SUPPRESSION OF OSTRINIA NUBILALIS IN CORN WITH UAV – SPRAY APPLICATION

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Abstract

The corn borer (*Ostrinia nubilalis*), along with the cotton bollworm (*Helicoverpa armigera*) and the western corn rootworm (*Diabrotica virgifera*), is one of the most important corn pests. Over 600,000 hectares planted in corn in Serbia are threatened by this pest. Crop height and a lack of adequate machinery limit the effective control of this pest. In order to explore the possibility of suppressing corn borer by using unmanned aerial vehicles (UAVs) for crop protection, an experiment was conducted at the location of Sremska Mitrovica (Glac) close to the Sava River (44.953980, 19.664681). The date of the treatment was determined taking into account the intensity of the moth flight and the threshold. Treatments with the DJI AGRAS T30 drone were performed on 17 June 2022 and 20 July 2022 with 15 l/ha of working liquid with insecticide based on chlorantraniliprole (150 ml/ha), with the addition of adjuvant agent. In addition to the yield, the researchers also analyzed the place where the larvae of the corn borer penetrated into the stalk and the cob, the position of the hole in the trunk, cob damage, cob disease, and the number of pupae in the stalk. Within the trial variants, three randomized repetitions were designed in the form of microplots. The laboratory analysis of the sampled corn plants showed that the average yield in the control was 5.18 t/ha, while in the treatment it was 6.94 t/ha, which was a difference of 34% due to cob damages and diseases, stalk breakage and all other symptoms found only in the untreated variant. The difference in yield shows that the drone treatment is effective and economically justified.

Keywords: *UAV-spray application, insecticide, crop treatment, suppression, Ostrinia nubilalis.*

Introduction

Corn as a crop in Serbia is produced every year on about one million hectares. In production conditions in Serbia, besides cotton bollworm (*Helicoverpa armigera*) and the western corn rootworm (*Diabrotica virgifera*) most important pest is the european corn borer *(Ostrinia nubilalis)*. Every year, to a greater or lesser extent, about 600,000 hectares are threatened by corn borer. This pest significantly affects the yield volume as well as quality in wide production areas. The corn borer is a polyphagous insect from the family *Crambidae*, which belongs to the order of *Lepidoptera*. It feeds with wide variety of wild and cultivated plants, but in its diet it prefers to choose corn (Bourguet et al., 2000). The caterpillars of the corn borer feed on the leaves and the inner parts of the corn stem (Umeozor, O.C. et all, 1985), causing indirect damage, reducing the plant's physiological activity and thereby weakening its potential for yield (Patch, L.H. et all, 1951). Caterpillars can also cause direct damage, feeding on tassel and cobs, damaging grains, and often causing plant breaks and cobs falling off. Direct damage to the yield can be from 15 to 25%, and in certain years with favorable climate conditions for insects, these damages can exceed 50%. In addition to mechanical damage, the action of corn borer also creates conditions that favor the development of

infections caused by various pathogens (*Fusarium spp. or Aspergilus spp.* infections), which produce mycotoxins, that can be very toxic if they enter the food chain of animals and humans (Franeta, F., 2019). In production conditions in Serbia, the corn borer usually has two generations (Čamprag, D., 1994, Almaši et al., 2002), but in some warm years and in conditions of warm and humid autumn, even third generation occurs. The flight of the first generation usually occurs from mid-May to the end of June. The flight of the second generation usually can start already at the beginning of July and last until the middle of August.
During the flight period of the corn borer moth, the corn is usually in advanced stages of development, in the tassel stage, when its height is a limiting factor for the use of conventional sprayers, so treatments can only be carried out with sprayers with high clearance. In recent years, the application of drones for crop treatments has been imposed as a new technique for treatments in protection against corn borer. Drones perform the treatments in a low flight above the crop (2-2.5 m), so the possibility for the treatment itself is not affected by the height of the crop, crop density or the condition of the soil moisture.
During the 2022 production season, an trial was conducted with the aim to evaluate the possibility of suppressing corn borer by drone DJI Agras T30 treatment, as well as evaluating the difference in yield achieved with this treatment.

Material and method

Experimental field was set up on the experimental field of the agricultural advisory service of Sremska Mitrovica at the Glac location (44.953980, 19.664681). Total area of the trial was 0,4 ha. The trial was carried out in two variants, a drone-treated variant and untreated variant. Within the trial variants, randomized repetitions of the size defined by the EPPO standard (10 x 4.2 m) were formed.

Image 1. –Trial location Glac, Sremska Mitrovica (44.953980, 19.664681), variants (treated and untreated) and micro plots positions (R1-R3)

Drone DJI AGRAS T30 was used for the treatment (https://www.dji.com/global/t30), which used XR11001VS nozzles. The treatment was performed in low flight from a height of 2 m. The swath width was 6 m. Speed of the drone during the treatment was 4 m/s.

Table 1. Environmental conditions during first treatment with drone

Date of treatment	6.17.2022.	Location	Glac, Sremska Mitrovica
Terain type	Flat, close to river Sava	Air temperature (℃)	22
Field area	0,4 ha	Air humidity (%)	52
Wind speed	1,5 (m/s)	Wind direction	NW

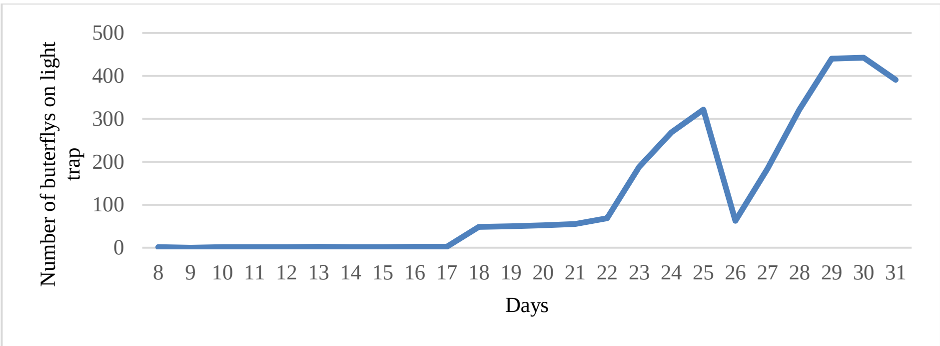
Table 2. Environmental conditions during second treatmant with drone

Date of treatment	7.20.2022.	Location	Glac, Sremska Mitrovica
Terain type	Flat, close to river Sava	Air temperature (℃)	24
Field area	0,4 ha	Air humidity (%)	40
Wind speed	1,5 (m/s)	Wind direction	NW

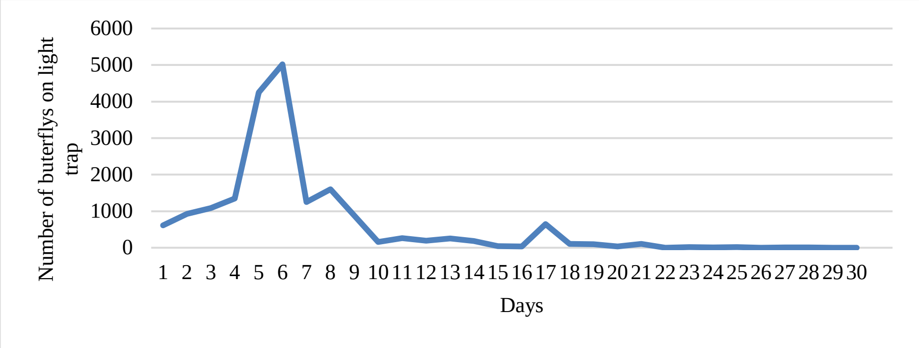
During the treatment, an insecticide based on chlorantraniliprole was used in the amount of 150 ml/ha, with the addition of a wetting agent based on fatty alcohol ethoxylate 20.3% and polydemethylsiloxane 1.0%. For the treatment, 15 l/ha of working liquid was used.

Image 2. –Maize insecticide treatmment with drone DJI AGRAS T30

In the treated variant, two treatments were carried out, the moment of which was determined by counting of moths on the nearby light traps and temperature thresholds for sawing the larvae of the corn borer.



Graph 1. Number of corn borer moths in May 2022. (locaton Laćarak)



Graph 2. Number of corn borer moths in June 2022. (locaton Laćarak)

The evaluation of the effects of the treatment was done 10 days before the harvest, by taking samples from all repetitions - micro plots within the variants of the trial (treated and non-treated). Three random samples (complete plants with roots) were taken from each micro plot - repetition, and in laboratory conditions an evaluation was carried out, which included: counting the punctures on the trunk of corn plants, locating the puncture site on the trunk, counting the punctures on the cobs, the number of pupae in the plants , occurrence of cob disease (*Fusarium spp. and Aspergillus spp.*), stem diameter, number of grain rows in the cob and weight of corn cobs by variant and repetition. Laboratory analysis of the sampled plants was done by longitudinal cross-section of the trunks and detailed examination of the cobs condition and cob measurement.

Results and Discussion

Stem and cobs damage analysis on the sampled plants showed that damage from the corn borer in the untreated variant of the experiment was present on all plants. On average, there were 6 punctures in the stem (min 2 max 16) and 6 punctures, in the cob (min 1 max 27). In 66% of the plant samples, a trunk breakage appeared under the tassel, on 22% plants under the cob, while in 12% of the plants no breakage occurred. The presence of pupae in the xylem on cross section of the trunks was found on 66% of the plants. The presence of fungal diseases was found on 45% of the cobs of the plant samples taken in untreated variant. On all cobs of plant samples taken in the untreated variant of the experiment, cob deformation was noted.

Image 3. - Damages caused by corn borer, larvae of the corn borer found in the corn trunk

Table 3. Laboratory evaluation of corn drone insecticide treatment samples

Varriant	Sample	No of holes in trunk	No of holes in cob	Stem brakage possition	No of pupae	Cob damage	Desease on cob	Stem diametar (mm)
Not treated rep 1	1	2	2	Below tassel	1	Yes	-	18
	2	6	1	Below cob	0	Yes	-	18
	3	16	12	Below cob	1	Yes	Fus. Asp.	17
Not treated rep 2	1	9	27	Below tassel	0	Yes	Fus. Asp.	17
	2	4	2	Below tassel	1	Yes	Fus. Asp.	17
	3	3	3	Below tassel	2	Yes	Fus. Asp.	17
Not treated rep 3	1	4	1	-	1	Yes	-	18
	2	3	3	Below tassel	0	Yes	-	19
	3	8	2	Below tassel	2	Yes	-	18
Treated 1	1	0	-	-	-	-	-	21
	2	0	-	-	-	-	-	24
	3	0	-	-	-	-	-	24
Treated 2	1	0	-	-	-	-	-	24
	2	0	-	-	-	-	-	23
	3	0	-	-	-	-	-	26
Treated 3	1	1	-	Below tassel	-	-	-	25
	2	0	-	-	-	-	-	24
	3	0	-	-	-	-	-	22

In the treated variant of the experiment only one sampled plant, in the cross-section of the trunk, had the presence of in the position below the tassel and above the cob. In the treated trial variant no cob deformations were detected, as well as no fungal diseases of any kind. In the untreated variant, the average thickness of the tree at the first internode was 17.67 mm, in the treated trial variant it was 23.67 mm. The grain rows number in the cob in the untreated variant was 14 (on 33% of cobs) and 16 (on 67% of cobs) while in the treated variant it was 16 (on 45% of cobs) and 18 (on 55% of cobs). Average weight of the cobs in treated variant was 162.6 g and in treated variant was 246.3 g with the difference in yield of 51.5%.

Table 4. Laboratory yield measurement

Varriant	Sample	Cob weight (g)	Average in repetition (g)	Average in variant (g)	Number of rows in cob
Not treated rep 1	1	98,7	165,3	162,6	16
	2	243			16
	3	154,3			16
Not treated rep 2	1	129,1	151,0		16
	2	139,7			16
	3	184,2			14
Not treated rep 3	1	212,2	171,4		14
	2	125,5			14
	3	176,6			16
Treated 1	1	297,2	255,5	246,3	18
	2	303,1			18
	3	166,1			16
Treated 2	1	210,2	212,6		16
	2	197,1			16
	3	230,4			18
Treated 3	1	345,6	270,8		16
	2	275,8			18
	3	190,9			18
Yield difference				**51,5%**	

After the harvest, the yield was measured with field weight. Results showed that the yield in the variant that was not treated was 5.18 t/ha, while in the treated variant yield was 6.94 t/ha, with the difference of 34% between variant.

Image 4. – Visual difference between cobs – treated and untreated trial variants

The difference in yield shows that the investment in crop treatment by drones is fully justified. The calculation of gross margin difference (based on the average yields in Serbia) shows that the investment in the drone for crop treatment pays off by treating corn on an area of 103 hectares in one season.

Conclusion

The results of the experiment show that drones for crop treatments during treatment with small amounts of treatment solution with properly designed and profiled air support can effectively and efficiently control the corn blight in the corn crop. The difference in yield achieved with this treatment justifies the investment not only in the treatment itself but also in the purchase of equipment. Drones for crop treatments can significantly contribute to pest protection in maize crops and reduce the risk of not only yield losses, but also cob and grain diseases, thus ensuring that the products of these pathogens do not enter the human and animal food chain.

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