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To evaluate the bioefficacy of granular insecticide molecules against pink stem borer

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Abstract
Experiment was conducted at Entomology Block of agriculture research cum instructional farm, I.G.K.V., Raipur, Chhattisgarh in year 2014-2015 to evaluation the bioefficacy of granular insecticide molecules against pink stem borer. The results revealed that the minimum leaf injury rating was recorded with carbofuran (3.00) which was at par with flubendiamide (3.23) followed by thiamethoxam (3.43), emamectin benzoate (3.57), rynaxypyr (4.03) and cartap hydrochloride (4.17) treated plots. The highest leaf injury mean was recorded 4.20 with fipronil. The minimum per cent of dead heart damage was recorded with carbofuran 36.67% which was at par with flubendiamide 43.33% followed by rynaxypyr 45.50%, thiamethoxam 46.67%, emamectin benzoate 50.0%, and cartap hydrochloride 56.67% treated plots. The highest per cent dead heart damage was recorded with fipronil 60.0%.Thegrain yields was also significantly highly influenced by carbofuran 3 G followed by flubendiamide 20 WG, thiamethoxam 25 WG, emamectin benzoate 5 SG and cartap hydrochloride 4 G, rynaxypyr 0.4% G and fipronil 0.3% G.

Keywords: Maize stem borer, *Sesamia inferens*, insecticides, evaluation

1. Introduction
Maize (*Zea mays* L.) belongs to family Poaceae is one of the most important cereal crops of the world and contributes to food security in most of the developing countries. In India, maize is emerging as third most important crop after rice and wheat [1]. Its importance lies in the fact that it is not only used as human food and animal feed but at the same time it is also widely used in corn starch industry, corn oil production, and as baby corn in different recipes [1].
At present, out of the total maize produced, 55 per cent is used for food purpose, about 14 per cent for livestock, 18 per cent for poultry feed, 12 per cent for starch and one per cent as seed, maize is composed of 71.5 per cent starch, 1.9 per cent protein, 4.8 percent fat and 1.4 per cent ash [2].
Therefore, there is a need to explore the possibilities of increasing the productivity through better understanding of constraints in its production. In recent years, maize is gaining greater popularity among the farmers, because of choice of the high yielding varieties and cultivability throughout the year. *Sesamia inferens* is said to be the major serious pest of maize next in importance to *Chilo partellus.* In addition to maize, it also infests sorghum, bajra, finger millet, wheat, rice, oat, barley, sugarcane and some grasses [3, 4].
Sesamia inferens is predominant throughout the year in the Peninsular India, particularly in the states of Andhra Pradesh, Karnataka, Tamil Nadu and Maharashtra. During *Rabi* season it also causes extensive damage to the maize crop in several northern states like Uttar Pradesh, Assam, Bihar, Delhi, Punjab, Orissa, Madhya Pradesh, Haryana, West Bengal and Andaman islands. The adults pink borer lays eggs inside the leaf sheath. The typical symptoms of pink borer damage are gummy oozing with water soaked lesions at the bottom of leaf sheaths, oblong holes in unfolded leaves, drying of central shoots and dead heart in young plants [5]. Losses due to *S. inferens* in *Rabi* season varies from 25.7 to 78.9 percent [6].
Insects attack on the maize crop throughout the cropping season and pink stem borer, *Sesamia inferens* is major insect pest of maize in Peninsular India during *Kharif* and *Rabi*. The loss primarily due to *S. inferens* in *Kharif* varies from 60 to 81.7% and in *Rabi* (winter) it varies from 25.7 to 78.9% [7].
Keeping in view the importance of maize crop in the economy of Chhattisgarh and the economic losses caused by the pink stem borer, *Sesamia inferens*, the present study aimed to find efficacy of seven granular insecticides against the maize pink stem borer, on maize crop.

2. Materials and Methods

The present investigation was conducted during *Kharif* season of 2014-15 at Maize crop Research Area, IGKV, Raipur (C.G.) to evaluation the bioefficacy of granular insecticide molecules against pink stem borer. Insect pest of Maize was observed on variety NK-30 which was sown on 1st week of July having spacing of 60 x 20 cm. during the whole cropping season *i.e*. from July to November.

Seven granular insecticides were evaluated for the management of *S. inferens.* Insecticides were applied twice on 15 and 30 days after emergence of crop. Pretreatment observation were recorded on one day before insecticide application and post treatment observation were taken after 3, 5, 7, 10, 15 DAT of insecticides. But, no significant difference between observation days, that's why observations was taken after 5 DAT, 10 DAT and 15 DAT after application of insecticides.

In this experiment of leaf injury rating and dead hearts per cent was counted on randomly selected 10 plants from each plot.

Following observations were recorded in the experimental plots.

1. Number of dead hearts /10 plants.
2. Leaf injury level /10 plants.
3. Yield /plot.

Yield data was analyzed and yield differences among different treatments were calculated. While comparing the yield from different treatments, the per cent increase in yield over control was calculated using the following formula (Pradhan) [8].

$$\text{Increase in yield over control (\%)} = \frac{(T - C)}{C} \times 100$$

Where,

T=Yield from treated plot.

C=Yield from control plot.

The leaf injury infestation was subjected to square root transformation (These transformed values were analyzed statistically by using the techniques of analysis of variance for randomized block design and significance was tested by “F” test (Cochran and Cox) [9].

Eight different insecticidal treatments were evaluated including untreated control for the assessment of their comparative performance against pink stem borer of maize. The details of tested insecticides which were applied on maize are presented in the Table 1.

Table 1: Insecticides molecules against pink stem borer in maize

Treatments	Insecticides	Formulation	Trade name	Doses (a.i./ha)
T_1	Thiamethoxam	25%WG	Actara	25g
T_2	Flubendiamide	20%WG	Takumi	25g
T_3	Emamectin Benzoate	5%SG	Xpload	9.5g
T_4	Cartap hydrochloride	4G	Kritap	750g
T_5	Rynaxypyr	0.4%G	Fertera	30g
T_6	Carbofuran	3G	Fury	1000g
T_7	Fipronil	0.3G	Regent	75g
T_8	Control			

Insecticides were applied in three forms *i.e*., whorl application, soil application and spray of wettable granules. In whorl application, carbofuran was applied inside the whorl of plant. fipronil, cartap hydrochloride and rynaxypyr were applied at the basal portion of stem. Whereas, the insecticide thiamethoxam, flubendiamide and emamectin benzoate were applied as foliar spray.

Economics of different insecticides were worked out as per the market price of the commodities and wages prevailing during the course of studies. For economic analysis, the factors considered were cost of different insecticides and additional cost involved. Gross and net returns and benefit cost ratio were worked out. Value of increased yield over untreated control was calculated by multiplying the increased yield over control by prevailing market price of maize (Rs 1310 per quintal). The net profit over untreated control was worked out by deducting cost of insecticides and labour charges from price of increased yield over control. The benefit: cost ratio was also calculated by dividing net profit over control by the total cost (insecticides and labour charges).

$$\text{Benefit cost ratio} = \frac{\text{Net returns}}{\text{Total cost (Insecticides + labour charges)}}$$

3. Results and Discussion

3.1 To evaluate the bioefficacy of granular insecticide molecules against pink stem borer

To evaluate the comparative efficacy of some granular insecticides to manage the pink stem borer on maize crop. An experiment with seven insecticides *viz*., Thiamethoxam 25% WG @ 25g a.i./ha, flubendiamide 20%WG @ 25ga.i./ha, emamectin benzoate 5% SG@9.5g a.i./ha,cartaphydrochloride4G@750ga.i./ha,rynaxypyr0.4%G @30ga.i./ha,carbofuran3G@1000g a.i./ha and fipronil0.3G@75g a.i./ha was laid out in randomized block design with three replications along with an untreated check for comparison.

All the tested granular insecticides were found significantly superior over untreated control in reducing the leaf injury rating and dead heart percent damage by pink stem borer. Among the granular insecticides carbofuran 3G proved to be the best in comparison to other tested insecticides in reduction of incidence of pink stem borer at each observation days with the significantly highest grain yield (44.22 qha^{-1}). The insecticide, flubendiamide 20%WG was next to carbofuran 3G in effectiveness for management of pink stem borer with a grain yield of (34.00 qha^{-1}).

3.1.1 Average leaf injury rating and incidence of dead heart before and after application of the insecticides as granule and spray forms

All the tested granular insecticides were found significantly superior over untreated control in reducing the leaf injury rating and dead heart percent at each observation days after application.

3.1.1.1 Leaf injury rating by *Sesamia inferens* after first application of the insecticides as granular and spray forms

Data in respect of pre-treatment and post treatment observations on leaf injury rating by *S. inferens* after first application are presented in Table 2 and Fig. 1. The leaf injury rating mean in the pre treatment observation ranged non-significant among them. However leaf injury rating from 0.57 to 1.67 was observed on 10 plants selected randomly.

It is clear that in post treatment observation after 5th days of treatment, there were significant differences among all the treatment with respect to the leaf injury rating. All the treatment was significantly superior over untreated control. Among the whorl treatment with carbofuran 3G @ 1000 g a.i./ha was recorded the effective treatment with the minimum leaf injury rating plant^{-1}(1.07) followed by flubendiamide 20 WG @ 25g a.i./ha (1.17), thiamethoxam 25WG @ 25g a.i./ha (1.30), emamectin benzoate 5 SG @ 9.5g a.i./ha (1.40), rynaxypyr 0.5% G @ 30g a.i./ha (1.57) and cartap hydrochloride 4G @ 750g a.i./ha (1.77) per plant, respectively. However, application of fipronil 0.3% G @ 75 a.i./ha was least effective leaf injury rating (1.83) but significantly superior over untreated control leaf injury rating (2.97) per plant.

Post treatment observation on the leaf injury rating at 10th days of first application of insecticide, showed that all the treatments were significantly reduce the leaf injury rating over control. The plots treated with carbofuran 3G depicted minimum leaf injury rating plant^{-1}(2.17) which was at par with flubendiamide 20 WG @ 25g a.i./ha (2.23) followed by thiamethoxam 25WG @ 25g a.i./ha (2.47), rynaxypyr 0.5% G @ 30g a.i./ha (2.90), emamectin benzoate 5 SG @ 9.5g a.i./ha (3.00) and fipronil 0.3% G @ 75 a.i./ha.(3.03) respectively. However, application of cartap hydrochloride 4G@ 750g a.i./ha was least effective leaf injury rating (3.23) but significantly superior over untreated control leaf injury rating (4.83) per plant.

After 15th days of first application of insecticide, the plot treated with whorl treatment with carbofuran 3 G once again proved to be most effective with minimum leaf injury rating plant^{-1} (2.83) which was at par with flubendiamide 20 WG (2.87) fipronil 0.3% G was the least effective treatment with the maximum leaf injury rating (3.90) per plant but significantly superior over untreated control leaf injury rating (5.33) per plant.

3.1.1.2 Leaf injury rating by *Sesamia inferens* after second application of the insecticides as granular and spray forms

Data in respect of pre-treatment and post treatment observations on leaf injury rating by *S. inferens* after second application are presented in Table 2 and Fig.1. The observations after 5th days of second application, all the tested doses of insecticides exhibited significant differences over control. Among the whorl treatments with carbofuran 3G recorded as the best effective treatment with minimum leaf injury rating (1.20) plant^{-1}which was followed by flubendiamide 20WG (1.87), thiamethoxam 25WG (2.20), rynaxypyr 0.4% G (2.57), emamectin benzoate 5 SG(2.60), and cartap hydrochloride 4 G (2.93), respectively. However, application of fipronil 0.3% G @ 75 a.i./ha was least effective leaf injury rating (2.97) but significantly superior over untreated control leaf injury rating (5.87) per plant.

Post treatment observation on the leaf injury rating at 10th days of second application of insecticide, showed that all the treatments were significantly reduce the leaf injury rating over control. The plots treated with carbofuran 3G depicted minimum leaf injury rating plant^{-1}(2.60) which was at par with flubendiamide 20 WG @ 25g a.i./ha (2.83) followed by thiamethoxam 25WG @ 25g a.i./ha (3.10), rynaxypyr 0.5% G @ 30g a.i./ha (3.17), emamectin benzoate 5 SG @ 9.5g a.i./ha (3.27) and fipronil 0.3% G @ 75 a.i./ha(3.70), respectively. However, application ofcartap hydrochloride 4G@ 750g a.i./ha was least effective leaf injury rating (3.77) but significantly superior over untreated control leaf injury rating (6.17) per plant.

After 15th days of second application of insecticide, the plot treated with whorl treatment with carbofuran 3 G once again proved to be most effective with minimum leaf injury rating plant^{-1} (3.00) which was at par with flubendiamide 20 WG (3.23). Fipronil 0.3% G was the least effective treatment with the maximum leaf injury rating (4.20) per plant but significantly superior over untreated control leaf injury rating (6.24) per plant.

Table 2: Leaf injury rating on maize by *Sesamia inferens* in pre and post-treatment observations

No	Treatments	Dose (a.i./ha)	leaf injury rating per 10 plant						
			Pre -treatment	Post treatment					
				First application			Second application		
				5 DAT	10 DAT	15 DAT	5 DAT	10 DAT	15 DAT
T1	Thiamethoxam 25 WG.	25g	1.07 (1.36)	1.30 (1.51)	2.47 (1.85)	3.13 (2.03)	2.20 (1.77)	3.10 (2.02)	3.43 (2.10)
T2	Flubendiamide 20 WG	25g	0.77 (1.29)	1.17 (1.47)	2.23 (1.78)	2.87 (1.96)	1.87 (1.69)	2.83 (1.95)	3.23 (2.05)
T3	Emamectin Benzoate 5 SG	9.5g	1.20 (1.42)	1.40 (1.54)	3.00 (1.99)	3.27 (2.06)	2.60 (1.89)	3.27 (2.06)	3.57 (2.13)
T4	Cartap hydrochloride 4 G	750g	1.67 (1.57)	1.77 (1.66)	3.23 (2.05)	3.57 (2.13)	2.93 (1.98)	3.77 (2.18)	4.17 (2.27)
T5	Rynaxypyr 0.4 G	30g	1.23 (1.49)	1.57 (1.59)	2.90 (1.97)	3.20 (2.04)	2.57 (1.88)	3.17 (2.04)	4.03 (2.24)
T6	Carbofuran 3 G	1000g	0.57 (1.22)	1.07 (1.43)	2.17 (1.77)	2.83 (1.95)	1.20 (1.48)	2.60 (1.89)	3.00 (1.99)
T7	Fipronil 0.3 G	75g	1.03 (1.39)	1.83 (1.67)	3.03 (2.00)	3.90 (2.21)	2.97 (1.99)	3.70 (2.16)	4.20 (2.28)
T8	Control		1.67 (1.62)	2.97 (1.98)	4.83 (2.40)	5.33 (2.51)	5.87 (2.61)	6.17 (2.67)	6.24 (2.69)
	SE (m) ±		NS	0.069	0.083	0.053	0.091	0.062	0.052
	CD at (5%)			0.211	0.255	0.163	0.280	0.18	0.160

Figures in parentheses are square root transformed values. DAT=Days after treatments

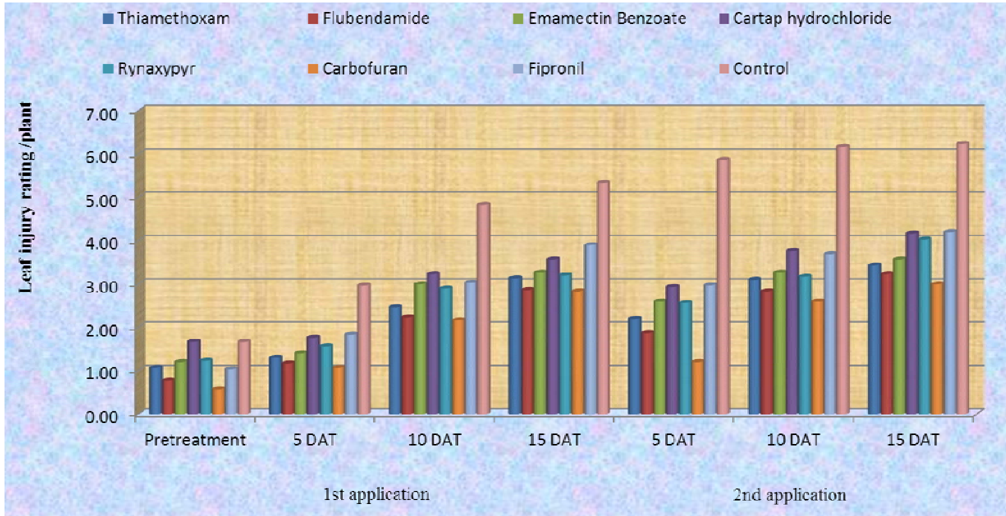

Fig 1: Leaf injury rating per plant of pink stem borer pre and post treatments between treated and field condition.

3.1.1.3 Dead heart infestation of *Sesamia inferens* after first application of the insecticides as granular and spray forms

Data in respect of pre-treatment and post treatment observations on dead heart per cent by *S. inferens* after first application are presented in Table 3 and Fig. 2. It is evident from the data, that the stem borer incidence before the insecticides application was non-significant among all the plots. The per cent incidence ranged from 6.67% to 16.67%.

After 5th days of treatment, the incidence varied from 10.00 to 36.67 per cent. All the treatment was found significantly superior over untreated control. Carbofuran 3G was recorded the best effective treatment with the minimum dead heartper cent per plant (10.0%) which was followed by flubendiamide 20 WG (13.33%), cartap hydrochloride 4 G (16.67%), thiamethoxam 25 WG (20.0%), emamectin benzoate 5 SG (20.0%) and rynaxypyr 0.4G (20.0%), respectively. However, application of fipronil 0.3% G was maximum dead heart per centplant^{-1}(26.67%) which was the least effective treatment but significantly superior over untreated control (36.67) per plant.

After 10th days of first application of insecticide, all the treatments again showed significant reduce the dead heart percent over control. The plots treated with Thiamethoxam 25 WG depicted minimum dead heart percent plant^{-1}(20.0%) which was at par with flubendiamide 20 WG (23.33%) and carbofuran 3 G (23.33%). The highest dead heart percent plant^{-1} (36.67%) was recorded in fipronil 0.3% G but significantly superior over untreated control (46.67) per plant.

After 15th days of first application of insecticide, whorl treatment with carbofuran 3 G once again proved to be most effective with minimum dead heart per cent plant^{-1} (23.33%) which was at par with flubendiamide 20 WG (26.67%). Maximum dead heart per cent plant^{-1} (46.67%) was observed in fipronil 0.3% G. but significantly superior over untreated control (53.33) per plant.

Present findings are in confirmation with the findings of Ahad *et al.* [10]. Carbofuran as whorl treatment significantly reduced the *C. partellus* infestation to 4.00% with increase in yield of 56.66%. Anuradha [11] reported that to evaluated the different doses of Thiamethoxam30FS as seed treatment chemical for controlling maize stem borers, *Chilo partellus* Swinhoe and *Sesamia inferens* Walker. Among the doses tested, higher dose of thiamethoxam 30FS (8 ml/kg) proved superior resulting in 0.38 per cent dead hearts during *Kharif* and 6.43 per cent dead hearts during *Rabi* compared to 0.79 per cent and 14.76 per cent in untreated check.

3.1.1.4 Dead heart infestation of *Sesamia inferens* after second application of the insecticides as granular and sprays form

Data in respect of pre-treatment and post treatment observations on dead heart infestation by *S. inferens* after first application are presented in Table 3 and Fig.2. In the post-treatment observations after 5th days of second application of insecticide, all the tested doses of insecticides exhibited significant differences over control. Among the treatments, carbofuran 3 G was recorded the best effective treatment with minimum dead heart infestation (20.0%) plant^{-1} which was followed by flubendiamide 20 WG (23.33%), thiamethoxam 25 WG and emamectin benzoate 5 SG (26.67%), rynaxypyr 0.4% G (30.0%), and cartap hydrochloride 4 G (33.33%), respectively. However, application of fipronil 0.3% G was maximum dead heart plant^{-1}(40.0%) was the least effective treatment but significantly superior over untreated control (60.0%) per plant.

After 10th days of second application of insecticide, plots treated with carbofuran 3G showed least dead heart percent plant^{-1}(36.67%) which was followed by flubendiamide 20WG and thiamethoxam 25WG (40.00%), rynaxypyr 0.4% G (43.33%), emamectin benzoate 5 SG(46.67%) and cartap hydrochloride 4 G (53.33%), respectively. However, application of fipronil 0.3% G was maximum dead heart plant^{-1}(60.0%) was the least effective treatment but significantly superior over untreated control (70.0%) per plant.

After 15th days of second application of insecticide, all the treatments once again showed significant reduce the dead heart per cent over control. The plots treated with carbofuran 3 G depicted least dead heart per cent plant^{-1} (36.67%) which was at par with flubendiamide 20WG (43.33%), respectively. However, application of cartap hydrochloride 4 G (56.67%) and fipronil 0.3%G (60.0%) was least effective treatment but significantly superior over untreated control (76.67%) per plant.

Granular application of insecticides showed better control of maize stem borer as compared to the emulsifiable concentrates (EC) as foliar application. Saleem *et al.* [12] recorded carbofuran 3G as the most effective insecticide against pink stem borer. Average dead hearts counted for carbofuran 3G were 3.167. Similar result was reported by Khan and Amjad [13].

Table 3: Dead heart incidence of *Sesamia inferens* in the pre and post treatment observations.

No.	Treatments	Doses (a.i./ha)	Incidence of dead heart (%)						
			Pre –treatment	Post treatment					
				First application			Second application		
				5 DAT	10 DAT	15 DAT	5 DAT	10 DAT	15 DAT
T1	Thiamethoxam25WG	25g	13.33 (21.1)	20.0 (26.5)	20.0 (26.0)	33.33 (35.2)	26.67 (30.9)	40.0 (39.1)	46.67 (43.0)
T2	Flubendiamide20WG	25g	10.0 (18.4)	13.33 (18.4)	23.33 (28.2)	26.67 (30.9)	23.33 (28.7)	40.0 (39.1)	43.33 (41.0)
T3	Emamectin Benzoate 5SG	9.5g	6.67 (12.2)	20.0 (26.06)	30.0 (33.1)	36.67 (37.2)	26.67 (29.9)	46.67 (43.0)	50.0 (44.9)
T4	Cartap hydrochloride 4G	750g	16.67 (23.8)	16.67 (23.8)	26.67 (30.9)	36.67 (37.2)	33.33 (34.9)	53.33 (46.9)	56.67 (48.8)
T5	Rynaxypyr 0.4G	30g	16.67 (23.8)	20.0 (26.0)	36.67 (37.4)	46.67 (43.0)	30.0 (32.6)	43.33 (41.1)	45.5 (41.0)
T6	Carbofuran 3G	1000g	6.67 (12.2)	10.0 (18.4)	23.33 (28.7)	23.33 (28.7)	20.0 (26.0)	36.67 (37.2)	36.67 (37.2)
T7	Fipronil 0.3G	75g	13.33 (21.1)	26.67 (30.9)	36.67 (37.2)	46.67 (43.0)	40.0 (39.2)	60.0 (50.8)	60.00 (50.8)
T8	Control		13.33 (21.1)	36.67 (37.2)	46.67 (43.0)	53.33 (46.9)	60.0 (50.8)	70.0 (56.7)	76.67 (61.1)
	SE (m)±		NS	2.68	2.14	2.48	3.45	3.81	4.15
	CD at 5%			8.21	6.55	7.62	10.5	11.6	12.7

Figures in parentheses are angular transformed values. DAT=Days after treatments.

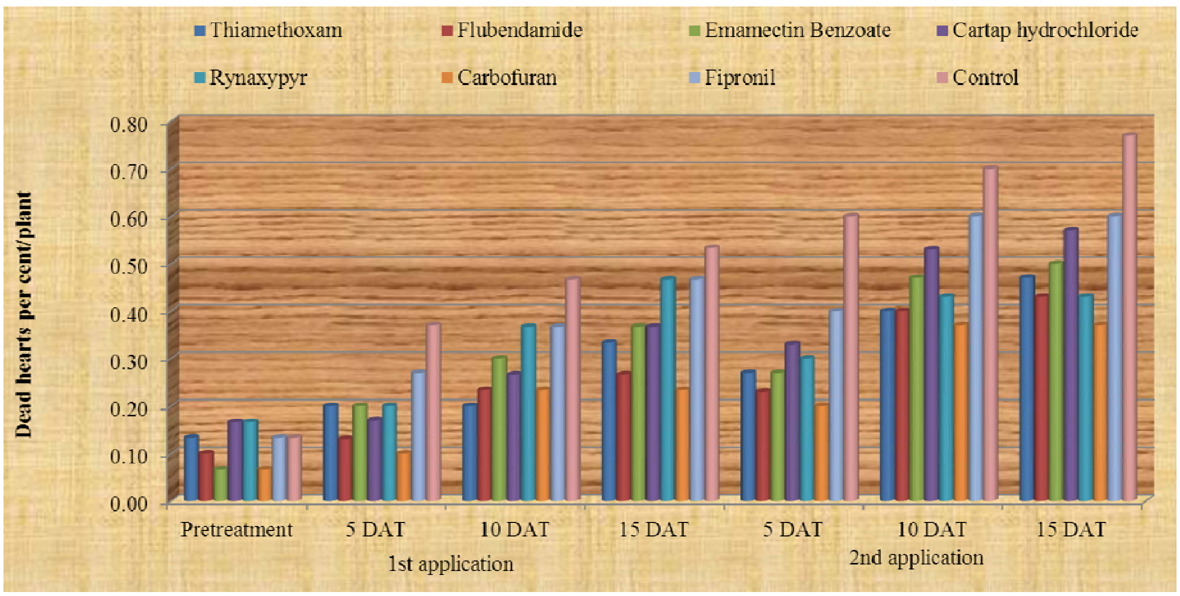

Fig 2: Incidence of dead heart per cent of pink stem borer pre and post treatments between treated and control condition.

3.1.2 Grain yield (q ha^{-1})

The highest grain yield was recorded in carbofuran 3G (44.22 q ha^{-1}) which was followed by flubendiamide 20 WG (34.00qha^{-1}), cartap hydrochloride 4 G (32.21qha^{-1}),thiamethoxam25 WG (30.90 q ha^{-1}), emamectin benzoate 5SG (31.92 q ha^{-1}) and rynaxypyr 0.4%G (30.6 qha^{-1}) while the lowest grain yield of 22.1qha^{-1}was recorded in fipronil 0.3%G treated plots, and the untreated control resulted least (15.00 qha^{-1}) grain yield in comparison to granular insecticides treated plots.

3.1.3 Economic estimation of different insecticides against pink stem borer of maize

The results of the present findings states that all the treatments showed best in yield over control. The highest yield over control was obtained under treatment carbofuran 3G (44.22q ha^{-1}) followed by flubendiamide (34.00 q ha^{-1}), cartap hydrochloride 4 G (32.21qha^{-1}) and thiamethoxam 25 WG (30.90 q ha^{-1}). Price of increased yield over control was calculated and highest price was with carbofuran 3 G (Rs.38278.2) lowest was with fipronil 0.3%G (Rs.9327.2). Thus application of carbofuran 3 G, flubendiamide 20 WG and thiamethoxam 25 WG proved to be the best regarding management of pink stem borer and grain yield of maize (Table 4).

Present findings are in confirmation with the findings of Khan [14]. Tested four granular insecticides *viz*., carbofuran, disulfoton, diazinon and fenthion against maize stem borer *C. partellus*. The carbofuran yield was the highest (3288.80 kg/ha) with the least percentage infestation of plants (3.66) and stubbles (9.82) followed by disulfoton. The economics of control operations of these insecticides showed that a highest net profit was obtained with carbofuran.

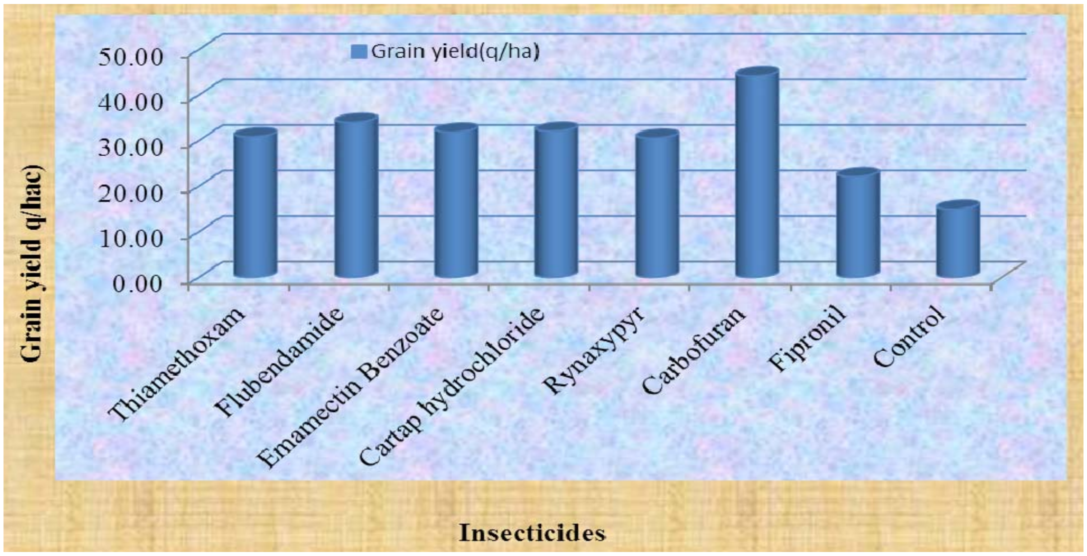

Fig 3: Insecticides application on effect of grain yields

Table 4: Cost economics of different insecticide for the management of pink stem borer in maize

Treatments	Insecticide	Doses (a.i./ha)	Yield (q/ha)	Increased yield over control (Kg/ha)	Price of Increased yield over control (Rs./ha)	Cost of chemicals &labour (Rs./ha)	Net profit over control	Benefit :cost ratio
T1	Thiamethoxam25WG	25g	30.9	15.9	20789.7	2980	17809.7	5.98
T2	Flubendiamide 20WG	25g	34.0	19.0	24916.2	3420	21496.2	6.29
T3	Emamectin Benzoate 5SG	9.5g	31.9	16.9	22165.2	4698	17467.2	3.72
T4	Cartap hydrochloride 4G	750g	32.1	17.1	22427.2	3994	18433.2	4.62
T5	Rynaxypyr 0.4G	30g	30.6	15.6	20396.7	5390	15006.7	2.78
T6	Carbofuran 3G	1000g	44.2	29.2	38278.2	5020	33258.2	6.63
T7	Fipronil 0.3G	75g	22.1	7.1	9327.2	5290	4037.2	0.76
T8	Control	-------	15.0	0.0	0	0	0	0.00

*Labour cost = 4 labour day/ha @Rs 180.00 perday
*Total labour cost /ha(Two sprays)= Rs 1440
*Price of Maize= Rs. 1310 per quintal

3.1.4 Net returns and cost benefit ratio

Among different granular insecticides tested, the highest net return was found in carbofuran 3G (Rs.33258.2) followed by flubendiamide 20WG (Rs.21496.2)**,** thiamethoxam 25WG (Rs.17809.7), cartap hydrochloride 4 G (Rs.18433.2), emamectin benzoate 5SG (Rs.17467.2), and rynaxypyr 0.4% G (Rs.15006.7), respectively while the lowest net return was with fipronil0.3% G (Rs.4037.2). The economic analysis of plant protection is based on the prevailing market rates of insecticides, labour wages and maize grain cost. The benefit cost ratio was worked out to know the economics of insecticidal treated plots. The highest benefit cost ratio was with carbofuran 3G @ 1000g a.i./ha (6.63) followed by flubendiamide 20 WG@ 25g a.i./ha (6.29), thiamethoxam 25WG @25g (5.98), cartap hydrochloride 4G @750g a.i./ha (4.62), emamectin benzoate 5SG @ 9.5g a.i./ha (3.72) and rynaxypyr 4 G @30g a.i./ha(2.78) while the lowest benefit cost ratio was with fipronil 3G @ 75g a.i./ha (0.76). The economic analysis of plant protection is based on the prevailing market rates of insecticides, labour wages and maize grain cost. The details of the benefit: cost estimates at presented in the Table. 4.

Present findings are in confirmation with the findings of Kakar *et al.* [15]. tested four granular insecticides *viz*., diazinon 10 G, aldicarb 10G, carbofuran 3Gand cartap hydrochloride 4G against maize stem borer *C. partellus*. Maximum net benefit (Rs. 4851.77 over the control) was obtained with application of carbofuran 3G, followed by cartap hydrochloride 4G (Rs. 3636.17), aldicarb 10G (Rs. 3431.17) and diazinon 10G (Rs. 2214.97) under field conditions.

4. Conclusion

Finally the economics of each insecticide was studied to determine the best insecticide in controlling the pink stem borer (*Sesamia inferens*) in maize. The maximum net profit over control was recorded with carbofuran 3 G (Rs. 38278.2) and the maximum benefit cost ratio (6.63) was also recorded with carbofuran 3 G, whereas the minimum net profit was recorded with fipronil 0.3% G (Rs. 9327.2) and benefit cost ratio (0.76) was recorded with fipronil 0.3% G.

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