

**Evaluation of the efficacy and residual activity of Chlorantraniliprole 600 g/L SC against fall armyworm *Spodoptera frugiperda* (J.E. Smith,1797) (Lepidoptera: Noctuidae) on Corn (*Zea mays* Linnaeus, 1753)**

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**Abstract**

The fall armyworm, *Spodoptera frugiperda* (J.E. Smith,1797), (Lepidoptera: Noctuidae) is a polyphagous pest that has a worldwide distribution. It is an invasive species and can cause significant damage to corn. In this study, the effectiveness of four doses (2, 3, 4, and 5 ml/da) of Chlorantraniliprole 600 g/l against *S. frugiperda* was first investigated. Then, the residue amount of 5ml/da dose of Chlorantraniliprole 600 g/l was determined. Efficacy trials were conducted in arable fields in Adana and Şanlıurfa provinces from August to September 2023 according to the randomized block design with five characters (four doses of the trial insecticide and control) and four replications. Residue experiments were carried out in Adana and Şanlıurfa provinces. When the seventh day counts were evaluated, mortality from the 2 ml/da dose was between 39.67 and 38.84%; mortality from the 3 ml/da dose was between 56.68 and 57.53%; mortality from the 4 ml/da dose was between 75.05 and 77.22%; and mortality from the 5 ml/da dose was between 93.96 and 93.86%. As a result of the sampling, the residue amount of Chlorantraniliprole in corn was found to be below the residue limit determined in Türkiye and Europe. It was concluded that a dose of 5 ml/da of Chlorantraniliprole 600 g/l can be used as an effective dose against *S. frugiperda*.

**Keywords:** Chlorantraniliprole, Corn, Residue, *Spodoptera frugiperda*

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**INTRODUCTION**

Corn is one of the most important cereal crops consumed in the world. In 2022, 1.129 million tons of corn were produced in 206 million hectares of planting area globally. In Türkiye, 8.5 million tons of corn were produced in 9.1 million da of planting area (Anonymous, 2023a). *Spodoptera frugiperda* (J.E. Smith, 1797), (Lepidoptera: Noctuidae) is a polyphagous pest and causes damage to many crops, including corn, rice, sorghum, and cotton (Montezano et al., 2018). The pest, which was first seen in cornfields in Adana province in Türkiye in 2022, has a wide distribution around the world (Wang et al., 2020; Pehlivan and Atakan, 2022; Mohamed et al., 2022). The larvae of the pest damage the leaves of the plants and can also cut the growth centers of the plants and cause them to dry out. Damage may increase depending on the larvae density (Anonymous, 2019). Chlorantraniliprole is known as a systemic insecticide with broad spectrum activity against Lepidoptera pests. (Adams et al., 2016). It leads to paralysis and death by activating the insect's ryanodine receptors and causing the internal calcium stores to be lost (Cordova et al., 2006). For the harvested products to be consumed healthily and safely, attention needs to be paid to the acceptable residue rate. The aim of this study was to evaluate the effectiveness of four doses (2, 3, 4, and 5 ml) of Chlorantraniliprole 600 g/l SC against *S. frugiperda*. In addition, the residue amount of the active substance at a dose of 5 ml/da was determined.

## MATERIALS AND METHODS

### Evaluation of the Effectiveness of Chlorantraniliprole (600 g/L)

The trial was conducted in cornfields in Adana (37°08'32.3"N 35°18'49.1"E) and Şanlıurfa (36°55'39.7"N 38°29'53.5"E) provinces in the period from August to September 2023 using a randomized block design with five characters (four doses of the insecticide and control) and four replications. The provinces selected are located in different geographical regions. Since there is no plant protection product with similar properties to Chlorantraniliprole, such as active substance and percentage, formulation, effect and application method, licensed as a comparator insecticide in the study, it was tested comparatively with the control. During the trial, it was determined that the plants were 30-35 cm tall, and that phenologically the plants generally had six leaves (BBCH 16). P 1551 hybrid varieties are used in Adana, while P0900 hybrid varieties are used in Şanlıurfa in arable fields (Seed date: 07.07.2024). In the examination carried out in the field in the direction of diagonals before the trial, fall armyworm larvae were searched for in the plant residues and weeds around the roots of randomly selected plants. As a result of this examination, it was determined that the larvae were scattered on the plants and there were more than two larvae (one-to-three stages) per plant. The plot size in the experiment was determined as 105 m<sup>2</sup> (10 plant rows x 15 m). Surface spraying was carried out in Adana on 05.09.2023 and in Şanlıurfa on 12.10.2023. The spray was applied to all plants in the plot in such a way that it would be distributed homogeneously. During the spraying, care was taken to wet all the green parts of the plants from top to bottom and also the weeds and plant residues around the plant. Counts were made on five different points in the inner part of the plot, after leaving sufficient safety strips at the beginning, sides and ends to reduce the edge effects of the plot, and on five plants located next to each other in the same row, for a total of 25 plants. During the count, all above-ground parts of the plant and the plant residues and weeds around it were examined and the live larvae found were counted and recorded. Counts were made before spraying and three, seven and 14 days after spraying. In the analysis, the results of the counting results were determined by applying the Henderson-Tilton formula to live larvae to determine the percentage effects of the insecticide. Variance analysis and the Duncan test were applied to the angle values of the percentage effects of the doses. No other pesticide was applied in the experimental area during the study.

### Evaluation of the Residue of Chlorantraniliprole (600 g/L)

The study was conducted in arable fields in Adana and Şanlıurfa. The study included two characters, namely the recommended 5 ml/da dose of insecticide and the control. Each plot in the experiments was 100 m<sup>2</sup> and three sprayings were performed at one-week intervals. To ensure homogeneous distribution of the pesticide to the plants in the plot, each row was entered and care was taken to spray every part of the plant thoroughly. Since the period between the last spraying and harvest (PHI) was predicted as 14 days by the company, six samples were taken from corn according to the "Standard Test Method for Testing Residues of Plant Protection Products on Plants or Plant Products". These samples were taken on day 0, and the first, fifth, 10th, 14th and 21st days after spraying. Samples were taken from the sprayed plot and the control plot on the same day. To obtain sufficient amount of corn grain sample, more than 12 plants were cut from different parts of the inner part of the plot and 12 cobs were randomly taken from these plants (Anonymous, 2023b). Samples for each character were labeled in separate containers and stored in an ice box (-20 °C). After the sampling process was completed, all samples were delivered to BİLÇEV Private Food Control Laboratory for residue analysis by preserving the cold chain feature. The QUECHERS extraction method was applied in residue analysis and the extracted products were analyzed with LC-MSMS device.

## RESULTS AND DISCUSSION

The effects of Chlorantraniliprole 600 g/l on live larvae (%) are given in Table 1.

When Table 1 is examined, it is seen that the greatest effect of Chlorantraniliprole 600 g/l was seven days after spraying in both regions. The greatest effect was found at a dose of 5 ml/da in both regions. The effect on live larvae was 93.96% in Adana and 93.86% in Şanlıurfa, and these results are statistically significant. Chlorantraniliprole is a systemic insecticide and is highly effective against lepidoptera (Adams et al., 2016; Moustafa et al., 2021). It is known that this active substance can activate the ryanodine receptors of the insect, causing paralysis and death. Moreover, it has been reported in studies that it has a very strong effect on *S. frugiperda* (Li et al., 2021; Meghana et al., 2023; Song et al., 2023). The results obtained in our study support the results of these studies.

The residue amounts in the residue trial conducted in cornfields in Adana and Şanlıurfa provinces are given in Table 2.

Table 1. Mortality effect of Chlorantraniliprole 600 g/l on *Spodoptera frugiperda* larvae in Adana and Şanlıurfa provinces (%)\*

Characters	Adana (larvae%)				Şanlıurfa (larvae%)			
	T+0 (Mean larvae)	T+3	T+7	T+14	T+0 (Mean larvae)	T+3	T+7	T+14
Chlorantraniliprole 600 g/l (2 ml/da)	90.50a	38.05d	39.67d	34.59d	83.00a	37.95d	38.84d	34.62d
Chlorantraniliprole 600 g/l (3 ml/da)	92.00a	55.40c	56.68c	50.84c	84.00a	56.26c	57.53c	51.86c
Chlorantraniliprole 600 g/l (4 ml/da)	91.50a	73.97b	75.05b	66.60b	83.00a	75.14b	77.22b	66.35b
Chlorantraniliprole 600 g/l (5ml /da)	92.50a	92.41a	93.96a	83.62a	82.75a	92.93a	93.86a	85.03a
Control	91.25a				84.00a			

\*Means followed by different lowercase letters are significantly different ( $P < 0.05$ ) within a column for the first

Table 2. Residue amounts in the residue trial conducted in cornfields in Adana and Şanlıurfa provinces

Parcels	Sampling day(T:treatment)	Adana	Şanlıurfa
		Chlorantraniliprole (mg/kg)	Chlorantraniliprole (mg/kg)
Control	T+0	<0,010	<0,010
Application	T+0	<0,010	<0,010
Control	T+1	<0,010	<0,010
Application	T+1	<0,010	<0,010
Control	T+5	<0,010	<0,010
Application	T+5	<0,010	<0,010
Control	T+10	<0,010	<0,010
Application	T+10	<0,010	<0,010
Control	T+14	<0,010	<0,010
Application	T+14	<0,010	<0,010
Control	T+21	<0,010	<0,010
Application	T+21	<0,010	<0,010

Considering all the sampling, the residue amounts of the active substance Chlorantraniliprole in corn were below the residue limits determined in Türkiye and Europe (Chlorantraniliprole: 0.02 mg/kg), so it was concluded that the samples taken from the 14th day were reliable. Similar studies are also available. Barmota et al. (2021) reported that the residues in corn leaves were below the quantification limit (LOQ) of 0.03 mg/kg 30 days after spraying at the recommended dose.

## CONCLUSION

This study aimed to evaluate the effectiveness of four doses (2, 3, 4, and 5 ml) of Chlorantraniliprole 600 g/l SC against *S. frugiperda*. It also aimed to determine the residue amount of the active substance at a dose of 5 ml/da. As a result of the analyses, it was determined that the dose of 5 ml/da of Chlorantraniliprole 600 g/l SC produced the greatest effect. In addition, no residue risk was found in the samplings. It can thus be said that a dose of 5 ml/da of Chlorantraniliprole 600 g/l SC can be used effectively against *S. frugiperda*.

## Compliance with Ethical Standards

### Peer-review

Externally peer-reviewed.

### Declaration of Interests

The authors have no conflict of interest to declare.

### Author contribution

The contribution of the authors to the present study is equal. All the authors read and approved the final manuscript. All the authors verify that the text, figures, and tables are original and that they have not been published before.

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