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Effectiveness of pesticides against maize stem borer in sahiwal (Punjab, Pakistan)

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Abstract
Efficacy of Fipronil 0.3G, Caorbofuran 3G and Cartal 10G @ 19.76, 19.76 and 4.94 kg/ha, respectively, were tested against *Chilo partellus* (Swinhoe) on maize genotype 6654 in the farmer's field district Sahiwal during 2015 (Altitude 174-m, latitude 30º 39′ 51.84″ N Longitude 73º 06′ 29.88″ E). All the insecticides showed non-significant influence with one another regarding percent reduction in damage caused by the insect at both applications in almost all the post treatment intervals except after 72 hours at the first application and after 7-days at 2nd application. The percent reduction in plant infestation was significantly the highest (87.75%) in Cartal treated plots compared with 86.43 and 86.32 percent reduction in Fipronil and Carbofuran, respectively after 7-days at 2nd application whereas the lowest damage reduction (50.0%) was found in Fipronil followed by Cartal (51.66%) and Carbofuran (53.33%). Fipronil treated plots showed a significantly maximum grain yield (360 kg/plot) followed by Cartal (320 kg/plot) and Carbofuran (280 kg/plot). Fipronil proved to be the best resulted in the maximum CBR i.e., 1:24 as compared to 1:15 and 1:13 in Carbofuran and Cartal, respectively.

Keywords: *Chilo partellus*, insecticides, maize, Sahiwal

Introduction
Among the various factors, insect pests are the main cause of low yield. Of which, Maize borer (*Chilo partellus* Swinhoe) is considered to be the most destructive pest causing losses up to 75 percent [1]. Infestation at the seedling stage may cause total failure of the crop [2, 3, 4]. Yield losses of 24-75% have been reported by the attack of this pest alone [5, 6 7]. Farid *et al.* reported 10 – 50% damage by maize stem borer in Peshawar valley [8]. In Africa, loss caused by stem borers was 80% for maize [9]. Chouraddi and Mallapur, reported 2.47% and 1.2% yield losses per larva during kharif and rabi seasons, respectively **[10]**.
The loss incurred by *C. partellus* were minimized by applying insecticides. Studies conducted in the past revealed that Carbofuran was superior in controlling the pest compared with Methamidaphos and Ccypermethin [11]. Similarly Kakar *et al*. compared Carbofuran @ 19.76 kg/ha with Basudin 10G (diazinon) @ 19.75 kg/ha, Temik 10G, (aldicarb) @17.75 kg/ha, and Padan 4G (cartap) @ 22.23 kg/ha and reported that maximum net benefit was obtained in Carbofuran application (Rs.4851.77) followed Padan (Rs.3636.17), Temik (3431.17) and Basudin (Rs.2214.97) [12]. Kumar and Alam reported that the highest benefit: cost ratio (13.96:1) was evinced in insecticidal treatment flubendiamide 480 SC @ 0.2 ml/l in sequence with Carbofuran 3G @ 7 kg/ha [13]. They further reported that all the treatments were found significantly superior to untreated control in reducing the maize stem borer infestation and increasing the yield. Kumar and Kumar found that all the treatments were significantly superior over control among all the treatments [14]. Carbofuran recorded highest reduction of *C. partellus* population *i.e.* (7.70%) followed by Cypermethrin (9.86%) and Fipronil (13.38%), Indoxacarb (14.44%), Cartap (15.37%), Profenophos (17.63%) and Imidacloprid (19.47%). The further reported that the best and most economical treatment was Carbofuran (1:1.91), followed by Cypermethrin (1:1.88), Fipronil (1:1.70), Indoxacarb (1:1.59), Cartap (1:1.41), Profenophos (1:1.32), Imidacloprid (1:1.20) as compared to Control (1:1.11).
Keeping in view the above evidences the Carbofuran is being often used by the farmers in the field on maize crop for a long period in Pakistan as well as abroad. This insecticide is one of the most toxic Carbamate and banned in Canada and European Union (en.wikipedia.org/ wiki/carbofuran).

In California, illnesses in farm workers were reported by the application of Carbofuran (www.edc.gov/mmwr/pdf/wk/mm4806.pdf) because of solubility (in water) and slight persistence (in the environment) and toxic properties (to birds and aquatic organisms). The use of Furadan resulted in significantly higher mortality of natural enemies [15].

Department of Agriculture in Pakistan always recommends to use those pesticides against Maize stem borer which are safer to use, friendly to the environment, safe to soil fauna and most effective against the problem using all precautionary measures at standard doses. Therefore the present study was conducted with the objective to find out some pesticides which would be safe, effective and environmental friendly, so Carbofuran 3G was compared with Fipronil 0.3 G (a broad spectrum insecticide belong to phenylpyrazole family, new chemistry insecticide) and Cartal 10% G at their standard doses under field conditions.

Materials and Methods

Study was conducted to determine the comparative efficacy of Fipronil 0.3% G, Carbofuran 3% G and Cartal 10% G at their standard doses i.e., 19.76/ha, 19.76 Kg/ha and 4.94 kg/ha, respectively, against maize shoot borer, *Chilo partellus* (Swinhoe) in the farmer's field at Chak No. 187/9L District Sahiwal (Punjab, Pakistan) situated at Altitude 174-m, latitude 30° 39′ 51.84″ N Longitude 73° 06′ 29.88″ E (https://en.wikipedia/wiki/sahiwal, elevationmap.net/ sahiwal-pk)

High yielding variety 6654 (Syngenta) was sown on 5th July, 2015 on beds. Recommended optimum agronomic requirements of the inputs were used. The maize crop was sown with bed to bed distance 0.76-m and plant to plant distance 0.23-m. The plot size was kept at 340-m^2. Experiment was conducted in randomized complete block design with three replications including a control plot for each treatment. Non Experimental area was taken additionally. Pesticides were applied manually.

Regular pest scouting was done weekly and 1st pesticide application was done at ETL level of the pest that is 5% infestation and the insecticides were applied for a second time one month after 1st application. Data on the plant infestation were recorded from 10 plants selected at random from each plot 24 hours before and 24 hours, 72 and 7 days after each application. Percent infestation was calculated by the following formula:

$$\text{Infestation (\%)} = \frac{\text{Total Plants} - \text{Healthy Plant}}{\text{Total Plant}} \text{ x } 100$$

Percent reduction in infestation for each plot was calculated as under:

$$\text{Reduction (\%)} = \frac{\text{Percent infestation in control} - \text{Percent Infestation in treated plot}}{\text{Percent Infestation in Control Plot}}$$

The data regarding grain yield from each plot were recorded after harvest.

Cost Benefit Ratio [13] was also calculated to determine the best insecticide for recommendation to the farmers.

$$\text{CB Ratio} = \frac{\text{Benefit over Control}}{\text{Cost of Treatment}} \text{ x } 100$$

The data so recorded were processed for ANOVA following RCB Design with the help of IBM compatible computer using M-stat software. Treatments means were compared by DMR Test at P = 0.05.

Results and Discussion

The results (Table 1) reveal significant differences among treatments at all the post treatment intervals regarding plant infestations caused by *C. partellus*. The effect of insecticides was, however at par statistically at all the post treatment periods of both the applications except 72 hours of first application where Fipronil showed maximum infestation (3.00%) and was at par statistically with Cartal (2.90%). In the same treatment, Carbofuran showed minimum infestation (2.80%) and explored non-significant variation with those plots where Cartal was applied. However, after 24 hours and 7-days of the first application and after 72 hours of the second application, Fipronil showed low infestation as compared to other treatments. The present studies can partially be compared with those of Gunewardena and Madugalla who compared Fipronil 0.3 G with insecticides used other than those applied in the present study and recommended Fipronil for the control of stem borer [1].

Variation was found to be significant in all the treatments at all post treatment interval for both applications (Table 2).The insecticidal effect was observed to be non-significant in most of the post treatment intervals except after 72 hour of the first application and after 7-days of 2nd application. The minimum damage reduction was recorded to be 50.00 percent in Fipronil treated plots and did not show significant difference with those of observed in Cartal treatment (51.66%) at 72 hours of post treatment interval of 1st application, whereas Carbofuran treated plots showed significantly maximum damage reduction (53.33%) and was at par statistically with those of recorded in Cartal treated plots.

The plant infestation reduction was recorded to be 86.43 and 86.32 percent in Fipronil and Carbofuran treatments, respectively at 7-days after treatment during 2nd application and showed non-significant difference with each other. Cartal showed maximum reduction in infestation (87.78%) and differed significantly from other treatments.

The present findings cannot be compared with those of Khan and Amjad who applied Furadan 3G at different doses and found significant reduction in pest infestation [11]. Similarly Rauf *et al*. compared granular insecticides with the foliar insecticides and reported that Furadan and Fipronil were effective showing minimum number of dead hearts [15]. The present findings can also not be compared with those of Mashwani *et al*. who compared granula, seed dressing and foliar insecticides for the control of *C. partellus* and reported that Confidor and Actara were the most effective as compared to granular and foliar insecticides [16].

In the present studies, all the treatments differed significantly from one another regarding grain yield (Fig. 1). The plots treated with Fipronil showed a significantly the highest grain yield (360 kg/plot) as compared to those plots treated with Cartal (320 kg/plot) and Carbofuran (280 kg/plot). The grain yield was recorded to be 120 kg/plot in the control treatment. These results indicated very pronounce difference that Fipronil found to be the best treatment resulted in the highest yield, whereas Carbofuran, the inferior showing significantly the lowest grain yield. Cartal was categorized as intermediate.

The results presented in Table 3 reveal that Fipronil was proved to be the best treatment resulted in the maximum CBR i.e., 1:24 as compared to Carbofuran (1:15) and Cartal (1:13). The present findings are not in conformity with those of

Kumar and Kumar (2017) who found that the best and most economical treatment was Carbofuran (1:1.91), followed by Cypermethrin (1:1.88), Fipronil (1:1.70), Indoxacarb (1:1.59), Cartap (1:1.41), Profenophos (1:1.32), Imidacloprid (1:1.20) as compared to Control (1:1.11). The present findings are not in conformity with those of Kakar *et al*. (2003) who reported that maximum net benefit was obtained in Carbofuran application (Rs.4851.77) followed Padan (Rs.3636.17), Temik (3431.17) and Basudin (Rs.2214.97).

Conclusion

It was concluded that insect growth regulators need to be promoted because these are target specific and risk free.

Table 1: Plant Infestation (%) caused Stem Borer in different Treatments on Maize Variety 6654.

Treatments			Dose kg/ha	1st Application				2nd Application			
Tr. No	Common Name	Trade Name		24 hrs Before Treatment	Post Treatment Intervals			24 hrs Before Treatment	Post Treatment Intervals		
					24 hrs	72 hrs	7-days		24 hrs	72 hrs	7-days
T1	Refree	Fipronil 0.3 G	19.76	6.50	4.50 B	3.00 B	0.85 B	3.90	3.00 B	1.82 B	0.39 B
T2	Carbofuran	Carbofuran 3 G	19.76	6.30	4.60 B	2.80 C	0.88 B	3.85	3.00 B	1.86 B	0.39 B
T3	Carbofuran 10 G	Cartal 10 G	4.94	6.40	4.50 B	2.90 BC	0.85 B	3.89	3.00 B	1.86 B	0.35 B
T4	Control		-	6.50	6.50 A	6.00 A	4.50 A	3.90	3.93 A	2.95 A	2.85 A
Lsd at 5%					0.368	0.189	0.063		0.731	0.089	0.063
F. Value				0.43 ns	85.10**	788.45**	6933.35**	0.36 ns	4.87*	470.77**	6889.69**

Means sharing similar letters in column are not significantly different by DMR Test.
** Significant at $p \leq 0.01$
ns = Non-significant

Table 2: Plant Infestation Reduction (%) caused by Stem Borer in different Treatments on Maize Variety 6654.

Tr. No	Name of Treatments		Dose kg/ha	Post Treatment Reduction in Plant Infestation (%)					
	Common Name	Trade Name		1st Application			2nd Application		
				24 hrs	72 hrs	7-days	24 hrs	72 hrs	7-days
T1	Fipronil 0.3 G	Refree 0.3G	19.76	30.77 A	50.00 B	81.11 A	23.08 A	38.30 A	86.43 B
T2	Carbofuran 3 G	Carbofuran 3 G	19.76	29.23 A	53.33 A	80.44 A	23.08 A	36.95 A	86.32 B
T3	Carbofuran 10 G	Cartal 10 G	4.94	30.76 A	51.66 AB	81.11 A	23.08 A	36.95 A	87.75 A
T4	Control		-	0.00 B	0.00C	0.00 B	0.00 B	0.00 B	0.00 C
Lsd at 5%				1.981	3.189	1.679	6.277	2.078	0.776
F. Value				698.87**	787.78**	6940.99**	40.45**	970.64**	37363.15**

Means sharing similar letters are not significantly different by DMR Test.
** Significant at $p \leq 0.01$
ns = Non-significant

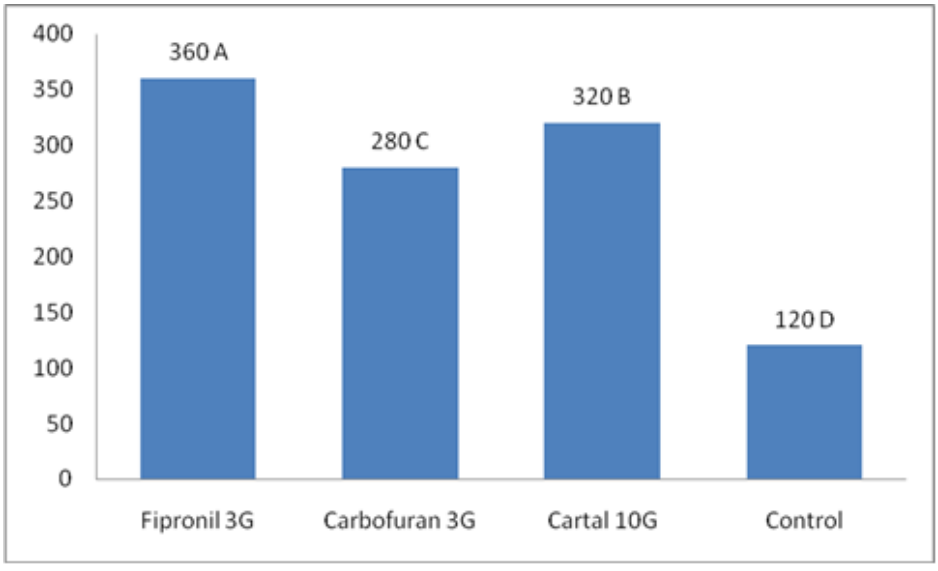

Fig 1: Showing Grain Yield (kg/plot) in different Treatments on Maize Variety 6654 (Sygenta)

Table 3: Cost Benefit Ratio

Treatment	Income				Expenditure			CBR
	Yield kg/ha	Net Yield kg/ ha	Price of Grain (Rs.)	Income (Rs.)	Insecticide used kg/ha for two applications	Price of insecticide per kg (Rs)	Cost of Insecticide + Labour Charges @ Rs. 2000 per application	
Fipronil 3G	10587	7057	23.0	162329.2	39.52	68.75	6717	1:24
Carbofuran 3G	8234	4704.8	23.0	108210.4	39.52	81.25	7211	1:15
Cartal 10 G	8411.2	5882	23.0	135286.0	9.88	600	9928	1:13

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