PROTECTION AGAINST WESTERN CORN ROOTWORM ADULTS (DIABROTICA VIRGIFERA VIRGIFERA LECONTE) IN BARANYA COUNTY (HUNGARY)
AMERIKAI KUKORICABOGÁR (DIABROTICA VIRGIFERA VIRGIFERA LECONTE) IMÁGÓK ELLENI VÉDEKEZÉS BARANYA MEGYÉBEN

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ABSTRACT

With the settle of western corn rootworm (Diabrotica virgifera virgifera LeConte) (from 1995), the spectrum of pests with potential damage in Hungary increased. The pest was followed by trapping (with sex-pheromone and colour traps). In 2000 the pest was found in whole Hungary (except Győr-Moson-Sopron, Vas and Szabolcs-Szatmár-Bereg county), in extremely fluctuating number (1-700 pest/trap). In the southern region for maize production (Csongrád, Békés, Bács-Kiskun, Baranya, Tolna county), where the pest was found first, the number of it increased in various centres. Based on these data, we carried out insecticide experiment.

KEYWORDS: Western corn rootworm, larvae, damage, chemical control, insecticides

ÖSSZEFOGLALÁS

1995-től az amerikai kukoricabogár (Diabrotica virgifera virgifera LeConte 1868) betelepedésével új potenciális kártételi veszélyt jelentő fajjal bővült a hazai rovarfauna. Az egész országra kiterjedő csapdázással (szexferomon, színcsapdák) nyomon követett faj 2000-ben Győr-Moson-Sopron, Vas és Szabolcs-Szatmár-Bereg megyék kivételével, szélsőségesen ingadozó egyedszámban (1-700 db/csapda) hazánk egész területén megtalálható. A déli 1-es kukoricatermesztési zónában (Csongrád, Békés, Bács-Kiskun, Baranya, Tolna) –az első betelepedések kőrnyékén, kisebb-nagyobb gócokban egyre nagyobb létszámban jelentkezett.

Ezek alapján , nagyparcellás inszekticid vizsgálatok elvégzésére került sor.

KULCSSZAVAK: Amerikai kukoricabogár, lárva, kártétel, vegyszeres védekezési lehetőségek (inszekticidek)

RÉSZLETES ÖSSZEFOGLALÁS

1995-től az amerikai kukoricabogár (Diabrotica virgifera virgifera LeConte 1868) betelepedésével új potenciális kártételi veszélyt jelentő fajjal bővült a hazai rovarfauna. Az egész országra kiterjedő csapdázással (szexferomon, színcsapdák) nyomon követett faj 2000-ben Győr-Moson-Sopron, Vas és Szabolcs-Szatmár-Bereg megyék kivételével, szélsőségesen ingadozó egyedszámban (1-700 db/csapda) hazánk egész területén megtalálható. A déli 1-es kukoricatermesztési zónában (Csongrád, Békés, Bács-Kiskun, Baranya, Tolna) –az első betelepedések kőrnyékén, kisebb-nagyobb gócokban egyre nagyobb létszámban jelentkezett.

Ezek alapján , nagyparcellás inszekticid vizsgálatok elvégzésére került sor. A vizsgálati területeken a védekezés optimális időpontjának megállapítását parcellánként 3 db CSALOMON típusú csapda segítette, valamint 5x10 tövön állapítottuk meg az érési táplálkozást végző imágók számát. A kezeléseket Görcsönydobokán július 12-én és 28-án végeztük esti méhkímélő technológiával, légi úton 80 l víz felhasználásával. Az értékelések során a (permetezést követő 2., 7., 13., 20., napon) csapdák fogásszámát, a tövek összegzett imágó abundancia értékét állapítottuk meg, majd Henderson-Tilton képlettel hatékonysági százalékot számítottunk. A kezelést követő 4. napon 5x10 tövön mért egyedszám alapján az eszfenvalerát 0,3 l/ha dózisban 97,22%-os hatékonyságot nyújtott, a CSALOMON típusú szexferomon csapda fogási eredménye alapján pedig 90,5%-ossággal szerepelt.

INTRODUCTION

A new pest, western corn rootworm (Diabrotica virgifera virgifera LeConte) appeared in European maize production in the last decades of the 20th century. Earlier the pest was known only in the American Continent, where it was regarded as the most important pest of maize. The damage of western corn rootworm in Europe was detected first in Yugoslavia in 1992 [1]. The first adults were found in a maize field of Surcine, which is close to the airport of Belgrade. According to assumptions it could be dragged into the country a few years earlier – probably at the end of the '80s. The prompt date of the ecesis is not known, because there was a war in the region at that time.

In the summer of 1995 the pest appeared in Hungary as well: first in Csongrád county, than in Békés county. In 1999 it reached, in 2000 it crossed the northern border of Hungary. The European appearance of western corn rootworm urged specialists of affected and endangered countries to action. International programs started to locate and follow the pest and to work out protection methods in order to reduce expected economic damages. After the appearance of the pest in Hungary, the first damage caused by adults (leaf-paring) was followed by larvae damage (root damage, plant heeling) in 1997, which affected 4 southern counties in 2000.

The importance of the pest is explained by the fact that in maize monoculture it causes significant yield decrease, incomplete fructification and the accretion of the pest is increased in monoculture.

Beyond spiked cereals, maize is the most important crop in Hungary. It is an important feed-source (corn and silage) of hog raising, herding and poultry-farming. It is grown on more ten thousand hectares as hybrid- and sweet corn. The importance of pop-corn has also increased in the last years. The income from maize growing is above the income of other cereals. It is the main crop in several small and large farms. The sown area of maize was 1,1-1,3 million hectares in Hungary in the last years, from which 40% is monoculture. This ratio differs in each county. In 2002, the ratio of monoculture exceeded the average of the last decades. For example, in Baranya county the total sown area of maize was 101,500 hectares in 2002, from which 45,000 hectares (44%) was monoculture [2]. In 2003, the sown area of maize was 95,500 hectares, with a monoculture ratio of 38% [3]. In the absence of accurate data, it can be only presumed that the ratio of monoculture in the relative small fields of individual farmers exceeds the national average of monoculture (39%). In more counties it can reach 60-80%, because only maize represents the crops which can be grown with reasonable profit. The Crop Protection Authority follows the fluctuation of the pest's population, the areal distribution and the expected damage of it with different traps (sex-pheromone, colour traps) from its first appearance. The Authority is working out protection methods against both adults and larvae from 1997. However, results are not satisfactory yet.

European invasion

In 2000 western corn rootworm spread in 182 thousand km^2, which equals the area of two times Hungary. In 2003 the area infected with adults reached 300,000 hectares. The spread of the pest could be increased to more hundreds or 1000 km with accidental drag-in (air and road transport) [4].

The natural spread of its population is continuous, it's about 50 km/year. It is limited by natural barriers (e.g. the Carpathians, Dinara Mountain), although on plain areas it is accelerated (e.g. Great Plain) [5]. The spread of the whole population is stemless. The most important for us is to follow up the pest's spread in order to calculate with the expansion of the population and with local and regional damage and to work out protection methods [6].

Until 2004 the pest appeared and caused damage in 17 European countries. The following expansion data are based on scientific literature.

1992. Yugoslavia
1993. Yugoslavia
1994. Yugoslavia, Croatia
1995. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina
1996. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina
1997. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina
1998. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina, Italy, Bulgaria
1999. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina, Italy, Bulgaria
2000. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina, Italy, Bulgaria, Slovakia, Switzerland
2001. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina, Italy, Bulgaria, Slovakia, Switzerland, Ukraine
2002. Yugoslavia, Croatia, Hungary, Romania, Bosnia-Herzegovina, Italy, Bulgaria, Slovakia, Switzerland, Ukraine, Austria, Czech Republic
2003. Countries in 2002, and the Netherlands, England and Slovenia

Invasion in Hungary

Western corn rootworm appeared in Hungary in the summer of 1995. Adults of this new pest was found in more points of Csongrád and Békés counties. The Hungarian crop protection organisation has been studying the pest from 1994. This work was internationally organized within a frame of a FAO-programme in 1997 and 1998, together with the affected bordering countries. In the last 9 years the County Plant Health and Soil Protection Stations (today: Service) found the pest in all counties of Hungary. In 1999 western corn rootworm reached, in 2000 it crossed the northern border of Hungary [7].

The first larva-damage was detected in maize monoculture in 1998. The root damage reached grade 2-3 on Hills-Peters scale (Iowa). The endangered area has significantly increased [8]. The national survey showed that root damage with an Iowa scale value of 2-5 occurred on 22,9% of strongly infected monocultures (more than 10 adults/plant). The area reached 50,000 ha. In 2003 damage was moderated because of drought (35,000 ha). The most significant damage was measured in Tolna, Baranya, Békés, Bács-Kiskun and Csongrád counties. Less significant damage (few 100 hectares with Hills-Peters 3-3,5 value) was measured in Somogy, Hajdú-Bihar and Szolnok counties. So, with its damage the pest took over the best maize producing areas of Hungary [8].

Data from trapping and local observations of crop protection specialists both showed significant growth in the pest's population. This is confirmed by the fact that aerial crop protection was necessary against adults on more thousand hectares not only in 2000, but in 2001 as well [9]. The sprayed area was 28,000 ha in 2002 and 45,000 ha in 2003 [10].

MATERIALS AND METHODS

The insecticide treatment against western corn rootworm adults was carried out in the G-5 field of Agricultural Producing and Service Co-op Görcsönydoboka (86 hectares, brown forest soil). Consistence value (according to Arany): 56, humus content: 1,8%, gold crown value: 28. Last year of manuring: 1990 (40 t/ha). Maize was grown on the field from 1998. The last year's crop was harvested on 26th September. 110 kg/ha nitrogen (active ingredient) fertilizer was used after stalk-shredding. Plough was done on 9th October. Agro-technical operations started on 16th March with smoothing, after that 190 kg/ha nitrogen (a.i.) fertilizer was strewn and incorporated. Maize was sown on 17th April with a plant density of 60 thousand stem/ha, the depth was 6 cm, the spacing was 0,75 m x 0,2 m. FRONTIER 720 EC (dose: 1 l/ha) and PLEDGE (dose: 0,08 kg/ha) herbicides (with 200 l/ha water) were used at the same day with RAU 3500 type sprayer. Post emergence herbicide treatment was carried out on 17th May using MOTIVELL (dose: 0,75 l/ha) and RING (dose: 20 g/ha).

Before the set of the experiment (on 27th July 2001) with 2 repeats on 2,5 hectare, we placed 1 CSALOMON sex-pheromone trap and 1 MULTIGARD yellow flat trap/ treatment to the plants, in the height of cobs.

Before spraying, we counted the adults caught by the traps and we counted them at 5 different places, on 10-10 plants. Treatments were carried out on 28th July evening, with KA 26 type helicopter, with 80 l/ha water, with Tee-Jet D-6-46 nozzles, at 3 bar, 70 km/h speed, from 5-6 m flying-height.

Weather circumstances: 26 ^{o}C air temperature, 55% air humidity, 0 m/sec wind. The assessment of the efficiency of spraying was done before and after (2, 7, 13 and 20 days) the treatments. We counted the catch-numbers of each trap and recorded the adults on 5x10 plants, then we calculated efficiency % with Henderson-Tilton formula.

During the experiment we used the following insecticides

Table 1. Results (based on counting adults on plants) of protection against western corn rootworm (Diabrotica virgifera virgifera) adults in maize (Görcsönydoboka, 28. 07. 2001.)

1. Táblázat: Amerikai kukoricabogár (Diabrotica virgifera virgifera) imágók elleni védekezés eredménye kukoricában tőfertőzöttség alapján (Görcsönydoboka, 2001. 07. 28.)

Treatments (dose)	Repeats	Number of living adults					Efficiency (%) (Henderson-Tilton)			
		Before treatment	2nd day	7th day	13th day	20th day	2nd day	7th day	13th day	20th day
Untreated	I.	239	219	118	70	51				
	II.	264	220	143	82	48				
	Average	251,5	219,5	130,5	76	49,5				
Methyl-parathion (1,5 l/ha)	I.	265	1	0	2	4				
	II.	289	0	1	1	8				
	Average	277	0,5	0,5	1,5	6	99,79	98,65	98,21	88,99
Chlorine-piriphos (1,5 l/ha)	I.	254	5	0	2	7				
	II.	245	0	2	1	6				
	Average	249,5	2,5	1	1,5	6,5	98,85	99,23	98,01	86,76
Chlorine-piriphos (2,0 l/ha)	I.	214	2	2	3	4				
	II.	302	1	0	0	9				
	Average	258	1,5	1	1,5	6,5	99,34	99,25	98,07	87,20
Endo-sulphane (2,0 l/ha)	I.	233	2	4	8	13				
	II.	264	3	2	4	10				
	Average	248,5	2,5	3	6	11,5	98,84	98,06	96,00	76,49
Esfen-valerate (0,3 l/ha)	I.	256	16	19	21					
	II.	227	31	26	12					
	Average	241,5	24,5	22,5	16,5		99,79	99,65	98,21	
Esfen-valerate (0,4 l/ha)	I.	297	21	15	7					
	II.	267	18	16	15					
	Average	286,5	19,5	15,5	11		92,20	89,20	89,57	

and doses:

Methyl-parathion: 1,5 l/ha
Chlorine-piriphos: 1,5 l/ha
Chlorine-piriphos: 2,0 l/ha
Endosulphane: 2,0 l/ha
Esfenvalerate: 0,3 l/ha
Esfenvalerate: 0,4 l/ha

RESULTS

Table 1. shows the results of the experiment.

The evaluation of adults on 5x10 plants on the 2nd day after the treatments showed 98,85 efficiency % for Chlorine-piriphos (1,5 l/ha). This ratio has increased to 99,34% with 2,0 l/ha dose. Endosulphane (2,0 l/ha) showed 98,84% mortality. 0,3 l/ha dose of Esfenvalerate showed 99,79%, while 0,4 l/ha dose of it showed 92,2% efficiency. Methyl-parathion (control product) with 1,5 l/ha dose resulted the same efficiency % (99,79%) as Esfenvalerate with 0,3 l/ha dose. On the 7th day there was an increase (99,23%) in the efficiency % of Chlorine-piriphos with 1,5 l/ha dose, while at 2 l/ha dose the efficiency % slightly decreased (99,25%). The mortality % of Endosulphane at 2 l/ha dose decreased (98,06%) as well. The tendency was the same at 0,3 l/ha dose of Esfenvalerate (99,25% mortality). However, the 0,4 l/ha dose of Esfenvalerate on the 7th day showed 3% decrease in efficiency (89,2%) compared to the 2nd day's result. We noticed nearly 1% decrease in the efficiency (98,65%) of the control product (Methyl-parathion). On the 13th day, the efficiency % of Chlorine-piriphos (1,5 l/ha and 2 l/ha dose) decreased to 98,01% and 98,07%. The efficiency of Endosulphane at 2 l/ha dose decreased with 2% (96,11%). Despite the decrease in efficiency, 0,3 l/ha dose of Esfenvalerate had still better performance than 0,4 l/ha dose of it (98,21% and 89,57%). The

Table 2. Results (based on the catch number of CSALOMON sex-pheromone trap) of protection against western corn rootworm (Diabrotica virgifera virgifera) adults in maize (Görcsönydoboka, 28. 07. 2001.)

2. Táblázat: Amerikai kukoricabogár (Diabrotica virgifera virgifera) imágók elleni védekezés eredménye kukoricában CSALOMON szexferomon csapda fogása alapján (Görcsönydoboka, 2001. 07. 28.)

Treatments (dose)	Repeats	Number of living adults					Efficiency (%) (Henderson-Tilton)			
		Before treatment	2nd day	7th day	13th day	20th day	2nd day	7th day	13th day	20th day
Untreated	I.	252	140	176	216	205				
	II.	212	148	121	225	379				
	Average	232	144	148,5	220,5	292				
Methyl-parathion (1,5 l/ha)	I.	361	16	4	18	79				
	II.	303	10	6	23	107				
	Average	332	13	5	20	93	93,69	97,65	93,50	77,74
Chlorine-piriphos (1,5 l/ha)	I.	211	10	9	30	138				
	II.	238	13	13	39	171				
	Average	224,5	11,5	11	34,5	154,5	91,75	92,34	83,83	45,32
Chlorine-piriphos (2,0 l/ha)	I.	198	9	15	31	136				
	II.	212	16	22	45	112				
	Average	205	12,5	18,5	38	124	90,18	90,18	85,90	80,49
Endo-sulphane (2,0 l/ha)	I.	170	14	38	80	176				
	II.	217	13	44	54	146				
	Average	193,5	13,5	41	67	161	88,76	66,89	63,57	33,89
Esfen-valerate (0,3 l/ha)	I.	181	31	61	101					
	II.	133	25	59	88					
	Average	157	28	60	94,5		71,2	40,29	37,00	
Esfen-valerate (0,4 l/ha)	I.	190	28	58	91					
	II.	117	29	52	92					
	Average	153,5	28,5	55	91,5		70,09	44,02	37,28	

decrease in the result of standard methyl-parathion was not significant (98,21%). On the 20th day the lower dose of Chlorine-piriphos showed 86,76 %, the higher dose showed 87,2% mortality. There was a 20% decrease in the efficiency of Endosulphane (2 l/ha dose). We didn't evaluated Esfenvalerate, because of the low efficiency % (under 10%).

Adult evaluation based on the catch number of CSALOMON sex-pheromone trap (Table 2.) showed 91,75% efficiency on the 2nd day for Chlorine-piriphos at 1,5 l/ha dose. At 2,0 l/ha dose the result was 90,18%. Endosulphane (2 l/ha dose) resulted 88,76% mortality. We reached 71,2% and 70,09% efficiency with Esfenvalerate (dose: 0,3 l/ha and 0,4 l/ha). The 2 l/ha dose standard Methyl-parathion showed 93,69% mortality. On the 7th day there was a slight increase in the efficiency of Chlorine-piriphos at 1,5 l/ha dose (92,34%), while at 2 l/ha the result was the same as on the 2nd day (90,18%). We observed significant decrease in the efficiency of 2 l/ha dose Endosulphane (66,89%). This tendency characterised the 0,3 l/ha and 0,4 l/ha dose Esfenvalerate as well (40,29% and 44,02% mortality). The efficiency of 0,4 l/ha dose exceeded by almost 4% the efficiency of 0,3 l/ha dose. There was a 4% increase in the efficiency of the control active ingredient (Methyl-parathion).

On the 13th day there was a decrease in the efficiency of all active ingredients, compared to the 7th day's results: 83,83% (Chlorine-piriphos, 1,5 l/ha), 85,9% (Chlorine-piriphos, 2,0 l/ha), 63,57% (Endosulphane, 2 l/ha), 37,0% (Esfenvalerate, 0,3 l/ha), 37,2% (Esfenvalerate, 0,4 l/ha). Standard Methyl-parathion showed 93,5% mortality.

On the 20th day further decrease in efficiency could be observed. 1,5 l/ha dose of Chlorine-piriphos showed 45,32%, while 2 l/ha dose of it showed 80,49% mortality.

Endosulphane (2 l/ha) resulted 33,89% efficiency, while it was 77,74 % for Methyl-parathion. Neither dose of Esfenvalerate showed mortality effect on the 20th day.

Table 3. Results (based on the catch number of MULTIGARD yellow flat trap) of protection against western corn rootworm adults in maize (Görcsönydoboka, 28. 07. 2001.)

3. Táblázat: Amerikai kukoricabogár (Diabrotica virgifera virgifera) imágók elleni védekezés eredménye kukoricában MULTIGARD sárgalap-csapda fogása alapján (Görcsönydoboka, 2001. 07. 28.)

Treatments (dose)	Repeats	Number of living adults					Efficiency (%) (Henderson-Tilton)			
		Before treatment	2nd day	7th day	13th day	20th day	2nd day	7th day	13th day	20th day
Untreated	I.	116	96	141	246	86				
	II.	255	60	187	261	105				
	Average	185,5	78	164	253,5	95,5				
Methyl-parathion (1,5 l/ha)	I.	218	20	2	3	11				
	II.	313	23	3	2	6				
	Average	265,5	21,5	2,5	2,5	8,5	80,74	98,93	99,31	93,78
Chlorine-piriphos (1,5 l/ha)	I.	213	29	4	4	6				
	II.	188	36	2	6	10				
	Average	200,5	32,5	3	5	8	61,45	98,33	98,17	92,56
Chlorine-piriphos (2,0 l/ha)	I.	194	22	5	3	12				
	II.	232	38	7	6	13				
	Average	213	30	6	4,5	12,5	66,5	97,18	98,45	89,06
Endo-sulphane (2,0 l/ha)	I.	157	14	31	12	20				
	II.	192	22	26	5	14				
	Average	174,5	18	28,5	8,5	17	75,47	81,86	96,43	81,83
Esfen-valerate (0,3 l/ha)	I.	223	41	114	101					
	II.	209	48	120	110					
	Average	216	44,5	117	105,5		51,00	38,73	61,52	
Esfen-valerate (0,4 l/ha)	I.	148	36	89	64					
	II.	173	38	105	77					
	Average	159,5	37	97	70,5		55,17	31,21	73,61	

Based on the catch number of MULTIGARD yellow flat trap (Table 3), on the 2nd day after the treatments Chlorine-piriphos showed 61,45% (1,5 l/ha) and 66,5% (2,0 l/ha) efficiency. 2,0 l/ha dose of Endosulphane showed 75,47% mortality, while the efficiency of Esfenvalerate was 51,0% (0,3 l/ha) and 55,17% (0,4 l/ha). Methyl-parathion (2,0 l/ha) resulted 80,74% mortality. On the 7th day we observed significant increase at both dose of Chlorine-piriphos: 98,33% (1,5 l/ha) and 97,18% (2,0 l/ha). The higher dose showed a weaker performance. The efficiency of Endosulphane (2 l/ha) improved by 6% (81,86%). The mortality effect of Esfenvalerate decreased to 38,73% (0,3 l/ha) and 31,21% (0,4 l/ha). There was a significant increase in the efficiency of Methyl-parathion (98,93%). On the 13th day after treatments the smaller dose of Chlorine-piriphos showed a little decrease in mortality (98,17%), while higher dose of it showed 1,2% improve in mortality (98,45%). The 2,0 l/ha dose of Endosulphane resulted in almost 15% increase in efficiency (96,43%). After former decrease, we noticed improvement in efficiency at both dose of Esfenvalerate (61,52% and 73,61%). Standard Methyl-parathion (2,0 l/ha dose) showed further improvement. On the 20th day the decreased efficiency of 1,5 l/ha dose of Chlorine-piriphos (92,56%) was still better than 2,0 l/ha dose of it (89,06%). Endosulphane showed almost 15% decrease in efficiency (81,83%). Neither dose of Esfenvalerate showed further mortality effect. The efficiency of Methyl-parathion decreased by almost 5% (93,78% mortality).

DISCUSSION

Two micro capsuled phosphoric acid ester (Methyl-parathion with 1 dose, Chlorine-piriphos with 2 different dose), a chlorinated hydrocarbon (Endosulphane with 1 dose) and a synthetic pyretroid (Esfenvalerate with 2 different dose) took part in the field experiment of protection against western corn rootworm adults. Assessments were made on the 2nd, 7th, 13th and 20th day after treatments. Methyl-parathion (2,0 l/ha dose) and

Chlorine-piriphos (1,5 and 2,0 l/ha dose) showed the best efficiency %. These insecticides retained their mortality effect until the 20th day without significant decrease. The efficiency % of Endosulphane was altering, but it proved to be an effective insecticide. Although, there was a significant decrease in its efficiency % in the 20th day. Both dose of Esfenvalerate showed satisfactory and good efficiency until the 13th day. We can't calculate with longer effect, only with contact (repellent) effect when using this group of insecticides. From the three different methods used for evaluation, the first (adult counting on plants) is considered as the most favourable in the point of view of the accuracy of results, because this method follows the best the dynamic of natural swarm in time and space. Furthermore, the applied sex-pheromone traps didn't give information about the female-number. That's why visual attraction based colour-traps are better which only have local attraction effects and they catch both male and female adults. Unfortunately they are polluted with other species as well, that's why frequent exchange is necessary.

Our results show, that the investigated insecticides are appropriate for protection against the adults of western corn rootworm. Despite their shorter effect, Endosulphane and Esfenvalerate are also offered to use in the flowering period of maize (or when there are flowering weeds around the maize field), because they could be sprayed in the evening, with bee-protecting technology. Phosphoric acid esters (with longer effect) could be used for stopping or decreasing multitudinous swarming and egg-laying after flowering. It is important for all insecticides, that they should be used on the base of prognosis, at the time of adult swarming, when pistil is endangered and all relevant regulations about health and environment protection must be complied during the application.

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