

Effect of various insecticides on the control of *Atherigona soccata* (Rond.) and *Chilo partellus* (Swinhoe) in maize *Zea mays* (L.)

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Abstract

Atherigona soccata (Rond.) and *Chilo partellus* (Swinhoe.) are major insect pests of maize in Sahiwal Punjab, Pakistan that cause considerable yield losses. For their efficient chemical control, four insecticides (Poncho Plus 600 FS, Confidor 70 WS, Actara 70 WS and Furadan 3G) were evaluated, to determine which were most effective. The first three of these insecticides were used as seed dressing while Furadan 3G was applied alongside the seed at sowing time, with a second dose applied in the plant whorl with the second irrigation. The results showed that in autumn Confidor 70WS gave the best control against shoot fly infestation (1.61%), followed by Poncho Plus 600 FS (1.69%), Actara 70WS (2.13%) and Furadan 3G (2.88%) as compared with the control (10.87%). Poncho Plus 600 FS gave the best control against maize stem borer infestation (2.21%), followed by Furadan 3G (2.34%), Confidor 70WS (6.04%) and Actara 70WS (8.71%) as compared with the control (20.79%). In terms of yield, Poncho Plus 600 FS gave the maximum yield (6061 kg/ha) followed by Furadan 3G (5614 kg/ha). Data from 2017 revealed that Actara 70 WS gave the best control against shoot fly infestation (0%) followed by Poncho Plus 600 (0.88%); whereas Poncho Plus 600 FS gave the best control against maize borer infestation (0.88%), followed by Furadan 3G (1.32%). In terms of yield, Poncho Plus 600 FS produced the maximum yield (12,375 kg/ha), followed by Confidor 70 WS (11,681kg/ha).

Keywords: clothianidin, imidacloprid, thiamethoxian, carbofuran

1. Introduction

Maize *Zea mays* (L.) is ranked third in world cereal crops with respect to cultivation. This high-yielding crop is successfully grown in all types of ecological regions of the world (Shah, *et al.* 2006) [18]. After wheat and rice, corn is the third largest grown crop of its group sown in Pakistan, and is the second highest autumn crop in Pakistan, cultivated largely in the Punjab and Khyber Pakhtunkhwa provinces (Khalil & Jan, 2005) [10]. Corn is particularly important in countries that have rapid population growth, such as Pakistan, to fulfill dietary needs. Corn and Sorghum are the major products of poultry feed in Pakistan (Mumtaz *et al.*, 2018; Mumtaz *et al.*, 2019) [14]. In Pakistan, corn adds 2.6 % to the value of agriculture and 0.5 percent to GDP. In 2018–19, maize was cultivated on 1,318 thousand hectares, a 5.4 percent increase on the previous year's 1,251 thousand hectares. Production was 6.309 million tonnes – a 5.1 percent increase compared to a target of 6.0 million tonnes and a 6.9 percent increase over the previous year's production (5.902 million tonnes) (Govt. of Pakistan 2018-19) [7]. Corn production increased as farmers shifted from cotton and sugarcane, owing to the availability of improved varieties of seed and better economic returns.

The maize crop is vulnerable to attack by 130 different species of insect pests, of which about half a dozen lead to economic losses (Atwal & Dhaliwal, 1997) [4]. Among these, stem borer (*Chilo partellus*) and shoot fly (*Atherigona soccata*) are the most serious insect pests, attacking all parts of the plant except the roots (Anonymous, 1986 [3]; Khan 1983) [11]. The maize stem borer, *Chilo partellus* (Swinhoe), is a key pest and is

reported to cause 7.0–35.7 per cent loss in grain yield in different agro-climatic regions of India (Anonymous, 2013 [2]; Yousaf *et al.*, 2019) [14]. These insects, if not appropriately managed, can cause major yield losses (Anonymous, 1986 [3]; Khan 1983 [11]; Yousaf *et al.*, 2018) [15, 17, 19] or even crop failure (Ahmed *et al.*, 2002; Ahmed *et al.*, 2003; Nazet *et al.*, 2003; Saeed *et al.*, 2018). The maize stem borer is a lepidopteran whereas the shoot fly is dipterous; larvae of both insects are the harmful stage in their life history.

The primary tool to control insect pest in maize is the use of chemicals. However, in subsistence farming systems such as those found in Pakistan, farmers are often not aware of the appropriate chemistry or use of suboptimal or supraoptimal doses of chemicals against insect pests. This situation causes flaws in insect pest management system and can lead to environment deterioration. The problem is intensified by the dearth of field studies regarding the efficacy of different insecticides against these two insects. Therefore, the objective of this field study was to evaluate the efficacy of different insecticides against *Chilo partellus* and *Atherigona soccata*, and their impact on maize grain yield.

Materials and Methods

The experiment was conducted in autumn 2016 and spring 2017 at the Maize and Millets Research Institute, Yusufwala-Sahawal (30.6°N latitude and 73.1° longitude) in the Punjab. Treatments comprised four different insecticides that were evaluated for their efficacy against maize shoot fly and stem borer. The detail of the treatments is given in Table 1.

Table 1: Detail of treatments

Name	Active ingredient	Mode of application	Dose
Poncho Plus 600FS	Clothianidin+ Imidacloprid	Seed treatment	20 ml /kg of seed
Confidor 70WS	Imidacloprid	Seed treatment	5 g/kg of seed
Actara 70WS	Thiamethoxian	Seed treatment	5 g/kg of seed
Furadan 3G	Carbofuran	Side dressing at sowing and top dressing with second irrigation	19.76 kg/ha at each event

Treatments were laid out according to randomized complete block design, replicated in quadruplicate on 11 August 2016 (autumn season) and 9 February 2017 (spring season). A control plot was also maintained for comparison. The experiment was sown in plots measuring 4 m × 2.25 m in suitable moisture conditions. Sowing was done on 75 cm spaced ridge-furrows, maintaining a plant distance of 20 cm in autumn and 15 cm in spring with the help of a dibbler. A single cross maize hybrid YH-1898 from the Maize and Millets Research Institute, Yusafwala-Sahiwal was used as planting material. Recommended fertilizers for the area (227:143:90 NPK ha⁻¹) were applied to all plots.

Data regarding maize shoot fly infestation were recorded after three weeks of germination and data of maize stem borer infestation were recorded after six weeks of germination. At

each sampling date, all plants from the central two rows were examined for insect attack, and percent attack was calculated. At maturity, the whole plot was manually harvested to record grain yield per hectare. The data collected were subjected to analysis of variance (ANOVA), to ascertain the significance of treatments. Means of significant effects were separated by LSD ($P \leq 0.05$ levels between the means).

Results and Discussion

The effect of treatments on plant stand was significant ($P < 0.05$). In autumn, the maximum plant stand was recorded. The results from autumn 2016 and spring 2017 are given below in Table 2. They clearly show the efficacy of the trialed insecticides against the target insect pests.

Table 2: Effect of different insecticides on maize shoot fly (*Atherigona soccata*) infestation in terms of percentage and percent infestation reduction in autumn 2016 and spring 2017

Treatments	Plant stand		Shoot fly infestation (%)		Infestation reduction (%)	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
Poncho Plus (600 FS)	41 a	57 a	1.69 b	0.88 b	84.45 a	94.09 b
Furadan (3G)	38 b	55 bc	2.88 b	0.89 b	73.50 b	94.03 b
Confidor (70 WS)	39 ab	57 a	1.61 b	1.75 b	85.18 a	88.26 c
Actara (70 WS)	39 ab	56 b	2.13 b	0.00 b	80.40 ab	100 a
Control	30 c	57 a	10.87 a	14.91 a	-	-
LSD @ 5 %	2.6	1.62	1.77	5.18	9.65	5.4

Treatments significantly increased ($P < 0.05$) the plant stand in both seasons, and decreased ($P < 0.05$) shoot fly infestation as compared to control. There were differences of seasonal infestation owing to the temperature (Kumar *et al.*, 2014), but these did not vary within the treatments. In autumn, the minimum infestation (1.61%) was in seed treated with Confidor 70WS, although this was not significantly different from treatments with Poncho Plus 600FS (1.69%) and Actara 70WS (2.13%), compared with the control (10.87%). Treatment with Furadan 3G was the least effective in minimizing shoot fly infestation (2.88%) as compared

with the control (10.87%). These outcomes concur with earlier results, in that the chemicals used in the present trials were effective (Rao and Panwar, 1996; Balikai, 2000^[9]; Karibasavraja *et al.* 2005)^[9].

In spring, Actara 70WS gave the best control against shoot fly infestation (00%), followed by Poncho Plus 600FS (0.88%), Furadan 3G (0.89%) and Confidor 70WS (1.75%), as compared with the control (14.91%). No significant variation was found among the treatments, but the highest infestation was recorded during spring owing to the low temperature at germination stage.

Table 3 shows the results for maize stem borer.

Table 3: Effect of different insecticides on maize stem borer (*Chilo partellus*) infestation (%) and infestation reduction (%) in autumn 2016 and spring 2017

Treatments	Maize stem borer infestation (%)		Infestation reduction (%)		Grain yield (kg/ha)	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
Poncho Plus (600 FS)	2.21 c	0.88 c	89.36 a	85.66 a	6061a	12375 a
Furadan (3G)	2.34 c	1.34 bc	88.74 a	78.17 a	5614 a	11681 b
Confidor (70 WS)	6.04 bc	1.32 bc	70.94 b	78.50 a	4731 b	11425 b
Actara (70 WS)	8.71 b	2.66 b	58.10 b	56.67 b	4409 b	11336 b
Control	20.79 a	6.14 a	-	-	3345 c	9953 c
LSD @ 5 %	4.8	1.73	16.19	14.7	708	556

The trials were repeated in spring 2017 with the same methodology as for the shoot fly.

The data presented in Table:3 indicate that, during autumn 2016, Poncho Plus 600 FS gave the best control against maize borer minimizing infestation (2.21%) followed by Furadan 3G (2.34%), Confidor 70WS (6.04%) and Actara

70WS (8.71%) as compared with the control (20.79%). Maize stem borer infestation was higher (70.46%) in autumn than in spring, and had a significant effect on yield reduction (up to 51%). In terms of yield, Poncho Plus 600FS gave the highest yield (6061 kg/ha), followed by Furadan 3G (5614 kg/ha).

During spring 2017, Poncho Plus 600 FS gave the best control against maize borer, showing the lowest infestation (0.88%), followed by Confidor 70WS (1.32%) and Furadan 3G (1.34%) and Actara 70WS (2.66%), compared with control (6.14%). As far as the yield is concerned, Poncho Plus 600FS was highest (12,375 kg/ha) followed by Confidor 70WS (11,681 kg/ha). All of the chemicals tested were significantly effective against the pests as compared with the controls. This is in line with other publications that that have shown the effectiveness of Furadan against maize stem borer Khan (1983) ^[11], Marwaha *et al.* (1984) ^[13], Ahmad (1987) ^[1], Halimie *et al.* (1989) ^[8], and Rahim and Masud (1992) ^[16].

It was clear that for shoot fly, the lowest infestation was in spring 2017, with Atara 70WS (0%), with a yield of 11,336 kg/ha; for maize stem borer, the lowest infestation was in spring 2017 with Poncho Plus 600 (0.88%), with a yield of 12,375 kg/ha. It was also clear that maize stem borer reduces yield more (8.3%) than shoot fly.

Conclusion

Confidor 70WP and Actara 70WP should be used for the control of maize shoot fly (*Atherigona soccata* Rond.) on autumn and spring crops owing to its high efficacy; Poncho Plus 600 FS should be used for the control of maize stem borer (*Chilo partellus* Swinhoe) for higher yield.

Applying Furadan 3G once or twice at corn plant leaf whorl stage is a common practice in the Punjab, Pakistan for the control of maize stem borer. This requires labor charges for two people for one day per acre for each application. Based on labor charges from the Maize & Millets Research Institute, Yusafwala-Sahiwal, the official payment is PKR= 538 (US\$ 3.40) per day per person, which amounts to PKR=1076 (US\$ 6.80) per application (given that it require two people). Thus, for two applications, the cost will be PKR=2152 (US\$ 13.53), plus the cost of Furadan 3G, giving a total of PKR=900 (US\$ 5.70). A separate seed treatment for shoot fly is required if Furadan 3G is used to control stem borer; this extra treatment will cost PKR=700 (US\$4.40) per acre. The current trials show that seed dressing with Poncho Plus 600 FS alone gives control of both maize borer and shoot fly, the most serious insect pests of maize, and can reduce the cost of production by PKR=3700 (US\$ 23.27) per acre in the current scenario of Pakistan. This practice will also help to reduce environment, water and soil pollution.

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