UNIVERSITY OF DEBRECEN
Agricultural Centre
Faculty of Agronomy
Department of Land Use

MULTIDISCIPLINARY DOCTORAL SCHOOL PROGRAM

Proposition of PHD Dissertation

INFLUENCE OF WHEATHER ON SENSITIVITY OF CORN CULTIVARS TO HERBICIDES

by
Molnár István

Supervisor:
Prof. Dr. Nagy János
Doctor of Hungarian Scientific Academy

DEBRECEN
2002.

1. INTRODUCTION

Corn was taken by Columbus from America and became a widely use crop in a short period in Europe,Asia due to it's higher yield potency and multilateral usage. Today corn takes over lands even countries of cooler climate like : Denmark, Sweden or Norway . Corn started to spread in the last part of XVI .century in Hungary.

In 1996 the growing area of corn was 140.106.000 ha world wide that was 7 % higher than growing area in 1989/91. The largest producer is USA, due to the high yield USA has 40-50 % of the world corn production.

The growing area is very stable in Hungary. During the period 1986-1997 the growing area ranged between 1.118.000 – 1.057.000 ha. Regarding yield (5-6 t/ha) Hungary belongs to countries that have high yield. The environmental factors, climate,soil parameters are favourable for corn growing .Corn is the most significant crop in Hungary since the year 1946. The planting area ranged during the period 1986-1997 from 1.118.000 to 1.057.000 ha. The basic use of corn is food for animal breeding, meat, milk, egg production but the use of corn became wider and wider.Beside the basic use corn finds new uses and markets. As alcohol refining, bio diesel production, fiber,plastic ,paper and medical use of corn are becoming todays practice. Modification of genetic heritage of corn opens wider possibilities of use of this important plant. New hybrids arrive to the markets having different needs of growing factors. Environmental factors have a great influence on quality and quantity of yield and also influencie the effect of growing practise. One of the key elements of growing technology is weed control . Weeds can decrease the quality and quantity of yield dramatically. Herbicides beside control weeds can have an important effect on corn development. They can cause significant damage. The environmentalfactors like temperature, soil moisture,humidity,radiation can influence the response of hybrids to herbicides before,during and after the application.The purpose of this study was to examine the response of corn hybrids to sulfonylurea type herbicides applied under unfavorable environmental conditions as cold and high temperature. Growers have to apply herbicides under unfavorable environmental conditions taking a risk of corn injury very often.

Having knowledge and data about the hybrids response to herbicides under unfavorable environmental condition growers either plan their choice of hybrids to plant or plan their choice of herbicide to use.

2. LOCATIONS, MATERIALS AND METHODS OF TRIALS

2.1 Location of trials

The data of this summary were based on experiments carried out between 1996- 2000 conducted at two different soil type locations: at Debrecen-Látókép, at reseach 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.

Trials were started at Debrecen-Látókép in 1996. This experimental station is located 15 km from the city of Debrecen. The soil ishigh quality homogenous black soil with calcium. Soil pH 5,5- 6,2.Potash and potash content of soil medium. Organic material is 2,76 %, humus spreading 80 cm deeply. Mobile water is 50 %- of the water capacity of soil. Groundwater located 3-5 m and is not located closer to surface than 2 m even under wet season. The soil quality belongs to the best quality in Hungary.

In 1999 trials were conducted at the research center of Plant Production Department of St. Stephan's University (at that time Agricultural University of Gödöllő.

The experimental station is located 1 km from, Gödöllő. The surface is hilly, soil is brown forest soil with high clay content. Soil pH 6,1- 6,5. Content of potash is low, potash is medium. Organic materials of soil is 0,8-1,2 %, Ground water is located 6-7 m. Quality of soil is very low regarding Hungarian soils.

2.2. MATERIALS AND METHODS

During field studies in 1996,1997,1998,1999,and 2000 7 herbicides and combinations were examined.

Examined herbicides /a.i/	Examined rate a.i g, ml, l/ha	Examined rate in f p. g, ml, l/ha
25 % rimszulfuron	10-12,5	40-50
50 % rimszulfuron + 25 %tifenszulfuron-metil	10-12,5+4-6,25	20-25
rimszulfuron+dikamba	10+271	307
nicoszulfuron	40	1 l, 20
nicoszulfuron+dikamba	40 +271	1 l +o.3 l
75 % izoxaflutol	105	140
S/ metolaklór+atrazin	1200+960	3000
30 % UAN oldat*	3000	10000
90% etoxilated izodecil alcohol**		0.1 % cc spay volume

* UAN liquid 28 %-os urea-ammonnitrate solution ** surfactant
** concentration of spray volume V/V %

The most of examined herbicides belongs to the sulfonilurea chemical class.They inhibits the ALS syntheses enzyme in the sensitive plants stopping the synthesis of leucin,isoleucin and valin . The symptoms of treated plants varies as chlorozis,stunting,leaf deformation,necrosis.The tolerant plants like corn metabolize the active ingredients of these herbicides in a short time. The rate of metabolism depending not only the genetic heritage of the hybrids but the environmental conditions like air and soil temperature.
Combinations of sulfonylureas in combinations with other type of, partly new developed herbicides, which purpose is getting wider spectrum and preventing or delaying resistance. These combination (rimsulfuron+dicamba and nikosulfuron+dicamba) also were examined.
Beside these herbicides izoxaflutole a newly developed chemistry was tested too. This chemistry belongs to the porfirin inhibitors (PBO) group.The izoxaflutole is a preemergent soil herbicides with markable postemergent activity.

During field studies in 1996,1997,1998,1999,and 2000 112 corn hybrids were examined.

Pi3515	Dahir	Furio	LG2447	PiX0965 V	PiX0863 B
Pi3752	Dante	Furio Sumo	Maraton	Sahara	Volens
Pi3860	DK 352	G.2390	Monessa 3905	Samoa	PiX 0876Z
4361 TC	DK 366	Gabriella	Mv 444	Stira	PiX 0935 N
4390 TC	DK 471	Goldaris	Mv 484	Sze SC 289	PiX 0935R Bonanza
Clarisia	DK 493	Goldena	Mv 514	Sze SC 348	PiX 0996 A
4532 SC	DK 527	H 2390	Mv TC272	Sze SC 361	PiX 1026 J
Alcyone	DK256	Hella	Norma	Sze SC 424	PiX0956 R
Alpha	Dk386	Horus	NX 2742	Sze SC 427	PiX1094 M
Alvina 3514	DK443	Hypnos	NX 2743	Sze TC 247	Pi xo965U
Anjou 235	DK463	Kincs	Occitan	Sze TC 277	Pi xo978H
AW 043	DK471	KWS 313	Occitan Sumo	Sze TC 294	Monalisa
AW 143	Domingo	KWS 353	Pelican	Sze TC 358	PI 3437
AW 723	Dunia	KWS-242	Peso	Sze TC 367	
Aztec	Duplo	KX 5364	pi 3730	Sze TC 373	
Bella	DUXCGS 2510	KX 6364	pi 3753	Sze TC 465	
Borbála	Emír	KX 7366	pi X 0954D	Sze TC 513	
Caracas	Evelina	Lasko	pi X 1005	Tornado	
Colomba	Felike	LG2231	Piroska	Venusz	
Coralba	Florencia	LG2310	Reinold	Veronika	

The 112 hybrids well represents hybrid portfolio of Hungary.
Some hybrids like Emir,Samoa are not cultivated in Hungary but we used them as a marker of sensitivity of sulfonilureas. Aslso newly developed sulfonilurea tolerant hybrids were tested as Occitan SUMO and Furio SUMO.

2.2.1 TRIAL SET UP

The corn hybrids were planted and at application time 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.

Size of experimental plots were 16-40 m, number of reps were 3. In Gödöllő the trials were carried out by same methods. The application was made by a sprayer developed and built by the University. Spray volume 200 l/ha spraying pressure 3.5 bar, nozzle type TeeJet 11004.At both location herbicides were applied at two application time regarding corn development stage. Early application was carried out at 4-5 leaves (BBCH 14-15) stage of corn and the late application was carried out at 6-7 leaves (BBCH 16-17) stage of corn.

The data of temperature was recorded 5 days before and 5 days after the application. Application was carried out under stresses condition as the temperature was permanently under +10 °C or over 25 °C. The development stage of corn was also recorded. At Latokep the effect of two most commonly used sulfonylurea herbicides as rimsulfuron and nicosulfuron on 3 hybrids as Occitan, Bonanza and AW043 were determined in 1997, 1998 and 1999. These hybrids were treated under stress conditions at two development stages maintained above.

2.2.2. ASSESMENTS OF TRIALS

Three sample areas were marked each parcel and 3x100 plants was examined regarding visual phytotoxicity symptoms. The visual symptoms as deformation, stunting, necrosis,chlorosis and rat tailing were recorded 1-2 weeks after the tratment at first time , than secondly 6-8 weeks after the treatment. Before harvest the cobs also was assest to determine any effect on them.

The treated plants were compared with plants located at mechanically controlled plots. During assesment the frequency of symptoms on the treated plants and the intensity of symptoms on the plants were calculated(table 1.) Symtom on leaves as chlorosis regarding frequency and intesity are shown on table 2. and 3.

The yields of treated plots were compared to each other and compared to the yield of mechanically controlled plots. The data were examined statistically too.

Table 1.

Method of assesments of visual symptoms.

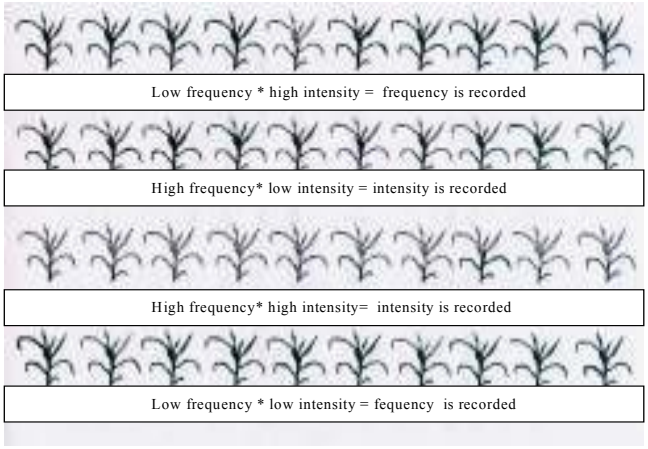


Table 2.

Visual symptom chlorosis appearing by 8o% frequency.

Table 3.

Visual symptoms chlorosis appearing by 3o% intensity.

3. RESULT

Corn cultivars responded differently to the treatments. Hybrids responded to the herbicides treatment regarding their genetic component. Heavier and more permanent symptoms were observed if herbicides were applied at 6-7 leaves (BBCH 16-17) stage (table 4. and 5). Herbicides applied younger stage of corn at 4-5 leaves (BBCH 14-15) caused lighter symptoms and the plants recovered fast. Genetically susceptible hybrids like Occitan, Pactol, Emir and Samoa responded to the herbicides aggressively and yield lost was observed if the treatment was applied at 6-7 leaves (BBCH 16-17) stage. Even severe phytotoxicity and large yield loss was observed if susceptible cultivars were treated under hot temperature. These hybrids were Occitan, Emir, Pactol, and Samoa.

Low or hot temperature, before, during and after the application influenced the response of hybrids to the herbicides. But some hybrid treated under hot temperature did not show strong visual symptoms and did not lost yield even the treatment was carried at 6-7 leaves (BBCH 16-17) stage. These hybrids were PIx1094, AW 723, KX 7366, Maraton, LG2310, DK 366, Hypnos, PI x 1026, Reseda, Monessa, Sze SC 424.

Regarding average of hybrids the most damage was caused by rimsulfuron+tifensulfuron-metil based herbicides. Dicamba herbicides caused tipical hormon simptoms when it was applied during hot temperature. Symptoms were more severe and permanent if the temperature was increased suddenly after treatment or a permanent cool temperature occurred at application when corn development stage was BBCH 15-16 (table 6.)

No difference was found between nicosulfuron and rimsulfuron regarding response of 3 hybrids (Occitan, Aw043 and Bonanza) during 1997,1998 and 1999.

The most susceptible hybrid among them was Occitan. Both herbicide reduced it's yield but no difference was found between nicosulfuron and rimsulfuron.

Both herbicides caused more severe damages if were applied at 6-7 leaves (BBCH 16-17) stage.

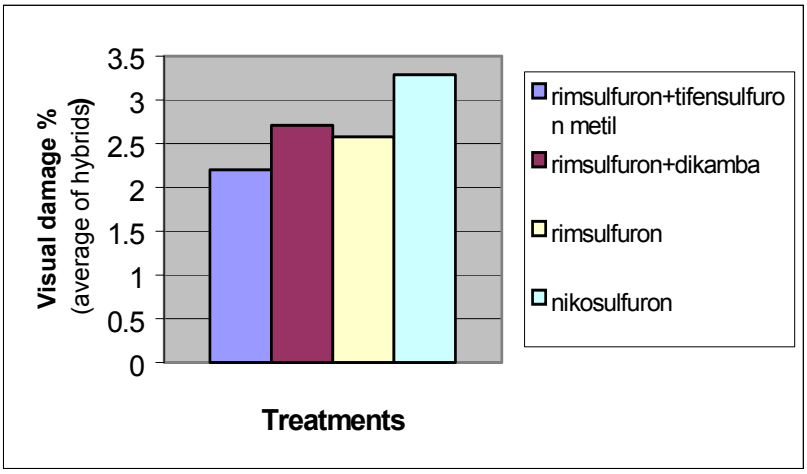
Other experience was found that herbicides reduced some hybrids' yield without remarkable visual damage like AW 043 responded in 1997. But some hybrids responded to the treatment with remarkable visual damage without any yield lost like Sze TC 277 responded in 1999.

The special sulfonylurea tolerant hybrids like Occitan SUMO and Furio SUMO showed high tolerance against these herbicides even they were treated under stress temperature.

These data can help growers,farmers to select hybrids to cultivate under unfavorable environmental condition.

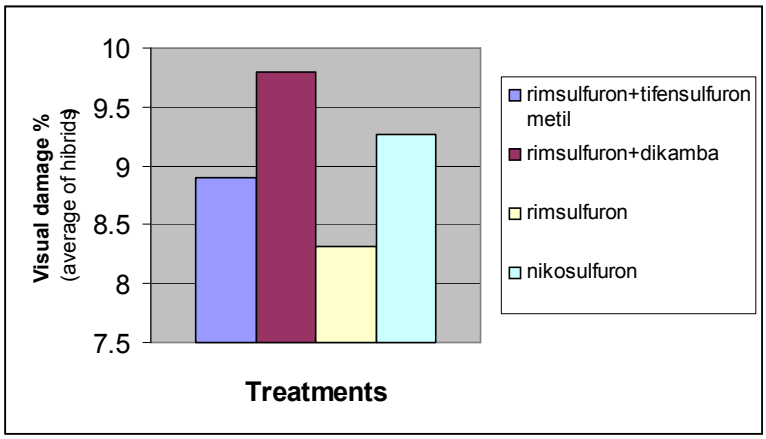
I suggest to use these test methods to find out the response of hybrids to herbicides in hot and cold temperature. It would be useful to establish a data base for growers to help them acessible make the best decision to choose the most suitable hybrids.

Table 4. A Visual symptoms of the treatments in first timing (Ps1,BBCH 14) calculated by average of hybrids at the first assesment. Debrecen-Látókép 1998.



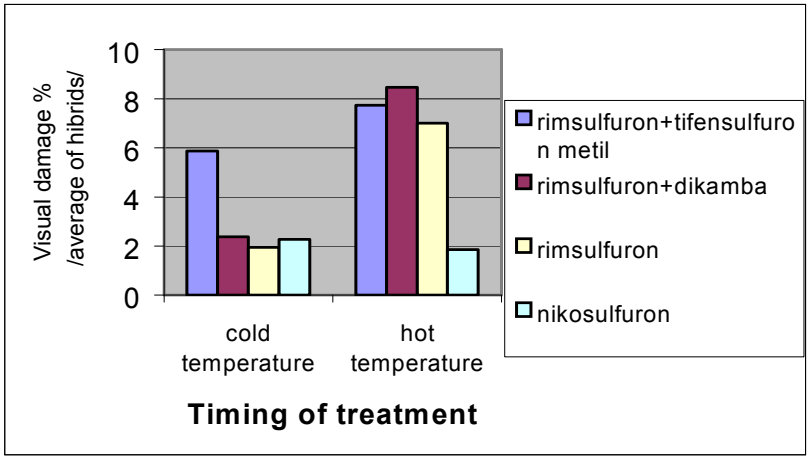
SzD 5% ns

Table 5. A Visual symptoms of the treatments in second timing (Ps2,BBCH 17-18) calculated by average of hybrids at the first assesment. Debrecen-Látókép 1998.



SzD 5% ns

6.ábra. Visual damage of hybrids % caused by treatment applied in hot and cold temperature. Debrecen-Látókép 1997.



3.1 Observation of the weedcontrol of herbicides

During 5 experimental years we can observed the weed control effect on 13 weed species (as part of natural weed flora).

These weed species are:

Annual grasses a broadleaves:

Amaranthus retroflexus L.
Amaranthus chlorostachys WILLD.
Amaranthus albus L.
Echinochloa crus-galli (L.) P.B.
Setaria pumila (POIR.) R. et SCH.-
Chenopodium album L.
Ambrosia artemisiifolia L.
Persicaria lapathifolia S.F. GRAY
Solanum nigrum L.
Digitaria sanguinalis (L.) SCOP.
Xanthium italicum MOR.-
Datura stramonium L.

Perennial bradleaves:
Cirsium arvense (L.) SCOP. *var. arvense-*

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 broadleved 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 1999 we tested two preemergent herbicides the S-metolochlor+atrazine and the izoxaflutole. The efficacy of izoxaflutole on Echinoclea crus-galli was pour even adecquate rain occured after application .

4. NEW SCIENTIFIC RESULTS AND ADAPTABLE RESULTS FOR GROWER PRACTICE

During the examination of hybrids response to sulfonylurea based herbicide I suggest to examine the hybrid response under application hot and cold temperature beyond today practice when the hybrid response is examined only using different rates of herbicides. Temperature below 10 °C couple of days before treatment or over + 25 °C in time of treatment can delay herbicide breakdown in the plant causing damage for hybrids even applied normal rate of herbicides. In that examination hybrids responded that way were Emir, Samoa, AW043, Dahir, PI x 0996 and Pactol.

By that examination some hybrids can be treated by the tested herbicides during unfavorable temperature at 6-7 leaves (BBCH 16-17) development stage without remarkable damage. These hybrids were: AW 723, DK 366, LG 2247, LG 2310, Reseda, Lasko, Sahara, KX 6364, Sze SC 361, Sze SC 424,PI x 1094 and PI x1026 J.

If cold temperature exist for longer period (more than 72 hours) during and after application the damage caused by sulfonilurea herbicides could be more severe and permanent than damage caused by same herbicides under hot condition. It was observed in 1997.

No difference was found between nicosulfuron and rimsulfuron herbicides regarding responses of 3 cultivars (Occitan,AW 047 and Bonanza) to these herbicides in trials conducted 1997,1998 and 1999.Both herbicides reduced the yield of Occitan cultivars.

New sulfonylurea tolerant hybrids as Occitan SUMO and Furio SUMO produced high tolerance to the examined herbicides even if these herbicides were applied under unfavorable environmental condition.

The efficacy of izoxaflutole on Echinoclea crus-galli was pour even adecquate rain occured after application .

LIST OF PUBLICATIONS CONNECTED WITH TOPIC OF DISSERTATION

1., **MOLNÁR, I.:**Experience of syulfonil ureas of DUPONT. Agroforum 1992. Special addition.

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

3., **MOLNÁR, I.** - TÓTH, E. - SOMLYAY, I. - KOVÁCS, GY. - VERECZKEY, K.: 1999./b Effect of sulfonylurea herbicides on the modern agriculture. Plant Production Scientific Days. Poster show.

4., 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. 52nd International Symposium on Crop Protection. May 9, 2000, Gent, Belgium. (poster) Abstracts, 94. P

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

6., **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.

7., **MOLNÁR, I**. - TÓTH, E. - SOMLYAY, I.: 2001/c. Effect of environmental factors on selectivity of corn hybrids. Plant Protection journal 37: 10; 2001.ppt.483-489.

8., SOMLYAY,I. - **MOLNÁR, I.:**2001./d Szulfonilurea herbicides:Chemical family for environmentallysound weed management. Symphosium of Hungarian Toxicologist Association . Oktober 27. 2001.,Eger. P1-9.

Other publications:

1., FROMMER ,L. - **MOLNÁR, I**.: 1989. Protection against European corn borer using chemigation technology. Plant Protection journal XXV.1989. 5:

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

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

4., 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.

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

6., **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.

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.b (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.c (poster). Summaries, 155.p.

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

19.,**MOLNÁR**, I.-TÓTH, E.- SOMLYAY, I.-PÉTER, J,-BENCSÉNÉ, BÁRDI,G.:2001. Examination of effect of tribenuron metil on *Cirsium arvense (L). Scop*. EWRS conference Martonvasar 2001./f Lecture and poster.

20., **MOLNÁR**, I.-TÓTH, E.- SOMLYAY,-PAKURÁR.,M-JOBBÁGY, J.-VASZINÉ KOVÁCS ,C.-PETRÓ, E.:2001. Steward 30 DF : A novel compound to control Helicoverpa armigera and Pyrausta nubilalis . 6. Plantprotection Forum of beyond Tisza ,November 06.2001/g.;poster proceedings ppt.386-395.

21., TÓTH, E.- **MOLNÁR, I**.- SOMLYAY, I.: 2001./h Charisma: a new fungicide in cereals. 47. Plant Protection Scientific Days, Budapest, February 27-28, 2001 (poster). Summaries, 155.p.

22., **MOLNÁR**, I.-TÓTH, E.- SOMLYAY,-PAKURÁR.,M-JOBBÁGY, J.-VASZINÉ KOVÁCS ,C.-PETRÓ, E.:2001. Control **MOLNÁR**, I.-TÓTH, E.- SOMLYAY,-PAKURÁR.,M-JOBBÁGY, J.-VASZINÉ KOVÁCS ,C.-PETRÓ, E.:2001. /i
Control Pyrausta nubilalis and Helicoverpa armigera leps in sweetcorn using chemigation technology. 47. Plant Protection Scientific Days, Budapest, February 27-28, 2001. Lecture.