Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(5): 147-151

Received: 15-08-2020
Accepted: 17-09-2020

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Effect of chemical insecticides on the incidence of rice hispa (*Dicladispa armigera*) in terms of leaf damage (LDH %)

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Abstract
The rice hispa (*Dicladispa armigera*) is a sporadic and occasional leaf feeding pest of rice. It is a one of those pests whose infestation has increased a lot in recent years. Present experiment was carried out to determine the relative bio efficacy of some newer insecticides against rice hispa. Among the nine insecticides application of Spinetoram 6SC+Methoxyfenozide 30SC @400 ml/ha was found to be most effective. But it was at par with Spinetoram 6%SC+ methoxyfenozide 30% SC@ 375ml/ha (0.74%). The highest damage of 7.14% LDH was observed in case of untreated crop of rice. The peak duration of the occurrence of rice hispa was almost from 25 days and onward period during both of years of the experimentation.

Keywords: Rice hispa, *Dicladispa armigera*, bio efficacy, newer insecticides

Introduction
Rice (*Oryza sativa* L.) is a principal source of food for more than half of the world population. It provides 20% of the world's dietary energy supply. The cultivation of rice provides income and employment to more than 100 million households in Asia and Africa [1]. During 2015-2016, the global rice production touched 474.02 million tons. Approximately 52% of the global production of rice is lost annually owing to the damage caused by biotic factors [2]. More than 100 species of insect pests attack the rice crop in vegetative and reproductive stages, however only one fourth of it is considered as serious pests. India has the world's largest area under rice cultivation with 44.0 million ha and is the second largest producer (105.6 million tonnes) next only to China**.** It contributes 21.5 percent of global rice production**.** India grows rice at 11% of the total world's agricultural area. The productivity of rice in India is 2.27 tonne/ha [3]. Insecticides are used as a major crop-protection tactics in managing pests of rice, *Oryza sativa* L. (Chelliah and Bharathi, 1994) [4] with worldwide use estimated at $1.14 billion in 1996 (International Rice Research Institute World Rice Statistics). Rice hispa is a sporadic and occasional leaf feeding pest. Incidence of Rice hispa generally occurs before flowering. Average loss of crop yield caused by rice hispa varied from 6-65%. Some insecticides are successful in reducing the population of rice hispa as it's life cycle is quite safeguarded [5]. Therefore, rice farmers have to necessarily choose an insecticide which could be effective against all these insect pests. Presently sprays of organophosphates like monocrotophos (500 g a.i./ha) or acephate (750 g a.i./ha) are the only choice of the rice farmers under these conditions. Several workers (Panda *et al.*, 2002; Misra and Parida, 2004; Raghu Ramudu and Misra, 2006; Sahithi and Misra, 2006 and Misra, 2010) [6, 7, 8, 9, 10] have suggested various insecticides for the rice pest. Dhaliwal *et al.*, (1983) [11] found hispa incident to be increased with increased nitrogen level from 0-100 kg/ha. Basu and Banerjee (1957) [12] showed that rice plants just after transplanting were found to be more prone to hispa damage than other stages of crop. However, Sontakke *et al.* (1999) [13] reported that the efficacy of insecticides was the highest when applied at the tillering and reproductive stage of rice crop.About 300 species of insect pests attack the rice crop at different stages and among them only 23 species cause serious damage [14]. Hence, it is essential to manage these insect pests. Thus by using this new type of insecticide we can enhance the production of rice significantly and get rid of the problem of environmental pollution and pest outbreak to a great extent.

Methods and Materials

In order to evaluate field bio-efficacy of newer molecules of different insecticides against hispa of rice, a field trial was conducted at Rice research farm, RAC, B.A.U, Kanke, Ranchi, Jharkhand during *kharif*, 2016 and 2017.Treatment application: Periodical and need based application of the respective test insecticidal treatments were applied based on the ETL of the pest species at the different stages of the crop. Observations on pest incidence were be recorded at 4th, 7th, & 10th days after insecticidal application (DAA)

Table 1: Detail of the field experiment, conducted during *kharif*, 2016 and 2017

Design Insecticidal treatments:	**:**	**RBD (Randomized block design)10**
Replications	:	3
Spacing (plant to plant)	:	15 cm
Spacing (row to row)	:	20 cm
Plot size	:	5 x 4 m
N:P:K	:	80:40:20 ka/ha (As per local recommendation)
Date of sowing	:	3rd July
Date of transplanting	:	22th July
Date of insecticide application	:	25 DAT
Date of harvesting	:	7th November
Crop variety	:	Naveen

Table 2: Treatment details of field bio-efficacy of some selected commercial formulations of newer molecules of chemical insecticide against major insect-pests of rice:

Treatments	**Trade name**	**Common Name**	**% a.i. in formulations**	**Dose of the formulated product (ml or g /ha)**	**Dose ml or g/l of water**
T 1	Spinetoram 6SC + methoxyfenozide 30SC	Spinetoram 6SC + methoxyfenozide 30SC	36SC	375 ml	0.75 ml
T 2	Spinetoram 6SC + methoxyfenozide 30SC	Spinetoram 6SC + methoxyfenozide 30SC	36SC	400 ml	0.80ml
T 3	DPX-RAB55	Triflumezopyrim	106SC	238 ml	0.475 ml
T 4	Fame	Flubendiamide 480 SC	48SC	50 ml	0.10 ml
T 5	Coragen	Rynaxypyr	20SC	150 ml	0.30 ml
T 6	Hunk	Acephate	95SG	526 g	1.053
T 7	Osheen	Dinotefuran	20 SG	200g	0.40 g
T 8	Hostathion	Triazophos	36SL	1500 ml	3 ml
T 9	Furadan + Hostathion (in form of alternate use)	Carbofuran + triazophos (in form of alternate use)	3G+40EC	30kg+1500ml	30kg+ 3 ml
T 10	Untreated control	-	--	-	-

Result and Discussion

The result is presented in Table -3. The observations of the leaf damage, caused by hispa, (LDH) were noticed in the middle vegetative stage of the crop. As such, observations on per centage of leaf damage, due to hispa (LDH %) was recorded at 4, 7 & 10 DAA (days after application) during *Kharif* 2016 and 2017. Peak duration of occurrence of hispa was observed almost from 25 DAT and onward period during both of years of the experimentations.

a) Incidence of leaf damage (LDH) recorded at 4 days after application (4 DAA)

i) Incidence of LDH recorded at 4 DAA, during 2016

At 4 DAA, the experimental data of insecticides used against rice hispa in terms of leaf damage were found to be statistically significant. The minimum leaf damage (0.44% LDH) was found in terms of leaf damage in the treatment comprising of the new combination product spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which was found superior over all the test insecticides, but it was found to be at par with its own lower dose of spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.50% LDH). The highest leaf damage of 5.57 per cent was observed in case of unprotected crop of rice (var. Naveen).

ii) Incidence of LDH recorded at 4 DAA, during 2017

At 4 DAA, the experimental data of insecticides used against rice hispa in terms of leaf damage LDH remained recorded statistically significant (Table 4.5.1). The minimum damage was found in terms of leaf damage (0.72% LDH) in case of the combination product of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which was statistically superior among all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.78% LDH), flubendiamide 48SC @ 50 ml/ha (0.88% LDH) and carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40EC @ 1500 ml/ha (1.01% LDH). The highest leaf damage of 5.85 per cent LDH was observed in case of the unprotected crop of rice.

iii) Pooled mean value of incidence of LDH recorded at 4 DAA, during 2016 and 2017

The pooled data of insecticides used against rice hispa in terms of leaf damage could be able to realize significant results. The minimum damage was found in terms of leaf damage 0.58 per cent LDH in the treatment of the new combination of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which in turn remained superior over all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.64% LDH) and flubendiamide 48SC @ 50 ml/ha (0.74% LDH). The highest leaf damage of 5.71 per cent was observed in untreated control plot.

b) Incidence of leaf damage (LDH) recorded at 7 days after application (7 DAA)

i) Incidence of LDH recorded at 7 DAA, during 2016

At 7 DAA, the data on the impact of insecticides used against rice hispa in terms of leaf damage (LDH) were found to be statistically significant. The minimum leaf damage (0.56% LDH) was found in terms of leaf damage in the treatment consisting of the new combination product of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which remained superior among all the test insecticides, but it was found to be at par with the lower dose of spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.64% LDH), flubendiamide 48SC @ 50 ml/ha (0.74% LDH), carbofuran 3G @ 30 kg/ha followed by need based foliar spray of triazophos 40EC @ 1500 ml/ha (0.85% LDH) and acephate 95SG @ 526g/ha (0.94% LDH). The highest leaf damage of 7.20 per cent LDH was observed in case of the untreated crop of rice (var. Naveen).

ii) Incidence of LDH recorded at 7 DAA, during 2017

At 7 DAA, the experimental data on the impact of the test insecticides used against rice hispa in terms of leaf damage LDH were found to be significant. The minimum damage was found in terms of leaf damage (0.92% LDH) in case of the combination product of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which was statistically superior among all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (1.00% LDH), flubendiamide 48SC @ 50 ml/ha (1.10% LDH), carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40EC @ 1500 ml/ha (1.21% LDH) and acephate 95SG @ 526g/ha (1.30% LDH). The highest leaf damage of 7.56 per cent LDH was observed in case of the unprotected crop of rice (var. Naveen).

iii) Pooled mean incidence of LDH recorded at 7 DAA during 2016 and 2017

The pooled experimental data on the impact of the insecticides used against rice hispa in terms of leaf damage (LDH) was found to be significant. The minimum damage was found in terms of leaf damage (0.74% LDH) in the combination product of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which in turn remained superior over all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.82% LDH) and flubendiamide 48SC @ 50 ml/ha (0.92% LDH). The highest leaf damage of 7.38 per cent LDH was observed in unprotected rice crop.

c) Incidence of leaf damage (LDH) recorded at 10 days after application (10 DAA)

i) Incidence of LDH recorded at 10 DAA, during 2016

At 10 DAA, the data on the impact of the insecticides used against rice hispa in terms of leaf damage (LDH) were found to be statistically significant. The minimum damage was found in terms of leaf damage (0.74% LDH) in the treatment of combination of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which remained superior among all the test insecticides, but it was found to be at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.83% LDH), flubendiamide 48SC @ 50 ml/ha (0.92% LDH) and carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40EC @ 1500 ml/ha (1.11% LDH). The highest leaf damage of 8.11 per cent was observed in case of the unprotected crop of rice (var. Naveen).

ii) Incidence of LDH recorded at 10 DAA, during 2017

At 10 DAA, the impact of the test insecticides used against rice hispa in terms of leaf damage (LDH) was found to be significant. The minimum leaf damage 1.19 per cent LDH were found in terms of leaf damage in the treatment consisting of the ready mix combination of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which was significantly superior among all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (1.29% LDH), flubendiamide 48SC @ 50 ml/ha (1.37% LDH), carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40EC @ 1500 ml/ha (1.56% LDH) and acephate 95SG @ 526g/ha (1.70% LDH). The highest leaf damage of 8.56 per cent LDH was observed in case of the untreated crop of rice.

iii) Pooled mean incidence of LDH recorded at 10 DAA, 2016 and 2017

The impact of the test insecticides against rice hispa in terms of leaf damage (LDH) was found to be significant. The minimum damage were found in terms of leaf damage 0.97 per cent LDH in the treatment of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which was superior over all the test insecticides, but was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (1.06% LDH) and flubendiamide 48SC @ 50 ml/ha (1.15% LDH). The highest leaf damage of 8.34 per cent LDH was observed in case of untreated crop.

d) Overall mean of leaf damage (LDH) recorded at 4, 7 and 10 days after application (DAA)

i) Mean LDH recorded at 4, 7 and 10 DAA during 2016

Overall mean LDH of three dates of observations (4, 7 & 10 DAA), the data on the impact of the insecticides used against rice hispa in terms of leaf damage (LDH) was found to be significant. The minimum damage were found in terms of leaf damage (0.58% LDH) in the treatment comprising of the readymade new combination product of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which remained superior among all the test insecticides, but it was found to be almost at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.66% LDH), flubendiamide 48SC @ 50 ml/ha (0.75% LDH) and carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40EC @ 1500 ml/ha (0.89% LDH). The highest leaf damage of 6.96 per cent LDH was observed in case of the unprotected crop of rice.

ii) Mean of LDH recorded at 4, 7 and 10 DAA, during 2017

Overall mean of LDH recorded at the three date's observations (4, 7 & 10 DAA), the impact of the test insecticides used against rice hispa in terms of leaf damage was found to be significant. The minimum damage was found in terms of leaf damage 0.94 per cent LDH in case of the new combination product of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which was statistically superior among all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (1.02% LDH), flubendiamide 48SC @ 50 ml/ha (1.12% LDH) and carbofuran 3G @ 30 kg/ha followed by need based foliar spray with triazophos 40EC @ 1500 ml/ha (1.26% LDH). The highest leaf damage of 7.33 per cent LDH was observed in case of the unprotected crop of rice.

iii) Pooled mean of LDH recorded at 4, 7 and 10 DAA, during 2016 and 2017

Overall mean results of the three dates observations (4, 7 & 10 DAA), in terms of leaf damage was found to be significant. The minimum damage was found in terms of leaf damage 0.76 per cent LDH in case of the readymade combination of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which in turn was superior among all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.84% LDH) and flubendiamide 48SC @ 50 ml/ha (0.94% LDH). The highest leaf damage of 7.14 per cent LDH was observed in case of untreated crop.

Earlier, various scientists evaluated the bioefficacy of different chemical insecticide against hispa in rice at different locations of the country. The findings of the present investigation are more or less in agreement with Kaul and Sharma (1999) [15] as they found that foliar spray with chlorpyriphos 20 EC @ 2.5 lit/ha proved to be highly effective against hispa and leaf folder infesting rice (var. Kasturi Basmati). The results of Prasad and Prasad (2011) [16] are almost in the line of findings of the present studies, indicating that the combination product of imidacloprid 40% + ethiprole 40% (80 WG) @ 125 g/ha proved to be superior over sole use of monocrotophos 36 WSC @ 1300 mlit./ha against hispa. Similarly, Super-D consisting of chlorpyriphos + cypermethrin remained the most effective, among all the treatments, against hispa.

Table 3: Effect of chemical insecticides on the incidence of rice hispa (*Dicladispa armigera*) in terms of leaf damage (LDH%)

				Percentage of damaged leaves (LDH) caused by hispa , recorded after spray at											
				4 DAA			7 DAA			10 DAA			Overall Mean		
S.N	Treatment	Formulations (a.i.) or	Dose (ml or g /ha)	2016	2017	Pooled Mean	2016	2017	Pooled Mean	2016	2017	Pooled Mean	2016	2017	Pooled Mean
T1	Spinetoram 6SC + methoxyfenozide 30SC	36 SC	375 ml	0.50 (4.04)	0.78 (5.04)	0.64 (4.54)	0.64 (4.43)	1.00 (5.58)	0.82 (5.01)	0.83 (5.12)	1.29 (6.43)	1.06 (5.78)	0.66 (4.56)	1.02 (5.72)	0.84 (5.14)
T2	Spinetoram 6SC + methoxyfenozide 30SC	36 SC	400 ml	0.44 (3.80)	0.72 (4.85)	0.58 (4.33)	0.56 (4.12)	0.92 (5.34)	0.74 (4.73)	0.74 (4.80)	1.19 (6.17)	0.97 (5.48)	0.58 (4.27)	0.94 (5.49)	0.76 (4.88)
T3	Triflumezopyrim	106 SC	238 ml	1.01 (5.71)	1.29 (6.45)	1.15 (6.08)	1.22 (6.06)	1.58 (6.96)	1.40 (6.51)	1.53 (7.05)	1.99 (8.05)	1.76 (7.55)	1.26 (6.32)	1.62 (7.20)	1.44 (6.76)
T4	Flubendiamide	48SC	50 ml	0.60 (4.43)	0.88 (5.35)	0.74 (4.89)	0.74 (4.81)	1.10 (5.89)	0.92 (5.35)	0.92 (5.37)	1.37 (6.63)	1.15 (6.00)	0.75 (4.89)	1.12 (5.98)	0.94 (5.44)
T5	Rynaxypyr	20SC	150 ml	1.11 (5.90)	1.39 (6.64)	1.25 (6.27)	1.35 (6.51)	1.71 (7.35)	1.53 (6.93)	1.68 (7.24)	2.14 (8.23)	1.91 (7.73)	1.38 (6.58)	1.75 (7.44)	1.57 (7.01)
T6	Acephate	95SG	526 g	0.87 (5.35)	1.15 (6.14)	1.01 (5.75)	0.94 (5.49)	1.30 (6.45)	1.12 (5.97)	1.24 (6.27)	1.70 (7.38)	1.47 (6.83)	1.02 (5.73)	1.38 (6.69)	1.20 (6.21)
T7	Dinotefuran	20 SG	200 g	1.19 (6.16)	1.47 (6.87)	1.33 (6.51)	1.55 (6.93)	1.91 (7.72)	1.73 (7.32)	1.86 (7.54)	2.32 (8.50)	2.09 (8.02)	1.53 (6.91)	1.90 (7.73)	1.72 (7.32)
T8	Triazophos	40 EC	1500 ml	0.92 (5.35)	1.20 (6.15)	1.06 (5.75)	1.11 (5.71)	1.47 (6.67)	1.29 (6.19)	1.41 (6.74)	1.87 (7.77)	1.64 (7.25)	1.15 (5.99)	1.51 (6.91)	1.33 (6.45)
T9	Carbofuran followed by triazophos	3G & 40 EC	30 kg & 1500 ml	0.73 (4.64)	1.01 (5.55)	0.87 (5.09)	0.85 (5.22)	1.21 (6.23)	1.03 (5.72)	1.11 (5.96)	1.56 (7.11)	1.34 (6.53)	0.89 (5.32)	1.26 (6.34)	1.08 (5.83)
T10	Untreated control	Water spray	500 lit.	5.57 (13.58)	5.85 (13.92)	5.71 (13.75)	7.20 (15.35)	7.56 (15.74)	7.38 (15.54)	8.11 (16.34)	8.56 (16.82)	8.34 (16.58)	6.96 (15.14)	7.33 (15.54)	7.14 (15.34)
SEm±				(0.42)	(0.37)	(0.25)	(0.47)	(0.43)	(0.29)	(0.46)	(0.44)	(0.29)	(0.39)	(0.36)	(0.24)
CD 5%				(1.25)	(1.08)	(0.72)	(1.40)	(1.28)	(0.83)	(1.38)	(1.32)	(0.83)	(1.15)	(1.07)	(0.69)
CV %				(12.39)	(9.45)	(10.86)	(12.64)	(10.07)	(11.28)	(11.09)	(9.23)	(10.10)	(10.20)	(8.29)	(9.18)

Figures under the parenthesis are angular transformed values. LDH-Leaf damage due to hispa

DAT-Days after transplanting; DAA-Days after application of insecticidal treatment

Foliar spray of the insecticidal treatments was applied at 25 DAT

Conclusion

Accordingly , based on the overall result of two years experimentation, it may be concluded that newer ready mix combination product of the minimum damage was found in terms of leaf damage 0.76 per cent LDH in case of the readymade combination of spinetoram 6SC + methoxyfenozide 30SC @ 400 ml/ha, which in turn was superior among all the test insecticides, but it was at par with spinetoram 6SC + methoxyfenozide 30SC @ 375 ml/ha (0.84% LDH) and flubendiamide 48SC @ 50 ml/ha (0.94% LDH). The highest damage of 7.14% LDH was observed in case of untreated crop of rice. The peak duration of the occurrence of rice hispa was almost from 25 days and onward period during both of years of the experimentation.

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