

**EVALUATION OF NOVALURON 5.25 % + EMAMECTIN BENZOATE  
0.9% SC AGAINST CHILLI FRUIT BORERS, *HELICOVERPA  
ARMIGERA* (HUB) AND *SPODOPTERA LITURA* (FB)**

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**ABSTRACT**

Chilli, is an important spice and vegetable crop of India. Field trials were conducted to determine the bio efficacy of Novaluron 5.25% + Emamectin benzoate 0.9% SC against Chilli fruit borers. Experimental findings indicate that foliar sprays with Novaluron 5.25% + Emamectin benzoate 0.9% SC combination effectively controlled *Helicoverpa armigera* and *Spodoptera litura* in chilli. No phytotoxic effect or symptoms were observed, with any of the treatment on chilli crop and also, there was no effect on non-target organisms. It is evident from the present investigation that, Novaluron 5.25 % + Emamectin benzoate 0.9% SC was effective against *Helicoverpa armigera* and *Spodoptera litura* @ 875 & 925 ml/ha is recommended for use. The treatment of Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha exhibited the highest cost benefit ratio (1: 4.97) during experiment.

**KEYWORDS:** Chilli Fruit Borers, Spice and Vegetable, Experimental Findings

**INTRODUCTION**

Chilli, is an important spice and vegetable crop of India. Chilli (*Capsicum annuum* L.) is an important cash crop, among the spices and belongs to family Solanaceae of dicots. The productivity of chilli is very low, due to several factors. Among them, insect pests cause severe loss, in chilli yield. It is attacked by various insect and mite pests from seedling to fruiting stage. The damage caused by *Helicoverpa armigera* (Hubner) and *Spodoptera litura* (Fb.), during flowering and fruit formation is more and reduced yields. Fruit borers lead to 90 per cent flower and fruit drop in chilli. Considering the above facts the present investigation was carried on the evaluation of new chemical Novaluron 5.25 % + Emamectin of benzoate 0.9% SC” against fruit borers in chilli.

**MATERIALS AND METHODS**

The field trials were conducted during *rabi* season of 2014 at Horticulture Research Station, Mahanadi, Kurnool district. The test variety RKHS - 105 was sown at a spacing of 60 × 45cm in a Randomized Block Design with seven treatments including control was evaluated and each treatment was replicated three times under assured irrigated conditions. All the agronomic practices were followed as per the recommended package of practices. The knapsack sprayer and spray volume @ 500 L. /ha was used with hollow cone nozzle to impose the spray treatments. First spray was initiated based on ETL when the larvae are present in sufficient number. Second and third application was imposed on need basis. Pretreatment count was taken at one day before spraying and post treatment counts were recorded at 1, 5 and 7 days after

each application. Data on total number of healthy and bored fruits were collected at the time of picking and the percent damage of the fruits due to the fruit borers was calculated. The percentage damage of fruits was calculated as follows.

Number of damaged fruits

Per cent incidence (%) = \_\_\_\_\_ x 100

Total number of fruits

Yield data were recorded plot wise and then converted to hectare basis. Data on fruit borer damage and yield were subjected to statistical analysis.

Phytotoxicity was assessed by visual observation. Ten plants in each treatment replicate were observed critically at 1, 3, 5, 7, 10 days after spraying for leaf chlorosis, necrosis, epinasty, hyponasty, scorching and wilting and were graded on 0-10 point phytotoxicity scale.

The data thus obtained from field experiments in a Randomized Block Design were analyzed statistically by ANOVA using the package AGRES, after converting it to square root value and arcsine percentage.

**Table 1**

Crop Response/Crop Injury	Grade
0-00	0
1-10%	1
11-20%	2
21-30%	3
31-40%	4
41-50%	5
51-60%	6
61-70%	7
71-80%	8
81-90%	9
91-100%	10

## RESULTS

### **Efficacy of Novaluron 5.25% + Emamectin Benzoate 0.9% SC on Larval Population of *Helicoverpa armigera***

During *rabi*, 2014 mean no. of larvae before application, ranged from 3.67 to 4.00 larvae per five plants in various treatments and difference was non-significant. Five days after spray, among the different chemical treatments, Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 925 ml/ha was recorded minimum (2.23) larvae per five plants and it was on par with Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha (2.32). Untreated control recorded highest population of 4.42 larvae per five plants. Similar fashion of efficacy was recorded after each application and at final observation i.e. 7 days after third spray Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 925 ml/ha and Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha recorded 0.30 and 0.38 larvae per five plants respectively. In untreated control condition it has reaches up to 5.22 larvae per five plants. (Table- 1)

### **Efficacy of Novaluron 5.25% + Emamectin Benzoate 0.9% SC on Larval Population of *Spodoptera litura***

During *Rabi*, 2014 mean no. of larvae before application ranged from 4.33 to 5.87 larvae per five plants, in various treatments and difference was non-significant. Five days after spray, among the different chemical treatments,

Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 925 ml/ha was recorded minimum (2.30) larvae per five plants and it was on par with Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha (2.30). Untreated control recorded highest population of 5.10 larvae per five plants. Similar fashion of efficacy was recorded after each application and at final observation i.e. 7 days after third spray Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 925 ml/ha and Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha recorded best with 0.37 and 0.47 larvae respectively. Whereas under untreated control condition it has reaches up to 6.20 larvae per five plants. (Table-2)

### **Yield and Fruit Borer Damage**

During *rabi*, 2014 treatment of Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 925 ml/ha recorded the highest yield with 18.70 Q/ha, but it was found statistically, on a par with Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha ml/ha (18.51 Q/ha). However, all the treatments were found significantly superior over the untreated control which recorded lowest yield i.e. 11 Q/ha (Table 3). The treatment of Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 925 ml/ha recorded lowest fruit damage (3.03), which was on par with of Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha (3.23). Whereas, under untreated control recorded highest fruit damage (17.00). The other insecticides in the experiment recorded high fruit damage and remained on par with untreated control. The treatment of Novaluron 5.25% + Emamectin benzoate 0.9% SC @ 875 ml/ha exhibited the highest cost benefit ratio during experiment (Table 4).

### **Effect on Natural Enemies' Population**

The natural enemies such as Spiders and some Reduvid bugs were observed in all the experimental plots, during the trial period and observation were made on the population of these natural enemies, during each observation from randomly selected 10 plants. However, statistically there were no significant differences among the treatments, regarding the incidence of natural enemies (Table 5).

### **Phytotoxicity**

The data regarding phytotoxic effects such as chlorosis, necrosis, epinasty, hyponasty, wilting and scorching at 1, 3, 5, 7 and 10 days after spraying revealed that, Novaluron 5.25% + Emamectin benzoate 0.9% SC even at its higher dose did not show any phytotoxicity in Chilli. (Table – 6)

### **CONCLUSIONS**

- The study revealed that, all the doses of Novaluron 5.25% + Emamectin benzoate 0.9% SC combination effectively controlled *Helicoverpa armigera* and *Spodoptera litura* in chilli.
- No phytotoxic effect or symptoms were observed, with any of the treatment on chilli crop and also there was no effect on non-target organisms.
- It is evident from the present investigation that Novaluron 5.25 % + Emamectin benzoate 0.9% SC was effective against *Helicoverpa armigera* and *Spodoptera litura* @ 875 & 925 ml/ha is recommended for use.

## DISCUSSIONS

Novaluron was most effective against pod borer on chilli, closely followed by spinosad, flubendiamide and chlorfenapyr. In the case of fruit borer on tomato, spinosad was the most effective. Shoot and fruit borers on brinjal and okra were also controlled effectively by flubendiamide, spinosad and chlorfenapyr. Emamectin benzoate methoxyfenozide, and *Bacillus thuringiensis*, also performed well in reducing damage and increasing yield. *Bacillus thuringiensis* and methoxyfenozide were, however, less effective against shoot and fruit borer on brinjal and okra. The new pesticides, with novel modes of action and high selectivity, were highly effective against Lepidopteran pests. They are safer to non-target organisms and quickly degrade to non-toxic products (Chatterjee, Mondal (2012).

The present observations on the effectiveness of Emamectin benzoate are in conformity with those of Anil and Sharma (2010). These results also coincide with Kalawate and Dethe (2012) who stated that Emamectin benzoate and spinosad are efficient in reducing the population and the subsequent damage caused by brinjal fruit borer.

Investigation on Bioefficacy of nine modern insecticides under field condition against *S. litura* on groundnut revealed that emamectin benzoate 0.005 per cent, chlorpyrifos 0.05 per cent, cypermethrin 0.016 per cent and chlorantraniliprole 0.006 per cent were found to be the most effective.(Naveen Kumar *et al*, 2015)

More or less, similar findings were recorded by the various workers *viz.*, Chatterjee and Roy (2004), Deshmukh and Bhamare (2006), Eswara Reddy and Srinivasa *et al* (2005), Srinivasa *et al* (2008), Hosamani *et al* (2008), Jagginavar *et al* (2009), Tatagar *et al* (2009) and Satanarayana *et al.*(2010), Sajjad Anwar(2015).

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**Table 2: Efficacy of Novaluron 5.25%+Emamectin Benzoate 0.9%SC against *Helicoverpa armigera* Infesting Chilli during Rabi, 2014**

Treatments	Dose/ha	PTC	Mean no. of larvae / 5 plants									Percent reduction in no. of larvae 7 days after 3 <sup>rd</sup> spray
			After 1 <sup>st</sup> spray			After 2 <sup>nd</sup> spray			After 3 <sup>rd</sup> spray			
			1 DAS	5 DAS	7 DAS	1 DAS	5 DAS	7 DAS	1 DAS	5 DAS	7 DAS	
Novaluron 5.25%+Emamectin benzoate 0.9 % SC*	825	3.83 (2.08)	3.78 (2.07)	3.70 (2.05)	3.63 (2.03)	3.57 (2.01)	3.50 (2.00)	3.43 (1.98)	3.37 (1.96)	3.23 (1.93)	3.12 (1.90)	39.41
Novaluron 5.25%+Emamectin benzoate 0.9 % SC*	875	3.80 (2.04)	3.70 (2.02)	2.32 (1.68)	2.27 (1.67)	2.17 (1.63)	1.03 (1.24)	0.97 (1.21)	0.88 (1.18)	0.48 (0.99)	0.38 (0.94)	92.62
Novaluron 5.25%+Emamectin benzoate 0.9 % SC*	925	4.00 (2.12)	3.82 (2.08)	2.23 (1.65)	2.18 (1.64)	2.08 (1.61)	0.97 (1.21)	0.90 (1.18)	0.80 (1.14)	0.43 (0.96)	0.30 (0.89)	94.17
Novaluron 10% EC	375	3.67 (2.04)	3.60 (2.02)	3.43 (1.98)	3.37 (1.96)	3.30 (1.94)	2.90 (1.84)	2.83 (1.82)	2.77 (1.80)	2.57 (1.75)	2.43 (1.70)	52.81
Emamectin Benzoate 5% SG	200	3.70 (2.05)	3.53 (2.00)	3.13 (1.90)	3.07 (1.89)	2.97 (1.86)	2.50 (1.73)	2.40 (1.70)	2.30 (1.67)	2.10 (1.61)	1.93 (1.55)	62.52
Fipronil 5% SC	1000	3.93 (2.10)	3.87 (2.08)	3.73 (2.06)	3.64 (2.04)	3.55 (2.01)	3.34 (1.96)	3.28 (1.94)	3.21 (1.92)	3.14 (1.90)	3.08 (1.89)	40.19
Untreated control	-	3.97 (2.11)	4.23 (2.17)	4.42 (2.22)	4.51 (2.24)	4.57 (2.25)	4.77 (2.29)	4.83 (2.31)	4.90 (2.32)	5.10 (2.36)	5.22 (2.39)	-
SEm(±)	-	NS	NS	0.03	0.02	0.02	0.01	0.01	0.04	0.02	0.02	-
CD(P = 0.05)	-	NS	NS	0.09	0.08	0.06	0.04	0.05	0.12	0.07	0.08	-

PTC – Pretreatment count; DAS - Days after spraying. \*Figures in the parentheses are Square root transformed values (X + 0.5)

Samples supplied by Adama India Pvt. Ltd. Hyderabad

**Table 3: Efficacy of Novaluron 5.25%+Emamectin Benzoate 0.9%SC against *Spodoptera litura* Infesting Chilli during Rabi, 2014**

Treatments	Dose/ha	PTC	Mean no. of larvae / 5 plants									Percent Reduction in No. of Larvae 7 Days After 3 <sup>rd</sup> Spray
			After 1 <sup>st</sup> spray			After 2 <sup>nd</sup> spray			After 3 <sup>rd</sup> spray			
			1 DAS	5 DAS	7 DAS	1 DAS	5 DAS	7 DAS	1 DAS	5 DAS	7 DAS	
Novaluron 5.25%+Emamectin benzoate 0.9 % SC*	825	5.33 (2.41)	4.92 (2.33)	4.77 (2.30)	4.67 (2.27)	4.61 (2.26)	4.47 (2.23)	4.37 (2.20)	4.27 (2.18)	4.10 (2.14)	4.00 (2.12)	35.48
Novaluron 5.25%+Emamectin benzoate 0.9 % SC*	875	5.87 (2.52)	4.79 (2.30)	2.30 (1.67)	2.23 (1.65)	2.13 (1.62)	1.07 (1.25)	0.97 (1.21)	0.87 (1.17)	0.67 (1.08)	0.47 (0.98)	92.42
Novaluron 5.25%+Emamectin benzoate 0.9 % SC*	925	4.48 (2.23)	3.93 (2.11)	2.30 (1.67)	2.20 (1.64)	2.10 (1.61)	1.00 (1.22)	0.92 (1.19)	0.77 (1.13)	0.57 (1.03)	0.37 (0.93)	94.03
Novaluron 10% EC	375	5.10 (2.37)	4.98 (2.34)	3.83 (2.08)	3.73 (2.05)	3.63 (2.03)	3.33 (1.95)	3.23 (1.93)	3.13 (1.91)	2.87 (1.83)	2.80 (1.82)	54.83
Emamectin Benzoate 5% SG	200	4.33 (2.20)	4.08 (2.14)	3.97 (2.11)	3.90 (2.10)	3.83 (2.08)	3.33 (1.96)	3.20 (1.92)	3.14 (1.91)	2.90 (1.84)	2.87 (1.83)	53.70
Fipronil 5% SC	1000	4.40 (2.21)	4.17 (2.16)	4.09 (2.14)	4.00 (2.12)	3.93 (2.11)	3.77 (2.07)	3.70 (2.05)	3.63 (2.03)	3.43 (1.98)	3.37 (1.97)	45.64
Untreated control	-	4.78 (2.27)	4.87 (2.30)	5.10 (2.34)	5.25 (2.38)	5.31 (2.41)	5.53 (2.43)	5.63 (2.45)	5.77 (2.48)	6.13 (2.54)	6.20 (2.56)	-
<b>SEm(±)</b>	-	<b>NS</b>	<b>NS</b>	<b>0.01</b>	<b>0.02</b>	<b>0.01</b>	<b>0.03</b>	<b>0.01</b>	<b>0.01</b>	<b>0.02</b>	<b>0.03</b>	-
<b>CD(P = 0.05)</b>	-	<b>NS</b>	<b>NS</b>	<b>0.04</b>	<b>0.08</b>	<b>0.05</b>	<b>0.09</b>	<b>0.03</b>	<b>0.05</b>	<b>0.07</b>	<b>0.09</b>	-

PTC – Pretreatment count; DAS - Days after spraying. \*Figures in the parentheses are Square root transformed values ( $X + 0.5$ )

\*Samples supplied by Adama India Pvt. Ltd. Hyderabad

**Table 4: Effect of Novaluron 5.25%+Emamectin Benzoate 0.9%SC on Fruit Borer Damage and Yield during Rabi, 2014**

Treatments	Rabi, 2014		
	Dose / ha (ml)	*Fruit Borer Damage (%)	**Yield (Q/ha)
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	825	11.33(19.67)	12.64(3.62)
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	875	3.23(10.36)	18.51(4.36)
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	925	3.03(10.03)	18.70(4.38)
Novaluron 10% EC	375	7.63(16.04)	12.87(3.66)
Emamectin Benzoate 5% SG	200	6.27(14.50)	12.77(3.64)
Fipronil 5% SC	1000	9.67(18.11)	12.56(3.61)
Untreated control	-	17.00(24.35)	11.00(3.39)
<b>SEm(±)</b>		<b>0.21</b>	<b>0.08</b>
<b>CD (P = 0.05)</b>		<b>0.67</b>	<b>0.27</b>

\*\*Figures in the parentheses are Square root transformed values ( $X + 0.5$ )

\*Figures in the parentheses are Angular/ arc sin transformed values.

**Table 5: Cost Benefit Ratio of (C: B Ratio) during Rabi, 2014**

SL. No	Treatments	Dose ml/g/ha	Formulation g or ml/ha	Cost of inputs (Cost of insecticide/ha + Cost of labour for spraying/ha)	Chilli yield (Q/ha)	Extra yield over untreated control (yield in treatment - yield in untreated control)	Value of additional yield (Rs.)	Cost Benefit Ratio
1	Novaluron 5.25%+Emamectin benzoate 0.9 % SC	43.31+7.43	825	8625.00	12.64	1.64	9840.00	1 : 1.14
2	Novaluron 5.25%+Emamectin benzoate 0.9 % SC	45.94+7.88	875	9075.00	18.51	7.51	45060.00	1 : 4.97
3	Novaluron 5.25%+Emamectin benzoate 0.9 % SC	48.56+8.33	925	9525.00	18.70	7.70	46200.00	1 : 4.85
4	Novaluron 10% EC	33.5	375	5189.25	12.87	1.87	11220.00	1 : 2.16
5	Emamectin Benzoate 5% SG	10	200	5598.00	12.77	1.77	10620.00	1 : 1.90
6	Fipronil 5% SC	50	1000	4710.00	12.56	1.56	9360.00	1 : 1.99
7	Untreated control		-	0.00	11.00	-	0.00	-

**Market rates**

Novaluron 5.25% + Emamectin Benzoate 0.9% SC – Rs. 3000/-per lit Price of chill/quintal - 6000/-

Novaluron 10% EC - Rs 3546/- per lit Labour cost of insecticide application - 400/-

Emamectin Benzoate 10% SG - Rs. 7330/- per kg No. of sprays - 3

Fipronil 5 % SC - Rs. 1170/- per lit

**Table 6: Influence of Novaluron 5.25 % + Emamectin Benzoate 0.9% SC on Natural Enemies on Chilli during Rabi, 2014**

Treatments	Dose / ha	Average no. of natural enemies / 10 plants			
		Spiders		Reduvid bug	
	Formulation (ml)	Before spray	10 DAS	Before spray	10 DAS
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	825	0.83(1.14)	0.60(1.05)	0.77(1.11)	0.83(1.15)
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	875	0.97(1.20)	0.63(1.06)	0.87(1.17)	0.73(1.10)
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	925	0.97(1.21)	0.57(1.01)	0.83(1.15)	0.83(1.15)
Novaluron 10% EC	375	0.63(1.06)	0.40(0.95)	0.87(1.17)	0.87(1.17)
Emamectin Benzoate 5% SG	200	0.80(1.14)	0.83(1.15)	0.77(1.12)	0.79(1.13)
Fipronil 5% SC	1000	0.83(1.15)	0.90(1.18)	0.57(1.03)	0.78(1.12)
Un treated control	-	0.92(1.19)	0.70(1.09)	0.82(1.14)	0.93(1.20)
SEm(±)	-	NS	NS	NS	NS
CD (P = 0.05)	-	NS	NS	NS	NS

\*Figures in the parentheses are square root transformed values (X + 0.5)



Table 7: Phytotoxicity Scoring in Chilli during *Rabi*, 2014

Treatments	Doses ml/ha	Yellowing					Necrosis					Wilting					Scorching					Epinasty					Hyponasty				
		DAA					DAA					DAA					DAA					DAA									
		1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10	1	3	5	7	10
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	825	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	875	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novaluron 10% EC	375	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emamectin Benzoate 5% SG	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fipronil 5% SC	1000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Untreated control	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	1750	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Novaluron 5.25%+Emamectin benzoate 0.9 % SC	3500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

\*Scale (0-10): 0= 00, 1= 1-10%, 2= 11-20%, 3= 21-30%, 4=31-40%, 5=41-50%, 6=51-60%, 7=61-70%, 8=71-80%, 9= 81-90%, 10= 91-100%

#### Meteorological Data during Crop Period

Table 8

Month	Monthly Average Temperature (°C)		Monthly Average RH (%)		Total Rainfall (mm)	No. of Rainy Days
	Max	Min	Max	Min		
<b>December-14</b>	30.4	18.2	78.5	58.5	0.00	00
<b>January-15</b>	31.6	17.1	79.8	45.1	0.03	01
<b>February-15</b>	34.2	16.9	79.7	44.7	0.00	00
<b>March-15</b>	37.6	22.6	65.8	3.5	0.10	02