25	84.51
Diafenthiuron 50 WP @ 600 g/ ha	7.05 (15.14)	8.55 (16.48)	7.55 (15.51)	8.86 (17.41)	10.0 (17.08)	9.00 (15.02)	6.75 (14.21)	8.20 (16.12)	8.00 (16.09)	10.00 (17.95)	82.52	81.79	80.65
Azadirachtin 10000ppm @ 1000 ml/ha	12.5 (20.26)	16.0 (23.27)	15.05 (19.43)	18.0 (21.33)	21.00 (26.77)	16.50 (22.33)	15.00 (21.83)	17.50 (22.84)	17.05 (19.85)	19.25 (25.61)	66.48	62.23	61.95
Untreated check	40.0 (38.83)	52.5 (29.19)	41.00 (31.14)	51.00 (43.30)	57.00 (54.37)	45.50 (33.30)	34.00 (35.94)	35.50 (37.29)	39.50 (36.45)	57.50 (49.60)	-	-	-
SE.D	**3.85**	**5.57**	**3.9**	**5.22**	**5.90**	**1.8**	**4.60**	**4.16**	**2.96**	**4.95**	**-**	**-**	**-**
CV	**25.02**	**32.40**	**21.61**	**28.11**	**29.83**	**11.8**	**30.96**	**25.10**	**19.80**	**24.57**	**-**	**-**	**-**
CD (p = 0.05)	**7.7**	**11.33**	**10.78**	**10.48**	**11.58**	**3.9**	**9.02**	**8.35**	**6.33**	**9.95**	**-**	**-**	**-**

DAT- Days after treatments; Figures in parentheses are arc sine transformed values.

Table 2. Economics of newer insecticide molecules on emerging pests in Rice (Pooled observations 2019 & 2020)

(Mean of three replications)

S. No	Treatments	Grain yield Kg/ha	Yield increase over control (%)	Net Income (Rs./ha)	Cost benefit ratio (C:B)
1.	Clothianidin 50 WDG @ 40 g/ ha	5950	52.17	64576	2.77
2.	Thiamethoxam 25 WG @ 100 g/ ha	5800	48.33	79070	3.14
3.	Carbosulfan 25% EC @ 1000ml/ ha	5637	44.16	75520	3.03
4.	Chlorantraniliprole 18.5% SC @ 150 ml/ ha	6075	55.37	83220	3.17
5.	Diafenthiuron 50 WP @ 600 g/ ha	5725	46.41	77820	3.12
6.	Azadirachtin 10000ppm @ 1000 ml/ha	5250	34.27	68720	2.89
7.	Untreated check	3910		42870	2.21
	SE.D	**180.7**			
	CV	**3.64**			
	CD (p = 0.05)	**364.4**			

Cost of insecticides and sale price of rice were considered as per local markets of Aduthurai

Table 3. Effect of newer insecticide molecules on Beneficial insects in Rice

(Pooled observations 2019 & 2020) (Mean of three replications)

Treatments	Spiders (no./ plant)			Coccinellids (no./ plant)			% reduction over control	
	I Application	II Application	mean	I Application	II Application	mean	Spiders	Coccinellids
Clothianidin 50 WDG @ 40 g/ ha	0.64 (0.77)	1.22 (1.10)	0.93	0.84 (0.90)	1.0 (1.0)	0.92	68.79	65.77
Thiamethoxam 25 WG @ 100 g/ ha	0.80 (0.88)	1.45 (1.17)	1.12	0.75 (0.85)	1.37 (1.13)	1.06	62.40	61.07
Carbosulfan 25% EC @ 1000ml/ ha	0.79 (0.88)	2.01 (1.38)	1.4	1.25 (1.10)	2.26 (1.48)	1.75	53.02	39.23
Chlorantraniliprole 18.5% SC @ 150 ml/ ha	0.98 (0.99)	2.04 (1.09)	1.51	1.50 (1.20)	2.0 (1.39)	1.75	49.32	39.23
Diafenthiuron 50 WP @ 600 g/ ha	0.48 (0.67)	1.12 (1.09)	0.8	0.62 (0.76)	1.50 (1.20)	1.06	73.15	63.19
Azadirachtin 10000ppm @ 1000 ml/ha	1.97 (1.40)	2.3 (1.49)	2.13	1.92 (1.36)	2.26 (1.48)	2.09	28.52	27.43
Untreated check	2.55 (1.58)	3.42 (1.82)	2.98	2.75 (1.64)	3.01 (1.70)	2.88	-	-
SE.D	**1.71**	**1.18**	**-**	**1.88**	**1.28**	**-**	-	-
CD (p = .05)	**0.20**	**0.22**	**-**	**0.13**	**0.12**	**-**	-	-

Fig 1- Rice hispa, *Dicladispa armigera*, (Oliver), (Chrysomelidae: Coleoptera) & damage symptom

Fig 2- Rice black bug, *Scotinophara lurida* (Burmeister), (Pentatomidae: Hemiptera) & damage symptom

Fig 3- *Hydrellia sasakii* Yuasa and Isitani (Diptera: Ephydridae) & damage symptom

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