



NEMZETI ÉLELMISZERLÁNC-BIZTONSÁGI HIVATAL

Sunflower Trials

April 28 ,2022.Euroseeds Meeting

Gábor Szekrényes, National Food Chain Safety Office

Agricultural Genetic Resources Directorate

TORDAS

**Development of the national sown area and yield of sunflower
2013-2021.**

	2013	2014	2015	2016	2017	2018	2019	2020	2021
eha	604,5	610,2	627,3	629,2	658,7	604,4	561,7	612,3	655,0
						HO:140	HO:200	HO:270	HO:220
t/ha	2,492	2,653	2,495	2,979	2,839	3,002	3,019	2,841	2,603
et	1 506	1 618	1 565	1 874,4	1 869,8	1 814,3	1 695,7	1 739,8	1 704,8

Location of sunflower trials in 2022



Trials/2022		Varieties	SRV	EU	AP
1.	II.Early	2		1	1
2.	III.Medium	2	2		
3.	IV.Confectionery-sh-bf	10	3	5	2
4.	V/1.IMISun Early	5	2	2	1
5.	V/2.IMISun Medium	7	1	4	2
6.	V/3.CLHA Plus Early	2	1	1	
7.	V/4.CLHA Plus Medium	7	2	1	4
8.	VII/2.SU-Early	4	1	3	
9.	VII/3.SU-Medium	15	1	5	9
10.	VII/4.AIR-Medium	7			7
Total:		61	13	22	26

Agent	Number of varieties		
MATE/Kaposvári Egyetem	2	6	9,80%
MATE/GK. Szeged	1		
Mogyi	3		
Syngenta	29	55	90,20%
Corteva/Pioneer	5		
Sun-Seed/S&W	3		
Lidea	2		
Mogyi	5		
Limagrain	2		
Karintia	5		
Saaten Union	1		
Saatbau Linz	2		
KWS	1		
Σ/ Total:	61		

HO sunflower hybrids in 2022.

1	III.	2	Tutti/NX73008 / HO	2010 CH	Syngenta
2	V/1.IMI Early	2	SY Barilio/NX92246 HO	2022 CH	Syngenta
3	V/2.IMI Medium	2	SY Excellio /NX22212 IMI,HO	2015 CH	Syngenta
4	V/2.IMI Medium	5	SVH90061 HO	h(2) US(2)	Sun Seed/S&W
5	V/2.IMI Medium	7	Sy Experto IMI/HO	EU CH	Syngenta
6	V/3.CLHAP Early	1	SY Gracia CLP/NX32235 CLHA Plus/HO	2016 CH	Syngenta
7	V/4.CLHAP Medium	3	NX12293/HO	h(1) CH(1)	Syngenta
8	V/4.CLHAP Medium	4	NX12294 /HO	h(1) CH(1)	Syngenta
9	V/4.CLHAP Medium	7	SUN21009 CLP/HO	fj(1)	Sun Seed
10	VII/2. SU Early	2	P64HE133 HO	EU/3 US	Pioneer
11	VII/3. SU Medium	3	P64HE144 HO	EU/2 US	Pioneer
12	VII/3. SU Medium	4	NX02267 HO	h(3) CH(3)	Syngenta
13	VII/3. SU Medium	11	NX12298 /HO	h(1) CH(1)	Syngenta
14	VII/3. SU Medium	13	NX22318 /HO	h(1) CH(1)	Syngenta

State registered sunflower varieties in Hungary in 2022.

HU :40 H+1 OP

HT:

- 7 IMISun
- 8 CLHA Plus/CLP
- 9 SU

HO/ High-Oleic : 8

2-LO,3-IMISun,1-CLP és 2-SU

EU:1616



SRV:35 PR

Pathotypes of *Plasmopora halstedii*:

3 (700), 4 (730) HU, 8 (710), 9 (330).

From 31 January 2006 PI / Gene, pathotype certification..

From 31 January 2020 PI / Gene, pathotype certificate.

704,714,724

SRV:4 /+704 PR



Plasmopara halstedii

Economic importance of sunflower downy mildew

- In the 1990's: serious yield losses due to systemic infection of *Plasmopara halstedii* causing stunting and chlorosis on the true leaves (the damage corresponds to the rate of infection!)
- Double protection against the disease:
 1. Chemical control: seed dressing with metalaxyl
 2. Genetic control: resistant hybrids carrying PI-genes
- In the last 3 decades there have been limited yield losses but the threatening nature of the pathogen has not passed away... because of the *new races or pathotypes*: R- hybrids ⇒ increasing selection pressure on the domestic population of the fungus...

Integrated Disease Control

1. **Cultural practices:** crop rotation (6-7 years), elimination of volunteers
2. **Chemical control:** *seed dressing* (metalaxyl+fludioxonil \Leftrightarrow R)
3. **Genetic control:** *resistant hybrids* (RM/PR genotypes)

▪ **Vulnerability** of the genetic control: hybrids carrying race-specific resistance with dominant PI-gene(s) cause an increasing selection pressure \Rightarrow emerging *new virulent and/or aggressive* races!

+ 704,+714,+724

▪ Basic requirement of the sunflower state registration in Hungary:

new variety candidates must have a resistance against the prevalent *Plasmopara halstedii* races (700, 730, 710 and 330)!



2021.



SRV:21 OR E



The sunflower broomrape

(*Orobanche cumana* Wallr.)

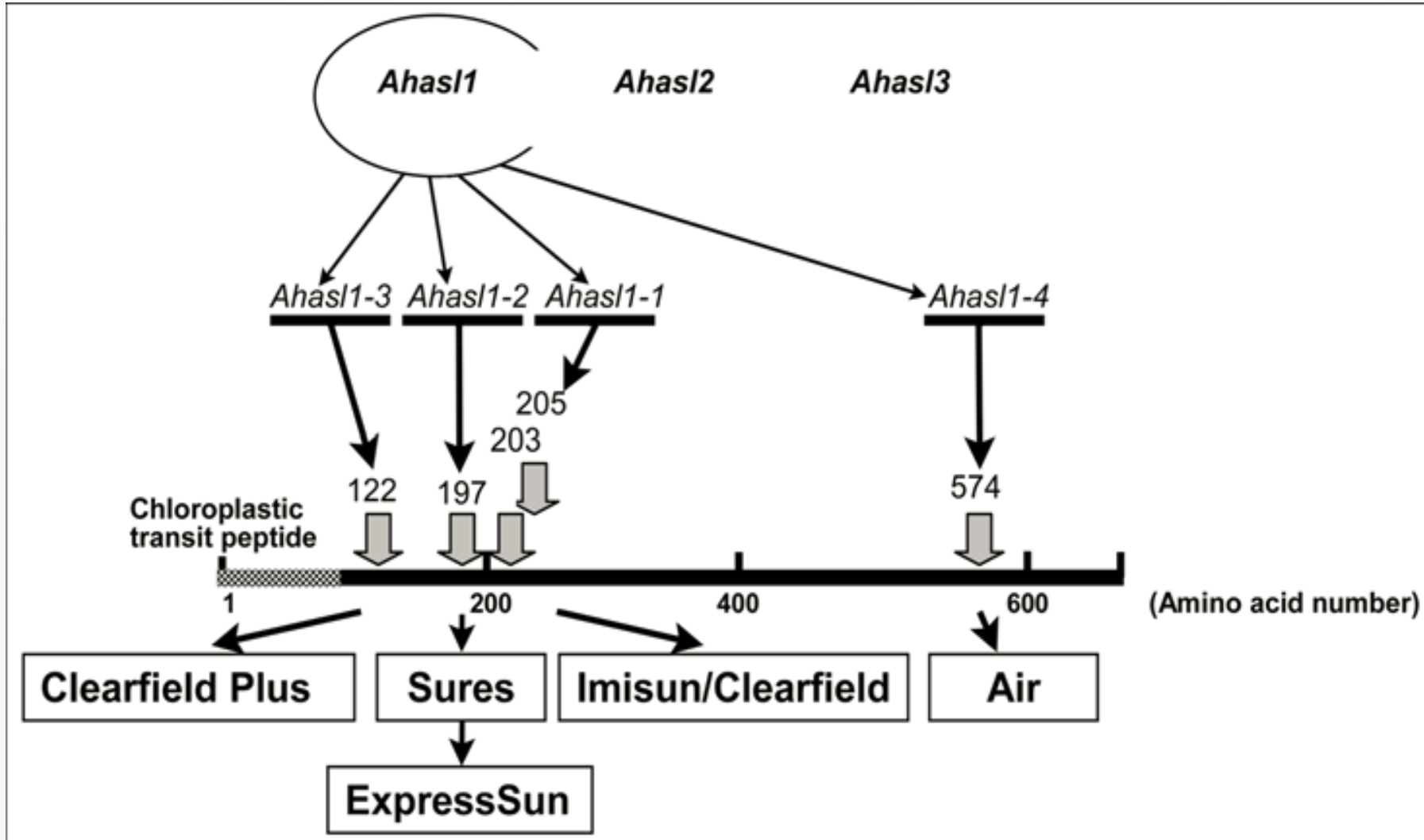
- This root-parasite appeared and started to spread in Hungary after the 2nd World War
- In the 1960 -70's the Soviet sunflower varieties (e.g. VNIIMK 6540, Tchakinsky 269) with high oil content proved to be resistant against the local broomrape population of that time
- The physiological specialisation of the parasite resulted in *new aggressive races* (e.g, race E, F, F+) besides the races previously widespread in Europe (A,B,C,D). Up to now the presence of race E is verified in HU
- Latest findings in the varietal behaviour in Southern Hungary (2013) indicated some change in the race-composition of the local population!
- Varietal resistance is an effective and environment-friendly control method and a major component of the IPM



Sclerotinia sclerotiorum

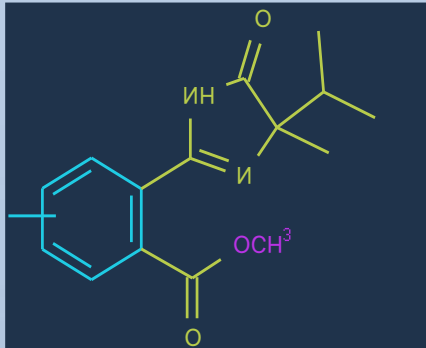


MACROPHOMINA 98915

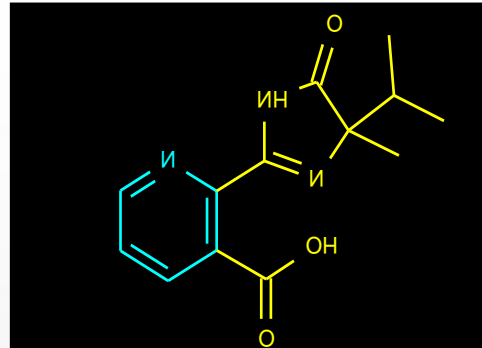


Genetics of AHAS-inhibitor herbicide tolerance in sunflower. There exist three genes encoding for catalytic subunits of the AHAS enzyme: Ahas1, Ahas2, and Ahas3. Known mutations for herbicide tolerance so far described were located in Ahas1.

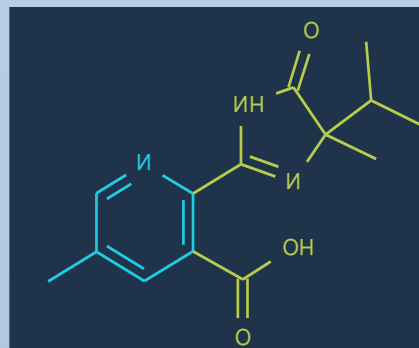
Imidazolinon herbicide family



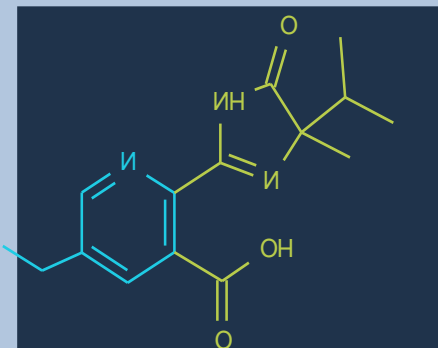
IMAZAMETHABENZ



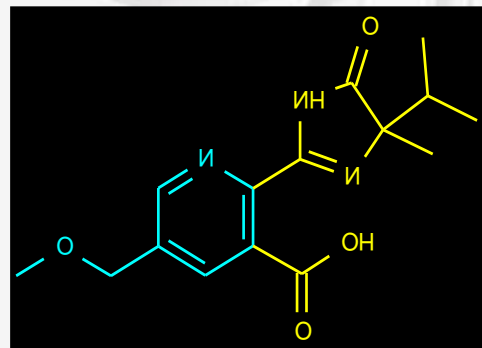
IMAZAPYR



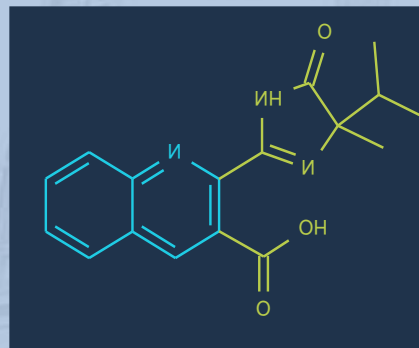
IMAZAPIC



IMAZETHAPYR



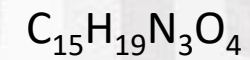
IMAZAMOX



IMAZAQUIN

Imazamox

Empirical Formula (Hill Notation):



1. Clearfield Trait in Sunflower

- Clearfield IMISun: Ahasl1-1
- Natural mutation discovered in wild sunflowers
- Transferred into cultivated sunflower inbred lines by USDA
- Requires R (Ahasl1-1) plus enhancers (E) in final hybrid for commercial tolerance
- Hybrid production requires all R and E genes homozygous on each inbred
No molecular diagnostic for E genes, to date
- BASF obtained CANADA PNT approval
- Commercial launch in 2003

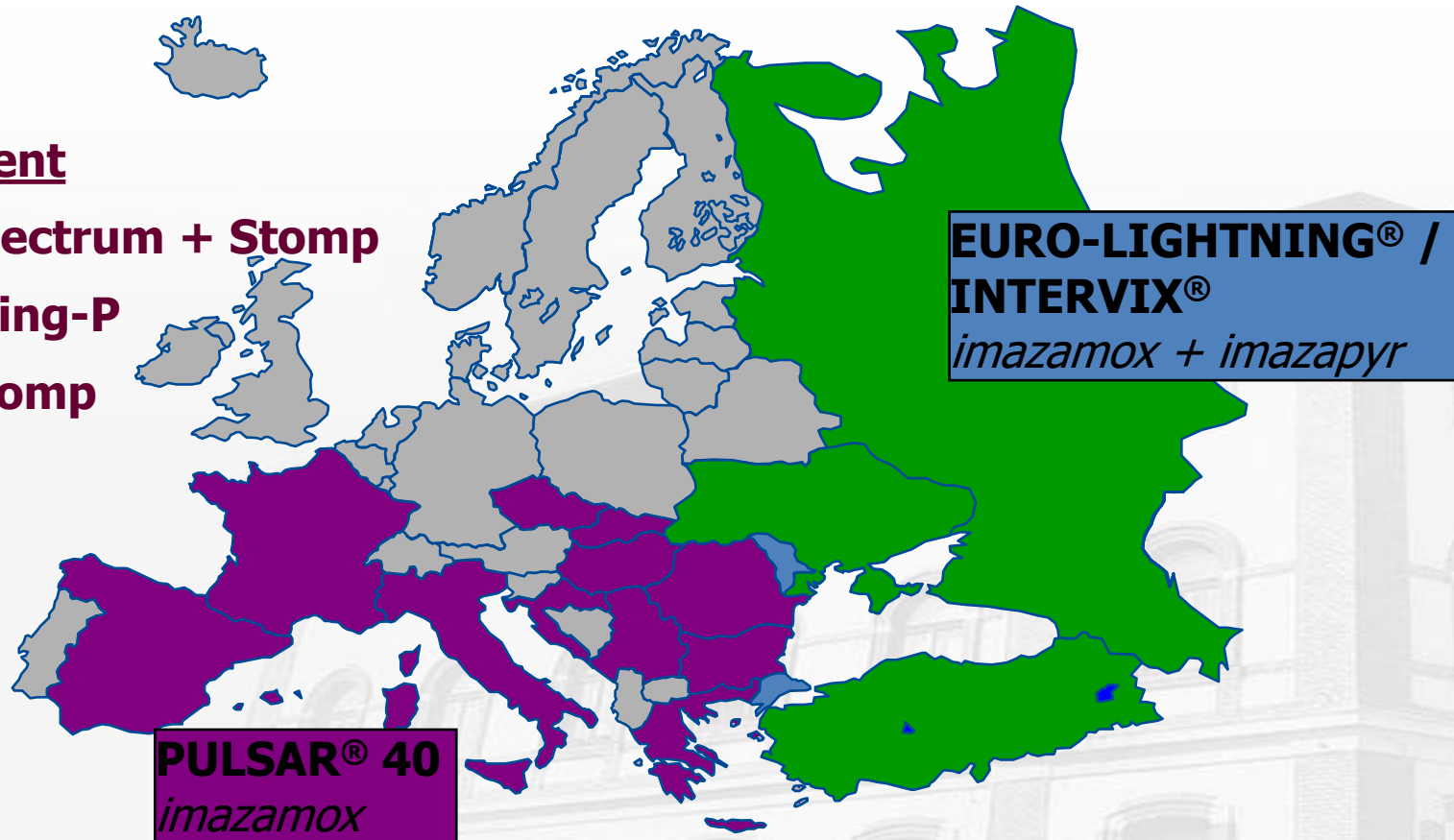
CLEARFIELD® production system in Europe

Treatment

SK: Spectrum + Stomp

HU: Wing-P

BG: Stomp



Argentina & USA important **CLEARFIELD** sunflower market

2. Development of an improved imidazolinone tolerance trait **CLHA PLUS**

-Collaboration with Nidera initiated in 2000

-EMS seed mutagenesis of an elite cultivated sunflower inbred delivered a single gene breeding system with greater herbicide tolerance

CLHA PLUS Ahas1-3 gene

Trait called Clearfield Plus

Molecular and biochemical characterization:

Mendelian segregation & mapping = single gene

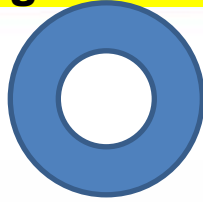
Full length gene sequencing

Protein (enzyme) activity analysis

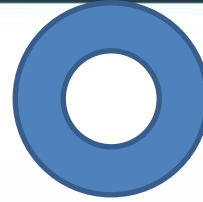
Publication in TAG and Crop Science/2008

Breeding formats

Female



Male



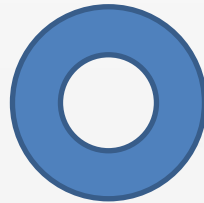
CLHA+/CLHA+
Homozygous

CLHA+/ CLHA+

CLHA+/CLHA+

**Clearfield
PLUS**

Female



Male



IMISun/CLHA+
Heterozygous

IMISun/IMISun

CLHA+/CLHA+

AHASL1-3/CLHA+ can only be combined with AHASL1-1/IMISun as a Heterozygous Stack in F1

Both breeding formats qualify as Clearfield Plus
First commercial hybrids will be Heterozygous.

1. Sures / USDA TBM/

SU-tolerant sunflowers were developed from wild sunflower populations discovered in USA. The tolerance allele Ahasl 1-2 was introgressed into cultivated sunflower by forward crossing and selection with the herbicide tribenuron and gave rise to the trait known as Sures. The target-site-tolerance is the result of mutation P197L at the Ahasl 1 locus.

2. ExpressSun[®] DuPont SU7-gene

The same type of tolerance as Sures sunflowers was obtained by EMS mutagenesis over the line HA89 and was developed and commercialized under the name ExpressSun.

The recommended dose is not uniform everywhere (some examples)

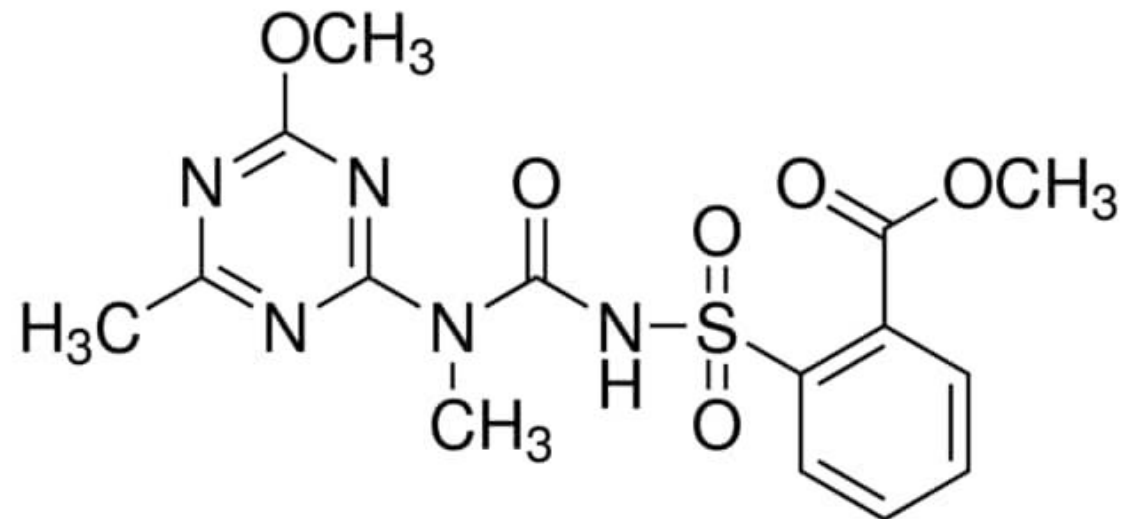
Hungary - Express 50 SX - 45 g / ha (22.5 g active ingredient)

Austria - Express 50 SX - 60 g / ha (30 g active ingredient)

Romania - Express 50 SL - 30 g / ha (15 g active ingredient)

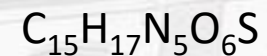
Bulgaria - Express 50 SL - 40 g / ha (20 g active ingredient)

Ukraine, Russia - Express 75DF - 50 g / ha (37.5 g active ingredient)



Tribenuron-methyl

Empirical Formula (Hill Notation):



SU damage:

bract necrosis



head deformation



Based on the results of the last research years, our office will present the following sunflower hybrids at the Variety Certification Committee meeting on March 10, 2022

Group of Imazamox-resistant IMISun / HO early group (2019-2021):

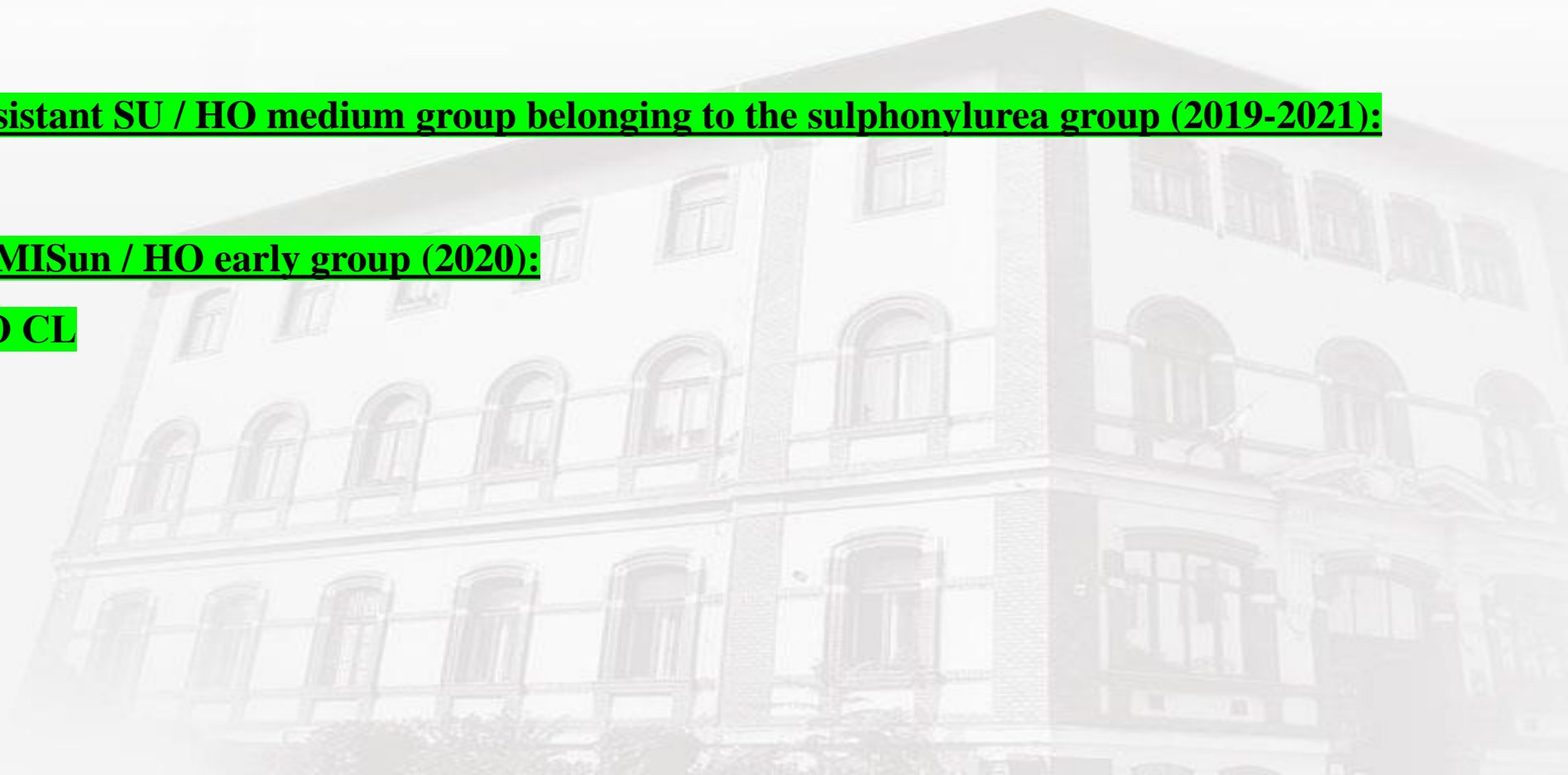
- NX92246 / SY Barilio

Group of tribenuron-methyl-resistant SU / HO medium group belonging to the sulphonylurea group (2019-2021):

- NX92250 / Sunato

Group of Imazamox-resistant IMISun / HO early group (2020):

- GN30152MHO / GK Milia HO CL



Sunflower experiments, plans, changes in 2022

Experiment types:

- Official trials
- Examination of EU varieties
- Examination of state registered varieties
- Private trials

Maturity groups, Imazamox -ImiSun and -CLHA Plus, -SU, AIR -HO group:

- Early, middle, edible / IMISun and peeling-bird food
- Imazamox (ImiSun-CLHA Plus), SU, AIR, HO groups.

Tests:

Achene yield, oil content, protein content (C-S-B), observations during the growing season (Thousand kernel mass, Vegetation period, Later flowering then to average, Lodged, Under head broken), fatty acid composition (HO), pathological tests (Sci), resistance tests (Plasmopara, broomrape E race), Imazamox / ImiSun and -CLHA Plus / -SU-AIR: Phytotoxicity tests TORDAS, classification studies (C-S-B).

Plan: Genetic testing of CLHA Plus and AIR hybrids.

Sunflower experiments, plans, changes in 2022

Very early group: none

Early group, Medium group:

Seed and oil production values exceed the level of group mean

Internal content : oil content -value higher than 45 %

Confectionery-shelling- bird food group:

-Confectionery

-**IMISUN (C-sh-bf)**

-Shelling, bird food

HO group:

Achene yield +, Oil yield +, 45% (oil content)

Quality standard: currently not available

/ N HO, ImiSun HO, CLP HO, SU HO /

HO 85% = +

Imazamox (ImiSun-CLHA Plus) -SU-AIR treated group:

KT +, OT +, 45% +

View points of submission



View points of submission

Imazamox (ImiSun-CLHA Plus)-SU-AIR treated groups :

Seed and oil production values exceed the level of group mean

Internal content : oil content -value higher than 45 %

Imazamox and tribenuron-methyl. resistance

GY+,OY+,45%+

In the case of hybrids the examination of pathological factors will be required.

Sunflower mildew local strain resistance (700, 730, 710, 330).

Concerning the compulsory recorded diseases (white mould, diaporthe) it cannot be considerably susceptible (5) for any of them, or susceptible exceeding the medium for two of that diseases (4)

Imazamox (ImiSun-CLHA Plus)-SU **HO treated groups:**

Seed and oil production values exceed the level of group mean

Internal content : oil content -value higher than 45 %

GY+,OY+,45%+

HO standard :NO

HO 85%=+

Group of A.I.R.® Sunflower Hybrids:

Applicable post-emergence weed control - in herd management:

Sequential post-emergence treatment with the maximum permitted single dose of herbicides registered in A.I.R.® sunflower, with a treatment-free period of 7-10 days between treatments.

First treatment: 2-4 true leaves in sunflower phenology (BBCH12-14)

Pulsar® Plus / Listego® Plus (1x 2.0 liters/ha)

Second treatment: 6-8 true leaves in sunflower phenology (BBCH16-18)

Express® 50 SX (1x 45 g/ha) + Trend® 90 (0,1%)

Herbicide phytotoxicity study:

- **Express® 50 SX** (2x 45 g/ha) + **2x Trend® 90 (0,1%)**
 - **Pulsar® Plus / Listego® Plus** (2x 2.0 liters/ha)
 - **Pulsar® / Listego®** (2x 1.25 liters/ha) – Label extension in progress in 2022.
 - **Listego Pro®** (2x 1.0 liter/ha) – Label extension in progress in 2022.
- + **Viballa®** 2X1,0 liter/ha (3,0 g/l halauxifen-metil)



fasor								
Kezelések	I. ismétlés		II. ismétlés		I. ismétlés		II. ismétlés	
Evonelle Express dupla dózis (120 g/ha) + Trend 90 (0,1%)	Sz	42-től 1	42-től 1	Sz	Sz	42-től 1	42-től 1	Sz
Express 50 SX dupla dózis (90 g/ha) + Trend 90 (0,1%)	Sz	1-től 42	1-től 42	Sz	Sz	1-től 42	1-től 42	Sz
Pulsar plus dupla dózis (4,0 l/ha)	Sz	42-től 1	42-től 1	Sz	Sz	42-től 1	42-től 1	Sz
Pulsar 40 SL dupla dózis (2,5 l/ha)	Sz	1-től 42	1-től 42	Sz	Sz	1-től 42	1-től 42	Sz
Kezeletlen kontroll	Sz	42-től 1	42-től 1	Sz	Sz	42-től 1	42-től 1	Sz
	←		→		←		→	
	Kender							

Kezelések
Viballa 300 SX szimpla dózis (60 g/ha) + Trend 90 (0,1%)
Express 50 SX szimpla dózis (45 g/ha) + Trend 90 (0,1%)
Pulsar plus szimpla dózis (2,00 l/ha)
Pulsar 40 SL szimpla dózis (1,25 l/ha)
Kezeletlen kontroll

Thank you for your attention!

