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Spotted stem borer, *Chilo partellus* (Swinhoe) infestation in corn fields of Türkiye

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Abstract: The presence of spotted stem borer, *Chilo partellus* Swinhoe (Lepidoptera: Crambidae) in Türkiye was recorded for the first time in 2014. *Chilo partellus*, an invasive species, originates in Southeast Asia and is widely distributed in Asia and Africa. It is among the most important pests of corn and sorghum with a high competitive ability among stem borers. Therefore, the study was carried out in 2018 and 2019 to determine the spread of the pest and the rate of contamination in the corn production areas which are the highest in the provinces of the Eastern Mediterranean and the Southeastern Anatolia Region of Türkiye. In both regions, sampling was carried out in 503 fields on a total area of 3.743,4 ha in 2018, and in 466 fields on a total area of 3.520,4 ha in 2019. The study revealed that *C. partellus* spread to Kahramanmaraş, Gaziantep, and Kilis provinces of the Southeastern Anatolia region, and entered the Erdemli district of Mersin for the first time in 2018 and the Mut district for the first time in the Eastern Mediterranean region in 2019. The infestation rate of the pest in the first crop corn production areas was found to be lower than in the second crop corn. As the number of pesticide applications increased in the fields where chemical control was applied, the rate of contamination decreased. While the contamination rate of the pest was 70% lower in the first crop corn, it reached 100% in the second crop corn. Furthermore, it has been observed that natural enemies are effective on the infestation rates of the pest. Since the pest spreads rapidly in seven provinces in both regions, it is very likely to infect other regions where corn is produced in Türkiye. If the pest is controlled especially in the vegetative period in corn, the rate of spread of the pest can be reduced.

Key words: *Chilo partellus*, corn, infestation, Türkiye

1. Introduction

Corn (*Zea mays* L.), a family of grasses, is one of the important cereal crops cultivated in Türkiye, and is grown in tropical and subtropical areas where water is sufficient. Corn plant is an important carbohydrate source used both in human nutrition and animal husbandry in the world and in our country. Corn is a strategically important product, also known for its wide use in industry. Grain and silage corn is planted on 1,217,893.7 hectares in Türkiye, and it ranks third among cereals with 6,626,142 t of grain and 27,186,949 t of silage corn production (TUİK, 2020). Approximately 30% of Türkiye's corn production is made in these provinces where the study was conducted.

Although there are many insect species in corn, the main damage is known as corn stalkborer, *Sesamia nonagrioides* Lef. (Lepidoptera: Noctuidae) and corn stem borer, *Ostrinia nubilalis* Hbn. (Lepidoptera: Crambidae). *Ostrinia nubilalis* is found in all regions of Türkiye, and

S. nonagrioides is found in all regions where corn is cultivated, except the Black Sea Region (Yürüten, 1971; Öztemiz et al., 2011).

While there are difficulties in controlling these corn borers, *Chilo partellus* (Swinhoe) (Lepidoptera: Crambidae), an invasive species that can compete with corn borers, was recorded for the first time in Türkiye during surveys conducted in first crop corn fields in Adana and Hatay provinces in 2014 (Sertkaya et al., 2014), in the same year spread to corn fields in Osmaniye (Bayram and Tonga, 2015) and in Tarsus district of Mersin in 2016 (Öztemiz and Akmeşe, 2018). The pest, which originates from Southeast Asia and poses a great risk to the corn plant, has spread over large areas in Asia and Africa. The pest has been recorded in India (Overholt et al., 1996) before the 1930s and in Africa (Malawi) since 1930 (Overholt et al., 1994). It has spread rapidly since 1932 in the hot, low-altitude eastern and southern regions of Africa (Kfir, 1997).

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It was determined that it spread from Tanzania in East to South Africa until 1952 (Overholt et al., 1994). By increasing its density in South Africa since 1958 (Van Hamburg, 1979), it formed a high population in regions up to 1600 m altitude and replaced *Busseola fusca* (Fuller) (Lepidoptera: Noctuidae), which is the main pest of sorghum and maize, within two years (Kfir, 1997). Spotted stem borer, *C. partellus* is the most important pest of maize and sorghum in the Far East, East and Southern Africa (Harris 1990; Van den Berg et al. 1991; Overholt et al. 1996; Getu et al. 2001; Guofa et al. 2001; Sylvain et al. 2015). The pest has spread in Asia in Bangladesh, Cambodia, India, Indonesia, Iran, Laos, Nepal, Pakistan, Sri Lanka, Thailand, Vietnam, Yemen, and Afghanistan (Harris 1990; Rajabalee 1990). Spotted stem borer was first recorded in Africa in 1930 in Malawi Malawi (Tams, 1932). Since then, it has spread to Eritrea, Ethiopia, Kenya, Lesotho, Mozambique, Somalia, South Africa, Sudan, Swaziland, Tanzania, Uganda, Zambia, and Zimbabwe (Overholt et al. 2000; Kfir et al. 2002; Sylvain et al. 2015). It has also been reported that this pest entered Israel in 2011 (Ben-Yakir et al. 2013). One of the reasons why *C. partellus* spreads faster than other harmful species and causes high contamination in corn and sorghum is that it completes its life cycle in a shorter time depending on the wintering period and has started to form a population earlier (Kfir, 1997). It has been inevitable to obtain basic data for the control of the pest, which is reported to be a potential risk in corn and sorghum production.

The invasive species has created a serious threat to corn production areas with the entry of *C. partellus* into the Türkiye. For this purpose, the study was carried out to determine distribution area of the pest and the rate of

infestation in the first and second crop corn production areas of both regions, the Eastern Mediterranean and the Southeastern Anatolia Region where corn cultivation is the highest in Türkiye in 2018 and 2019.

2. Materials and methods

The study was conducted in first and second crop corn fields of both regions in which the Eastern Mediterranean Region (Adana, Mersin, Osmaniye, Hatay and Kahramanmaraş province) and the Southeastern Anatolia Region (Gaziantep and Kilis province) of Türkiye in 2018 and 2019 (Table 1 and 2).

The sampled areas and numbers of the first and second crop corn fields of the provinces are given in Table 1.

Samplings for the determination of distribution area and infestation rates were made between May 14, and September 11, in 2018 and between May 09, and September 03, in 2019, since the length of the seed planting interval and the possibility of the pest to infect the first crop corn in the early period. Stalks and ear left in the field during and after harvest were also sampled. In the second crop corn, field studies were carried out between June 27, and November 7, in 2018; between July 3, and November 12, in 2019.

Sampling was done randomly according to the Bora and Karaca (1970), in three phenological periods (vegetative, generative and maturation) of corn and all above-ground organs of the plants were visually inspected. Based on the size of the field (0,1–5 ha and larger than 5 ha), a total of 25 or 50 plants were visually inspected at 5 or 10 different points and five plants on the same row at each point, and the percent contamination rates were deter-

Table 1. Corn production area and sampled area, and number of fields sampled in the provinces of the two regions.

Province	Corn production area (ha)*	Sampled area (ha)	Number of sampled fields
The Eastern Mediterranean Region			
Adana	95,782	958	192
Mersin	18,339.2	184	37
Osmaniye	33,010.6	331	67
Hatay	20,053.3	201	41
Total	167,185.1	1.674	337
The Southeastern Anatolia Region			
Kahramanmaraş	26,642.2	267	54
Gaziantep	4100.9	42	9
Kilis	2096.3	21	5
Total	32,899.4	330	68

Table 2. Data of the sampled corn fields in provinces of the two regions.

Province	Counties	2018				2019			
		First crop		Second crop		First crop		Second crop	
		Number of fields	Area (ha)	Number of fields	Area (ha)	Number of fields	Area (ha)	Number of fields	Area (ha)
Adana	Ceyhan	21	246.4	9	109.1	21	300.5	5	27
	Çukurova	16	98.3	8	56.8	4	28	9	28
	İmamoğlu	4	48.6	12	105.5	4	50	22	147
	Seyhan	9	93.7	2	20.5	9	86	6	16
	Karaisalı	5	45.4	21	90.2	6	53	20	83.8
	Kozan	29	243.8	15	84.4	21	161.5	9	64.5
	Yüreğir	22	189.4	2	10.4	10	102	-	-
	Tufanbeyli	-	-	-	-	-	-	3	1.6
	Yumurtalık	8	39.8	3	26	14	87	5	27
	Karataş	10	119.4	1	1.5	7	70	3	14
	Sarıçam	20	161.7	10	58.3	8	119	12	53.7
Total	144	1291.5	83	562.7	104	1057	94	462.6	
Osmaniye	Merkez	9	68.6	2	11.5	6	53	2	5
	Kadirli	12	112.2	3	13	29	308	6	21.5
	Toprakkale	8	627	1	5	4	29	1	5
	Sumbas	8	43	10	43.5	18	148	5	23
	Düziçi	6	39.8	18	79.3	10	81	7	38
	Total	43	326.3	34	152.3	67	619	21	92.5
Hatay	Antakya	1	12.5	-	-	4	38.5	13	89.5
	Arsus	11	66.2	2	9.6	-	-	7	41.5
	Erzin	-	-	-	-	2	12	-	-
	Kumlu	10	119	2	29	2	13	2	3
	Kırıkhan	1	4.5	6	44	5	55	-	-
	Reyhanlı	8	71.6	3	12,5	5	43	5	42.5
	Total	31	273.8	13	95.1	18	161.5	27	176.5
Mersin	Tarsus	22	178.5	4	48	28	256	-	-
	Silifke	-	-	16	44.5	-	-	2	12
	Mut	-	-	-	-	-	-	8	10.6
	Total	22	178.5	20	92.5	28	256	10	22.6
Kahramanmaraş	Dulkadiroğlu	4	43.1	10	54.5	3	14	7	29
	Narlı	8	83.4	4	43	4	32	-	-
	Türkoğlu	9	97	13	104.6	13	116	7	63.2
	Pazarcık	4	39.5	1	5	4	36	8	48
	Onikişubat	-	-	1	18	-	-	8	49
	Total	25	263	29	225.1	24	198	30	189.2

Table 2. Continued

Gaziantep	Oğuzeli	12	72	15	53	9	66	7	31
	Nurdağı	3	20.8	17	74	9	68	-	-
	Şahinbey	1	7.1	1	4	-	-	-	-
	Islahiye	-	-	1	4.2	-	-	-	-
	Şehitkamil	-	-	-	-	1	12	1	7
	Total	16	99.9	34	135.2	19	146	8	38
Kilis	Elbeyli	8	42.5	1	5	8	59.5	5	29
	Musabeyli	-	-	-	-	3	13	-	-
	Total	8	42.5	1	5	11	72.5	5	29
Total	289	2475.5	214	1267.9	271	2510	187	1010.4	

mined (Walker, 1971; Muhammad and Underwood, 2004; Sertkaya et al., 2014). It was considered as contaminated if any of the biological stages of pest or damage was detected and the infestation rate was determined by the formula shown below (Çetin et al., 2014).

$$\text{Infestation rate (\%)} = \frac{\text{Number of infected plants}}{\text{Total number of plants examined}} \times 100$$

3. Results

In the provinces of the two regions, sampling was carried out in 503 fields (289 fields first crop corn, 214 fields second crop corn) on a total area of 3743.4 ha, of which 2475.5 ha were the first crop corn and 1267.9 ha were the second crop corn in 2018, and in 466 fields (271 fields first crop corn, 195 fields second crop corn) on a total area of 3520.4 ha, of which 2510 ha were the first crop corn and 1010.4 ha were the second crop corn in 2019.

In the surveys carried out in the Eastern Mediterranean (Adana, Osmaniye, Hatay, Mersin and Kahramanmaraş) and the Southeastern Anatolia (Gaziantep and Kilis) regions in 2018 and 2019, in a significant part of the fields where *C. partellus* was spread but not infested, the plants were in the 4–6 leaf (seedling) stage and no contamination was detected in the Kahramanmaraş, Gaziantep and Kilis provinces, along with the Tufanbeyli district of Adana. It is thought that there was no contamination in the first crop corn fields as chemical spraying was done one or two times throughout the vegetation. Contamination rates of *C. partellus* were lower in the first crop corn planted early in the spring compared to the late planted. It has been observed that the date of sowing and the application of pesticides af-

fect the infestation rate of the pest. Contamination reaching 100% was detected in the first crop corn fields planted late and not sprayed. Especially in the second crop corn fields where chemical control was not applied, 100% yield loss was observed as a result of the invasion of *C. partellus*. The spotted stem borer invades plants starting from the end of the 4–6 leaf period until the pollination period in the first and second crop corn and leaves them from the milk stage. The infestation rate of *C. partellus* in the provinces of the Mediterranean and the Southeastern Anatolia regions in 2018 and 2019 are given in Table 3.

It was seen that *C. partellus* has spread to all provinces where survey was conducted (Table 3). More than half of the fields sampled and contaminated for two years in the provinces were in Adana in the Mediterranean region. In Southeastern Anatolia region, *C. partellus*, which was determined not to enter Kahramanmaraş, Gaziantep and Kilis provinces in the first crop corn in 2018, spread rapidly to the second crop corn in the same year. The distribution of *C. partellus* in these provinces of the Southeastern Anatolia region was the first record for the Türkiye. *C. partellus* has been shown to infest plants between 2%–100% in first and second crop corn. The spotted stem borer contaminates the second crop corn approximately four times more than the first crop. *C. partellus* infested the first crop corn at an average rate of 4.69% and 4.52%, respectively, in seven provinces in both years, and 20.87% and 15.90% contamination rates in the second crop corn.

4. Discussion

The first and second crop corn fields where *C. partellus* was not found were the fields in the districts where the pest has not yet entered or has a limited spread. Since a significant part of the fields in the first crop was planted in February-

Table 3. The infestation rate of *C. partellus* spread in the provinces of the two regions in 2018 and in 2019.

Province of the two regions	2018				2019			
	First crop		Second crop		First crop		Second crop	
	Number of fields	Infestation (%)	Number of fields	Infestation (%)	Number of fields	Infestation (%)	Number of fields	Infestation (%)
Adana	113	4.40	81	25.96	56	5.18	87	14.76
Osmaniye	26	5.65	33	17.90	36	4.83	21	18.48
Hatay	29	5.06	12	19.33	8	4.00	27	15.85
Mersin	18	4.55	20	13.94	14	2.00	4	25.00
K.Maraş	0	0	5	12.40	6	4.33	14	17.00
Gaziantep	0	0	7	4.57	7	2.93	4	10.00
Kilis	0	0	0	0	1	8.00	3	22.00
	186	4.69	158	20.87	128	4.52	160	15.90

March and the adults of *C. partellus*, which emerged in late March, April, and May, depending on the climatic conditions in the spring, preferred late sown corn fields, it was observed that some early planted fields were not infected by the pest. Since some of the first and second crop corn fields were in the 4–6 leaf stage, no contamination with the pest was recorded. Ofomata et al. (2000) reported that *C. partellus* prefers 6–10 leaves of corn plants for laying eggs. In the remaining limited number of first crops and especially in the second crop fields, it was observed that the pest was not transmitted due to the chemical control applications.

Overholt et al. (1996) determined that *C. partellus*, which was known in India before the 1930s, has spread from Asia to large areas planted with maize and sorghum in the hot and low altitude eastern and southern regions of Africa since 1932 (Kfir, 1997). *C. partellus*, which entered the corn and sorghum fields of the Middle East country Israel in 2011 (Ben-Yakir et al., 2013). The spotted stem borer was recorded for the first time in Türkiye in 2014 in the first crop corn in the Eastern Mediterranean Region (Sertkaya et al., 2014), and two years later, it spread to other parts of our country (Öztemiz and Akmeşe, 2018). In both years in the first and second crop corn, it was revealed that *C. partellus* infested the plants between 2%–100%. Nabeel et al. (2018) conducted a survey in 2016 in the seven districts of Punjab where the most corn was grown, the highest infestation of *C. partellus* was found in Khanewal with an average of 12%, followed by Multan with 6%, and the lowest infestation at 1% in Okara. It has been revealed that *C. partellus*, which infects 100% of second crop corn fields

in 6–12 leaf periods in the provinces of the Eastern Mediterranean region, with its high population, prevents the growth of plants by cutting the growth center and causes a significant part of them to completely dry out, the main pests, *S. nunagriodes* and *O. nubilalis* were prevented from infecting these fields. In a similar survey, Pehlivan and Atakan (2021) reported in their study in Adana in 2020, that the spotted stem borer did not allow the development of other corn stem borers due to early damage in second crop corns.

It was determined that the invasive species *C. partellus* spreads to the first and second crop corn fields in the provinces of the Eastern Mediterranean Region (Adana, Mersin, Osmaniye, Hatay and Kahramanmaraş) and Southeastern Anatolia Region (Gaziantep and Kilis). The distribution of *C. partellus* to the provinces of Kahramanmaraş, Gaziantep and Kilis is the first record for the Türkiye. This study revealed that *C. partellus* contaminates the second crop maize approximately four times more than the first crop. *C. partellus* has been shown to infest plants between 1%–100% in first and second crop maize. Since *C. partellus*, which infects 100% of the second crop corns in 6–12 leaf periods in the Eastern Mediterranean region with its high population, prevents the growth of plants by cutting the growth center and causes a significant part of them to completely dry out, the main pests *S. nunagriodes* and *O. nubilalis* are prevented from infecting these fields. Since the invasive species, *C. partellus*, was found to spread rapidly in seven surveys within the scope of the study, it is known that it can invade corn production areas by spreading to other parts

of our country. It is foreseen that the rate of spread can be reduced by early sowing in the first crop against the pest and by combating the two crops, especially in the vegetative development period, within the framework of integrated pest control principles.

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