

THESIS OF A Ph.D. DISSERTATION

UNIVERSITY OF DEBRECEN

CENTER OF AGROSCIENCES

AGRICULTURAL FACULTY

PLANT PROTECTION DEPARTMENT

Ph.D. SCHOOL OF PLANT PRODUCTION AND HORTICULTURE SCIENCES

Leader:

**Dr. László Ruzsányi**

professor

Doctor of Hungarian Scientific Academy

Consultant:

**Dr. Péter Solymosi**

leader of Research Project Secretariate of Hungarian Scientific Academy

Ph.D. of biological science

**EXAMINATION OF SULFONYLUREA TYPE HERBICIDES IN WINTER  
WHEAT, CORN AND SUGAR BEET**

Written by:

**Elemér Tóth**

DEBRECEN

2001.

---

**1. INTRODUCTION**

The claim-controlling weeds, protecting crops is interlaced with history of culture of

mankind.

Experience of few ten years of chemical control of weeds can seem trifling versus more year thousands of mechanical weed control, although we have a lot of data, we can think sometimes like our physician colleagues: there is more thing what we do not familiar than what we know.

From the cca. five decades old history of chemical weed control there are some sulfonylureas in the past two decades, which are part of integrated weed regulation including agrotechnical, mechanical and chemical methods.

The first sulfonylurea (or sulfonylcarbamide) was invented by a Dutch researcher, Koog in 1966, the next one, chlorsulfuron was discovered in 1975. Today we have more than 25 active ingredients registered in the world.

Sulfonylureas had and have an important effect for applied plant protection and plant production technologies and are decreasing by decisive way versus traditional chemicals the environmental pollution made by pesticides. It is coming from two factors: sulfonylurea-type herbicides have really good human- and ecotoxicological parameters and the applied use rate per hectare is very low (3-75 g/ha). The first active ingredient, chlorsulfuron started in 1982 on the market. Now we have more than twenty active ingredients in the world and more than 60 million hectares are treated by them. In cereals the following actives are registered: chlorsulfuron, triasulfuron, metsulfuron-methyl, thifensulfuron-methyl, amidosulfuron, tribenuron-methyl, flupyrsulfuron-methyl, sulfosulfuron and iodosulfuron-methyl-natrium, in rice bensulfuron-methyl, chlorimuron, cinosulfuron, pyrasulfuron and azimsulfuron, in corn rimsulfuron (rimriduron), nicosulfuron, primisulfuron, prosulfuron, halosulfuron-methyl and thifensulfuron-methyl, in grapes flazasulfuron, in soybean thifensulfuron-methyl, in oilseed rape ethametsulfuron-methyl, in sugar beet – up to now alone – trifluszulfuron-methyl.

We made with some of them comparing trials in winter wheat, corn and sugar beet in 1996, 1997, 1998 and 1999. Trials were sprayed on small scale, we carried out them at the research center of Agrosiences Center of University of Debrecen (at that time Agricultural University of Debrecen) and at research center of St. Stephan's University (at that time Agricultural University of Gödöllő).

Purpose of trials were: to compare the efficacy of different sulfonylurea type herbicides against various weed species on different soil types, and to examine selectivity of winter wheat, corn and sugar beet varieties and hybrids in case of using of sulfonylureas. Tests were made in that time still developing code numbered products or active ingredient combinations which today have become registered (chlorsulfuron+ flupyrsulfuron-methyl, tribenuron-methyl+ thifensulfuron-methyl, rimsulfuron+ thifensulfuron-methyl, rimsulfuron+ dicamba DF formulation, trifluszulfuron-methyl, thifensulfuron-methyl+ carfentrazone).

Combinations of sulfonylureas in combinations with other type of, partly new developed herbicides, which purpose is getting wider spectrum and preventing or delaying resistance.

---

## 2. LOCATIONS, MATERIALS AND METHODS OF TRIALS

The data of this thesis were based on results of four years- 1996-1997-1998-1999- of small scale trials made in arable crops. Trials were carried out in two locations: in Debrecen-Látókép, at research center of Plant Production Department of

Agrosciences Center of University of Debrecen (at that time Agricultural University of Debrecen) and at research center of Plant Production Department of St. Stephan's University (at that time Agricultural University of Gödöllő).

The plot size – except corn selectivity trials- was in each four year in every case small scale: 2X6 m size, number of replications were three by randomised.

Trials were sprayed by a small scale trial spraying machine (type: AZO Sprayer, made in Holland). Quantity of water was 250 l/ha, nozzle type and pressure was the following: in the first three years TeeJet 11004 for spraying herbicides, in 1999 we got some Lechler ID 04 type nozzles, which are antidrift type and we could use them by middle wind also (up to 7 m/s).

In years of examinations by corn selectivity trials corn hybrids were sowed in 2-2 rows, then were treated vertical perpendicular of rows of corn with a “Berthoud” type spraying machine towed by a tractor “MTZ-80”, with TeeJet 11004 type nozzles under 3 bar pressure with 200 l/ha quantity of water.

To increase of weed covering percentage and improve homogeneity of weed covering, in 1998 and 1999 we sowed some weed species seed in Debrecen-Látókép.

We compared the efficacy of treatments in herbicide-efficacy trials (in winter wheat, corn and sugar beet) to untreated (covered by weeds) plots (in varietal selectivity trials compared with soil cultivated plots) or to efficacy of standard treatments. We assessed the weed control efficacy of herbicides in %. In case of spraying trials we used as a standard other sulfonylurea or other tape of herbicide (like hormones, triazines etc.), which that time were registered already and used in practice.

Corn selectivity trials were sprayed in each four years under cold or heat stress conditions. The reason of it was: if a treatment sdoes not cause any phytotoxic reactions under stress conditions, probably it does not do it under normal conditions also. Trials were assessed visually one week after the treatment (in case of using of sulfonylureas after one week are the symptoms more visible) than one and a half or two months later and just before the harvesting, we assessed in the first two cases visible differences oon leaves and on total plants (chlorosis, necrosis, stunting, deformation and binding), than before harvesting we assessed pitching ears in %.

Harvesting was made and measured by a “Sampo”-type harvester machine. The sampling was made on the harvester, than the samles were dried in 105 ° C, after it we could calculate in case of winter wheat and corn the yield for 14 % moisture.

Measuring of quality in case of winter wheat trials ( protein and gluten) was done by laboratory of St. Stephan University in Gödöllő.

In case of most important weed species or yield and quality measuring we made statistics: one factor variancy-analysis for justify significant differences.

## **2.1. Winter wheat**

### **2.1.1. Herbicide efficacy trials**

In case of winter wheat herbicide efficacy trials until four years we assessed the efficacy of the following active ingredients and combinations of active ingredients: (17 treatments): tribenuron-methyl, tribenuron-methyl+ fluroxypyr, tribenuron-methyl+ dicamba, tribenuron-methyl+ MCPA, tribenuron-methyl+ MCPP, tribenuron-methyl+ etoxyfen, tribenuron-methyl+ thifensulfuron-methyl, tribenuron-

methyl+ chlorpyralid, tribenuron-methyl+ non-ionic surfactant, 2,4-D+ fluroxypyr, chlorsulfuron+ flupyrulfuron-methyl, amidosulfuron+ metribuzine, triasulfuron+ dicamba, pendimethalin+ izoproturon, carfenthrzone+ thifensulfuron-methyl, carfenthrzone+ MCPP, dichlorprop-P+ MCPA+ MCPP.

## 2.1.2. Yield measuring

### 2.1.2.1. Effect on yield quantity

The effect on yield quantity of winter wheat was examined in case of using of different herbicides. We sprayed trials with normal, double and four-times higher rates of sulfonylureas and we compared the result with effect of hormones or effect of sulfonylurea+ hormon combinations and measured the yield quantity of plots.

### 2.1.2.2. Effect on yield quality

The effect of herbicide treatments was examined on protein and gluten content of yield.

### 2.1.3. Selectivity trials

This trial was sprayed with chlorsulfuron+ flupyrulfuron-methyl active ingredient combination on the following varieties:

Agria	Boka	Brea
Emma	Fatima	Gabi
Gaspard	GK-Kincsem	Hardy
Irma	Kompolti-3	Kucsma
Madrigál	Magdalena	Matador
Mezőföld	Moniko	MV 15
MV 16	MV-17	MV-19
MV-23	MV-230-96	MV 25
Optima	Pálma	Petra
Summa	Szigma	Tewo
Vilma	Martondur (durum)	Motto (rye)

## 2.2. Corn

### 2.2.1. Herbicide efficacy trials

In herbicide efficacy trials the following active ingredients or combinations of active ingredients were examined (25 treatments): rimsulfuron, rimsulfuron+ atrazine, rimsulfuron+ thifensulfuron-methyl, metolachlor+ atrazine, rimsulfuron+ dicamba, rimsulfuron+ primisulfuron+ prosulfuron, pendimethalin+ atrazine, acetochlor+ atrazine, rimsulfuron+ metolachlor+ atrazine, nicosulfuron, nicosulfuron+ dicamba,

nicosulfuron+ primisulfuron+ prosulfuron, sulcotrione, rimsulfuron+ thifensulfuron-methyl, nitrogen+ non-ionic surfactant, rimsulfuron+ bromoxynil, rimsulfuron+ thifensulfuron-methyl+ chlorpyralid, rimsulfuron+ thifensulfuron-methyl+ dicamba, nicosulfuron+ bentazone+ atrazine, nicosulfuron+ sulcotrione, isoxaflutole+ metolachlor, nicosulfuron+ bentazone+ dicamba, S-metolachlor+ atrazine, isoxaflutole, flufenacet+ metribuzine.

### 2.2.2. Yield measuring

In these trials yield of corn plots was also measured. There was examined the effect of active ingredients and its combinations or the effect of different application methods (preemergence, early post and postemergence) for corn yield.

### 2.2.3. Selectivity trials

In corn selectivity trials the effect of the following treatments was examined for the corn hybrids: rimsulfuron, nicosulfuron, rimsulfuron+ thifensulfuron-methyl, rimsulfuron+ dicamba, S-metolachlor+ atrazine, isoxaflutole.

Until four years we assessed the following 109 hybrids:

3515	Dahir	Furio	LG2447	Reseda X0965 V	Virginia X0863 B
3752	Dante	Furio Sumo	Maraton	Sahara	Volens
3860	Dk 352	G.2390	Monessa 3905	Samoa	X 0876Z
4361 TC	DK 366	Gabriella	Mv 444	Stira	X 0935 N
4390 TC	DK 471	Goldaris	Mv 484	Sze SC 289	X 0935R
3769 Clarisia	DK 493	Goldena	Mv 514	SzE SC 348	X 0996 A
4532 SC	DK 527	H 2390	MV TC272	Sze SC 361	X 1026 J
Alcyone	DK256	Hella	Norma	SzE SC 424	X0956 R
Alpha	Dk386	Horus	NX 2742	Sze SC 427	X1094 M Agana
Alvina 3514	Dk443	Hypnos	NX 2743	SzE TC 247	
Anjou 235	DK463	Kincs	Occitan	Sze TC 277	
AW 043	Dk471	KWS 313	Occitan Sumo	SzE TC 294	

AW 143	Domingo	KWS 353	Pelican	SzE TC 358	
AW 723	Dunia	KWS-242	Peso	SzE TC 367	
Aztec	Duplo	KX 5364	pi 3730	SzE TC 373	
Bella	DUX CGS 2510	KX 6364	pi 3753	Sze TC 465	
Borbála	Emir	KX 7366	pi X 0954D	SzE TC 513	
Caracas	Evelina	Lasko	pi X 1005	Tornado	
Colomba	Felike	LG2231 (Limastar)	Piroska	Venusz	
Coralba 3437	Florencia	LG2310	Reinold	Veronika	

## 2.3. Sugar beet

### 2.3.1. Herbicide efficacy trials

In the herbicide efficacy trials there was tested combinations of altogether 15 active ingredients of sugar beet herbicides, the list of these: triflusulfuron-methyl, metolchlor, S-metolachlor, phenmedifam, desmedifam, etofumezate, metamitron, lenacil, fluazifop-P-butyl, haloxifop-R-metilester, propaquizafop, quizalofop-P-tefuril, chlorpyralid, chloridazone and quinmerac.

### 2.3.2. Selectivity trials

Sugar beet selectivity trials were connected with herbicide efficacy trials: we assessed the phytotoxic reactions of sugar beet in case of using different active ingredients.

## 3. RESULTS

### 3.1. Winter wheat

#### 3.1.1. Herbicide efficacy trials

Until the four years of examination there were 20 weed species (as part of natural weed flora or as sowed weed species), in which we could assess. These were the following based on using of "Ujvárosi system for life type of weeds":

T<sub>1</sub> type of weed species (emerging in early autumn, flowering in early spring):

*Veronica hederifolia* L.

T<sub>2</sub> type of weed species (emerging in late autumn or early spring, flowering in spring):

*Galium aparine* L.

*Papaver rhoeas* L.

*Fumaria schleicheri* SOY.-WILL.

*Fumaria officinalis* L. subsp. *officinalis*

*Consolida regalis* S.F.GRAY

*Lithospermum arvense* L.

*Apera spica-venti* (L.) P.B.

*Centaurea cyanus* L.

*Descurainia sophia* (L.) WEBB.

*Viola tricolor* L.

T<sub>2-3</sub> type of weed species:

*Thlaspi arvense* L.

T<sub>2-3-4</sub> type of weed species:

*Viola arvensis* MURR.

T<sub>4</sub> type of weed species (emerging in late spring, flowering in summer):

*Fallopia convolvulus* (L.) A. LÖVE

*Chenopodium album* L.

*Helianthus annuus* L.

*Pisum sativum* L.

*Ambrosia artemisiifolia* L.

*Amaranthus retroflexus* L.

G<sub>3</sub> type of weed species (emerging from rhizoms):

*Cirsium arvense* (L.) SCOP. var. *arvense*

In winter wheat trials we established that against *Galium aparine* among the examined treatments tribenuron-methyl+ fluroxypyr combination proved 95-99 % efficacy.

Among the “difficult to control” weeds against *Viola spp.* we found most efficient tribenuron-methyl+ etoxyfen combination, against *Veronica hederifolia* L., *Fumaria* spp., *Centaurea cyanus* L., *Lithospermum arvense* L., *Apera spica-venti* (L.) P.B. species chlorsulfuron+ thifensulfuron-methyl combination. Against non-typical cereal weed species, which are T<sub>4</sub> type, emerging from deep soil and requiring hot

conditions, like *Chenopodium album* L., *Ambrosia artemisiifolia* L. can be an efficient solution application of tribenuron-methyl+ thifensulfuron-methyl combination.

### 3.1.2. Yield mesuring

#### 3.1.2.1. Effect on yield quantity

In case of sulfonilureas tribenuron-methyl and thifensulfuron-methyl are applicable up to flag leaf stage of winter wheat without yield depression. In case of using hormon type ingredients or its combinations can be allowed only up to the end of tillering stage of winter wheat, using after this phenophase yield depression can occur.

#### 3.1.2.2. Effect on yield quality

Until this examination we did not get undiscovered results: in one year protein content was increasing by hormones, in another year not. It is necessary to continue to examine which factors are influencing protein content ( environmental factors in time of treatment, development stage of crop etc.). It would be maybe more interesting to examine the effect of different herbicides for the protein content specially for spring barley.

### 3.1.3. Selectivity trials

Based on our experiments the chlorsulfuron+ flupyrulfuron-methyl combination did not cause any phytotoxic symptoms on before mentioned winter wheat varieties.

## 2.2. Corn

### 2.2.1. Herbicide efficacy trials

Until four experimental years there were 17 weed species in corn (as a part of natural weed flora or sowed weed species), in which case we could make assessments.

These were the following type by type:

T<sub>2</sub> type:

*Galium aparine* L.

T<sub>4</sub> type:

*Amaranthus retroflexus* L.

*Amaranthus chlorostachys* WILLD.

*Amaranthus albus* L.

*Echinochloa crus-galli* (L.) P.B.

*Hibiscus trionum* L.

*Setaria pumila* (POIR.) R. et SCH.

*Fallopia convolvulus* (L.) A. LÖVE

*Chenopodium album* L.

*Helianthus annuus* L.

*Ambrosia artemisiifolia* L.

*Persicaria lapathifolia* S.F.GRAY

*Solanum nigrum* L.

*Digitaria sanguinalis* (L.) SCOP.

*Xanthium italicum* MOR.

*Datura stramonium* L.

G<sub>3</sub> type:

*Cirsium arvense* (L.) SCOP. *var. arvense*

The experience of corn herbicide efficacy trials was that low use rate of nitrogen fertilizer (ammonium-sulphate 3 kg/ha, ammonium-nitrate 4 kg/ha or liquid nitrogen 8-10 l/ha) can increase the efficacy of sulfonylurea herbicides, but not increase the danger of phytotoxicity. We experienced some antagonism between sulfonylurea and triazine type herbicides in case of annual grass weeds, decreasing or abolishing of it using of a low rate nitrogen fertilizer can help. Using of atrazine can make wider the weed spectrum of sulfonylureas, make longer the period of effect and decreasing the new flush of some broad-leaved weed species. Sulfonylureas registered in corn have usually wide weed spectrum, but against some weed species should be completed (e.g.: *Chenopodium album* L., *Datura stramonium* L., *Solanum nigrum* L.).

The optimal timing for postemergence spraying of corn is if the broadleaved weeds are in 2-4 leaves stage and grass weeds in 1-3 leaves stage. In case of using of sulfonylureas we have to complete the tankmix with non-ionic surfactant in case also, if we use nitrogen fertilizer. If the corn herbicide treatment is rimsulfuron+bromoxynil combination, so it is forbidden to give to the tankmix nitrogen-fertilizer and should decrease the use rate of non-ionic surfactant to the half (0.05 %). Based on our experience postemergence method of weed control can give better efficacy versus preemergence method in case if there are on the territory weeds, having large seed, emerging from deep soil, requiring hot conditions for emerging (T<sub>4</sub> type)- among weed species examined by us are *Helianthus annuus* L.- volunteer sunflower, *Ambrosia artemisiifolia* L., *Xanthium italicum* MOR. and *Cirsium arvense* (L.) SCOP. *var. arvense*).

### 3.2.2. Yield measuring

The results showed that in optimal timing sprayed early postemergence weed control does not have any negative effect on corn yield. On the other hand if we spray a preemergence product as early post application (in 2-3 leaves stage of corn), it is highly probable that it will have yield decreasing effect for corn (in our trials average of this yield decreasing was 1 t/ha)

### 3.2.3. Selectivity trials

In our corn selectivity trials we found that postemergence treatment of corn can be in some cases potentially dangerous under cold or heat stress conditions. In practice this means that do not spray corn if the temperature is under + 10 ° C couple of days

before treatment or over + 25 ° C in time of treatment.

It turned out from the experiments that corn is highly sensitive for cold stress. It means when temperature falling under +10 ° C few days before treatment and also cold stress if this happens 2-3 days after treatment. In our trials Samoa, Emir and Occitan were the most sensitive hybrids. Based on our experience not only sulfonylureas, but also as a standard used S-metolachlor+ atrazine and isoxaflutole can cause different level of phytotoxic symptoms on corn hybrids.

## 2.3. Sugar beet

### 2.3.1. Herbicide efficacy trials

Until four experimental year there were 11 weed species (as part of natural flora or as sowed weed species) in which case we could make some assessment. These species were the following type by type:

T<sub>2-3-4</sub> type weed species:

*Viola arvensis* MURR.

T<sub>4</sub> type:

*Amaranthus retroflexus* L.

*Amaranthus chlorostachys* WILLD.

*Amaranthus blitoides* L.

*Echinochloa crus-galli* (L.) P.B.

*Hibiscus trionum* L.

*Setaria pumila* (POIR.) R. et SCH.

*Chenopodium album* L.

*Persicaria lapathifolia* GRAY

*Persicaria maculosa* S.F. GRAY

*Abutilon theophrasti* MEDIC.

In our sugar beet herbicide trials we found that chemical weed control of sugar beet by the most efficient way can be solved with one preemergence treatment followed by two postemergence treatment in case of average Hungarian sugar beet weed flora. Base of these postemergence treatments can be also a sulfonylurea, triflusaluron-methyl. This ingredient is applicable from 70 % emerging stage of sugar beet, triflusaluron-methyl+ phenmedifam+ metamiltron combination from cotyledon stage of sugar beet. We can reach the best result in weed control of sugar beet, if we spray the treatment in cotyledon- 2 leaves stage of weeds. Weed control of sugar beet can be solved sufficient by only postemergence way also, in this case to triflusaluron-methyl+ phenmedifam+ metamiltron combination is necessary to give 60 % use rate of graminicides by annual grass weeds and total use rate by perennial grass weeds. Using of surfactant registered in sugar beet is not explained: if the tankmix contains etofumezate.

### 3.3.2. Selectivity trials

Sugar beet selectivity trials showed that among the applied treatments combinations containing etofumezate caused the strongest phytotoxic reactions.

Triflurosulfuron-methyl- as only one registered sulfonylurea- can cause some passing chlorosis, but it is still one of the most selective sugar beet herbicides.

---

## 4. NEW SCIENTIFIC RESULTS

### 4.1. Winter wheat:

- Among Hungarian soil and weather conditions we tested first the following new active ingredients and ingredient combinations: flupyr-sulfuron-methyl+ chlorsulfuron, thifensulfuron-methyl+ carfenthrazole, tribenuron-methyl+ thifensulfuron-methyl.
- In winter wheat selectivity trials we found that chlorsulfuron+ flupyr-sulfuron combination did not cause any phytotoxic symptoms on the given 32 winter wheat varieties.
- We proved that using of a sulfonylurea+hormon combination can cause some phytotoxic reactions and can cause yield decreasing in case of using in 2-node stage of winter wheat.
- We worked out a technology, which can solve the problem of control of *Galium aparine* L. in different phenological stages of weed and can be sprayed up to flag leaf stage of winter wheat.
- We found solution against some weed species, which were before “difficult to control weeds”- these have hairy or waxy leaf surface ((*Veronica hederifolia* L., *Fumaria schleicheri* SOY.-WILL. subsp. *schleicheri*, *Fumaria officinalis* L. subsp. *officinalis*, *Lithospermum arvense* L., *Centaurea cyanus* L., *Viola tricolor* L., *Viola arvensis* MURR.).

### 4.2. Corn:

- Under Hungarian conditions we established antagonism between sulfonylurea and atrazine active ingredients on annual grass weed species.
- We determined that this antagonism can be solved or decreased by low use rate of nitrogen fertilizers and that time it can help the absorption of leaf herbicides to weeds, but does not increase the danger of phytotoxicity.
- We found that nitrogen-fertilizer+ non-ionic surfactant combination has also some efficacy against some weed species.
- We established use rate of rimsulfuron+ thifensulfuron-methyl active ingredient combination adapted to Hungarian weed and weather conditions.
- We found that in case of spraying of rimsulfuron+ bromoxynil combination is forbidden to give nitrogen-fertilizer to the tankmix and the use rate of non-ionic surfactant should be a half of the normal use rate.
- In corn selectivity trials we tested altogether 109 corn hybrids (among them the

newest and some other which were never tested in Hungary). We found that different factors are influencing corn selectivity in case of sulfonylurea treatments (development stage of plant, temperature, precipitation).

### 4.3. Sugar beet:

- We tested first under Hungarian soil and weather conditions the new active ingredient triflusaluron-methyl.
- We established with which compounds can be applicable triflusaluron-methyl in combinations.
- We established the use rate of postemergence graminicides usable together in combination with triflusaluron-methyl.
- We worked out a weed control technology well adaptable to the Hungarian weed, soil and weather conditions and applicable in cotyledonous stage of sugar beet.
- We found an efficient solution against *Abutilon theophrasti* MEDIC., which was not or not enough well controllable before.

---

## 5. PRACTICAL USE OF RESULTS

Farmers treat their winter wheat fields based on winter wheat selectivity trials with chlorsulfuron+ flupyralsulfuron-methyl on some thousands, against *Galium aparine* L. tribenuron-methyl+ fluroxypyr combination on some ten thousand hectares in Hungary. More and more farmers are using chlorsulfuron+ flupyralsulfuron-methyl and thifensulfuron-methyl+ carfenthrazole combinations against “difficult to control” weeds. Followed by our experiments farmers pay more and more attention to limits of using of application of herbicides.

In corn we made practical offering for using of nitrogen-fertilizers together in tankmix with sulfonylureas and farmers started its using in the last two dry years. Followed our herbicide efficacy trials farmers are using on some ten thousand hectares rimsulfuron+ thifensulfuron-methyl and rimsulfuron+ bromoxinil combinations in use rate established by us. By weed control of corn people care more and more for stress conditions and different sensitivity of corn hybrids.

In sugar beet farmers are spraying this weed control technology on some thousand hectares by the by us written way. Where there is *Abutilon theophrasti* MEDIC. a part of the weed flora, triflusaluron-methyl is unleaveable from the technology.

We should continue experiments with sulfonylureas to have more data about its application and its limits of application also.

---


## LIST OF PUBLICATIONS CONNECTED WITH TOPIC OF DISSERTATION

- 1., **TÓTH, E.** - PÉTER, I.: 1997/a. Weed control in sugar beet with triflusaluron-methyl based programs: the Hungarian experience. 49<sup>th</sup> International Symposium on Crop Protection. Gent, Belgium, May 7, 1997 (*lecture Summaries*, 80.p.
- 2., **TÓTH, E.** - PÉTER, I.: 1997/b. Weed control in sugar beet with triflusaluron-methyl based programs: the Hungarian experience. 49<sup>th</sup> International Symposium on

Crop Protection. Mededelingen. *Proceedings*, Part III.. MFLBER 62 (3a). pp. 791-798.

3., **TÓTH, E.** - MOLNÁR, I. - SZABÓ, L.: 1998/a. Newer experiences with Safari 50 DF. Plant Protection Scientific Days. Budapest, 1998. (lecture) Summaries. 171.p.

4., **TÓTH, E.** - MOLNÁR, I. - SOMLYAY, I.: 1998/b. Efficacy of some herbicide combinations against Galium aparine L. 50<sup>th</sup> International Symposium on Crop Protection. May 5, 1998, Gent, Belgium. (poster) Summaries. 176.p.

5., SOMLYAY, I. - **TÓTH, E.** - HUNYADI, K.  - SPILÁK, K.: 1998/c. Herbicide resistency- role of sulfonyl carbamids in modern agriculture. Agrofórum. IX.. 7. pp.15-17.

6., **TÓTH, E.** - MOLNÁR, I. - POPOVICS, I.: 1998/d. An opportunity for autumn weed control in winter wheat: Balance 56 DF. III. Tiszántúli Plant Protection Forum. Debrecen, November 4-5, 1998 (lecture) Summaries. 44-45. p.

7., MOLNÁR, I. - **TÓTH, E.** - SOMLYAY, I. - KOVÁCS, GY. - VERECZKEY, K.: 1999. Effect of sulfonylurea herbicides on the modern agriculture. Plant Production Scientific Days. (poster) Summaries. 83. p.

8., SOMLYAY, I. – BUDAI, P. – MOLNÁR, I. – **TÓTH, E.** : 2000/a. Setting and application of acute reference dose (ARFD) in the dietary risk assessment of pesticides. 52<sup>nd</sup> International Symposium on Crop Protection. May 9, 2000, Gent, Belgium. (poster) Abstracts, 94. p

9., MOLNÁR, I.- **TÓTH, E.**- HARTMANN, F.: 2000/b. Stork 50 DF new herbicide in winter wheat. Plant Protection Scientific Days, Budapest (lecture). Summaries, 151.p.

10., SZŐKE, L. - **TÓTH, E.** : 2000/c. Weed flora and weed control of apples.

in :Hunyadi, K.- Béres, I.- Kazinczi, G. edited.: Weeds, weed control, weed biology. Mezőgazda Kiadó, Budapest (a part of university school-book). Pp.539.-543.

11., MOLNÁR, I.- **TÓTH, E.**- SOMLYAY, I.: 2001/a. Experiences of orn selectivity trials XI. Keszthelyi Plant Protection Forum, Keszthely, January 24-26, 2001 (poster).

12., MOLNÁR, I.- **TÓTH, E.**- SOMLYAY, I.: 2001/b. Effect of environmental factors on selectivity of corn hybrids. 47. Plant Protection Scientific Days, Budapest, February 27-28, 2001 (lecture). Summaries, 130.p.

13., MOLNÁR, I. - **TÓTH, E.** - SOMLYAY, I.: 2001/c. Effect of environmental factors on selectivity of corn hybrids. Plant Production journal (article before printing).

### **Other publications:**

1., **TÓTH, E.**-KÖVICS, GY.-TÓTH, O.: 1992/a. Damage of Diachea leucopodia /Bulliard/ Rostafinski slime mould on strawberry. Plant Protection Scientific Days 92., Budapest 110. p.

2., **TÓTH, E.**-KÖVICS, GY.-TÓTH, O.: 1992/b. Slime mould on strawberry.

Kertészet és Szőlészet. 41 (21), 16-17. p.

3., **TÓTH, E.**: 1992/c. Damage of *Diachea leucopodia* (Bulliard) Rostafinski slime mould on strawberry. Scientific Student Essay, Debrecen 34pp.

4., **TÓTH, E.** : 1993. Damage of *Diachea leucopodia* (Bulliard) Rostafinski slime mould on strawberry. Diplom Essay, Debrecen 35pp.

5., **KÖVICS, GY.** - **TÓTH, E.** - **TÓTH, O.**: 1994. Occurrence of *Diachea leucopodia* (Bulliard) Rostafinski slime mould on strawberry in Hungary. *Acta Phytopathologica et Entomologica Hungarica* 29 (1-2), pp.49-56

6., **GONDOLA, I.** - **TÓTH, E.** : 1997/a. Opportunity of chemical weed control of *Orobanche ramosa* L. in tobacco. Plant Protection Scientific Days, Budapest '97

7., **TÓTH, E.** - **MOLNÁR, I.** - **VERECZKEY, K.** - **SOMLYAY, I.**: 1999/b. Tanos: a new fungicide in plant protection of grapes and potato. Plant Protection Forum, Keszthely, January 27-29, 1999 (poster) Summaries. 82. p.

8., **TÓTH, E.** - **MOLNÁR, I.** - **SOMLYAY, I.** - **SCHWEIGERT, Ané.**: 1999/c. Tanos: a new fungicide in plant protection of grapes and potato. 45. Plant Protection Scientific Days, 1999. (lecture) Summaries. 129. p.

9., **TÓTH, E.**- **MOLNÁR, I.**- **SOMLYAY, I.**- **VERECZKEY, K.**- **SCHWEIGERT, A.né.**: 1999/d.. Tanos: a new fungicide in plant protection of grapes and potato. Plant Protection journal 35 (6) pp. 295-298.

10., **MOLNÁR, I.**- **TÓTH, E.**- **VERECZKEY, K.**- **KOVÁCS, GY.**: 1999/e. Curzate is 20 years old. Plant Protection journal. 35 (7). pp. 349-350.

11., **MOLNÁR, I.**- **TÓTH, E.**- **SOMLYAY, I.**- **SZENDREI L.-né**- **MOLNÁR J.-né**: 2000/a. STEWARD: insecticide of the new thousand years. Tiszántúli Plant Protection Forum. (lecture) Summaries, pp. 43.-44.

12., **TÓTH, E.**- **MOLNÁR, I.**- **SOMLYAY, I.**- **SCHWEIGERT, A.**: 2000/c.. Tanos: a new fungicide in plant protection of grapes and potato X. Keszthelyi Plant Protection Forum.(Poster) Summaries, 82.p.

13., **MOLNÁR, I.**- **TÓTH, E.**- **SOMLYAY, I.**- **SZENDREI, L.**- **MOLNÁR, J.**: 2000/d. Steward: insecticide of the new year thousand.Plant Protection Scientific Days. (lecture) Summaries, 65.p.

14., **MOLNÁR, I.**- **TÓTH, E.**- **SOMLYAY, I.**- **SZENDREY, L.**- **MOLNÁR, J.**: 2000/f. Steward, insecticide of the new thousand years. Integrated production in orchards and arable crops. XXI. Budapest, November 28, 2000 (lecture). Summaries, pp.54-55.

15., **TÓTH, E.**- **MOLNÁR, I.**- **SOMLYAY, I.**: 2001/a. Azafenidin, a new active herbicide ingredient in weed control of grapes. XI. Keszthelyi Plant Protection Forum, Keszthely, January 24-26, 2001 (poster). Summaries, 50.p.

16., **TÓTH, E.**- **MOLNÁR, I.**- **SOMLYAY, I.**: 2001/d. Azafenidin, a new active herbicide ingredient in. 47. Plant Protection Scientific Days, Budapest, February 27-28, 2001 (lecture). Summaries, 137.p.

17., **TÓTH, E.**- **MOLNÁR, I.**- **SOMLYAY, I.**: 2001/e. Charisma: a new fungicide in cereals. 47. Plant Protection Scientific Days, Budapest, February 27-28, 2001

(poster). Summaries, 155.p.

18., MOLNÁR, I.- **TÓTH, E.**- SOMLYAY, I.- SALAS, M.- ROLLINSON, P.-  
MÁTÉ, A.: 2001/f. Evolus 80 WG (azafenidin 80 %) a new selective preemergence  
triazolone herbicide for the control of broad-leaved weeds in sunflowers. 53<sup>rd</sup>  
International Symposium on Crop Protection. May 8, 2001, Gent, Belgium. Poster.