



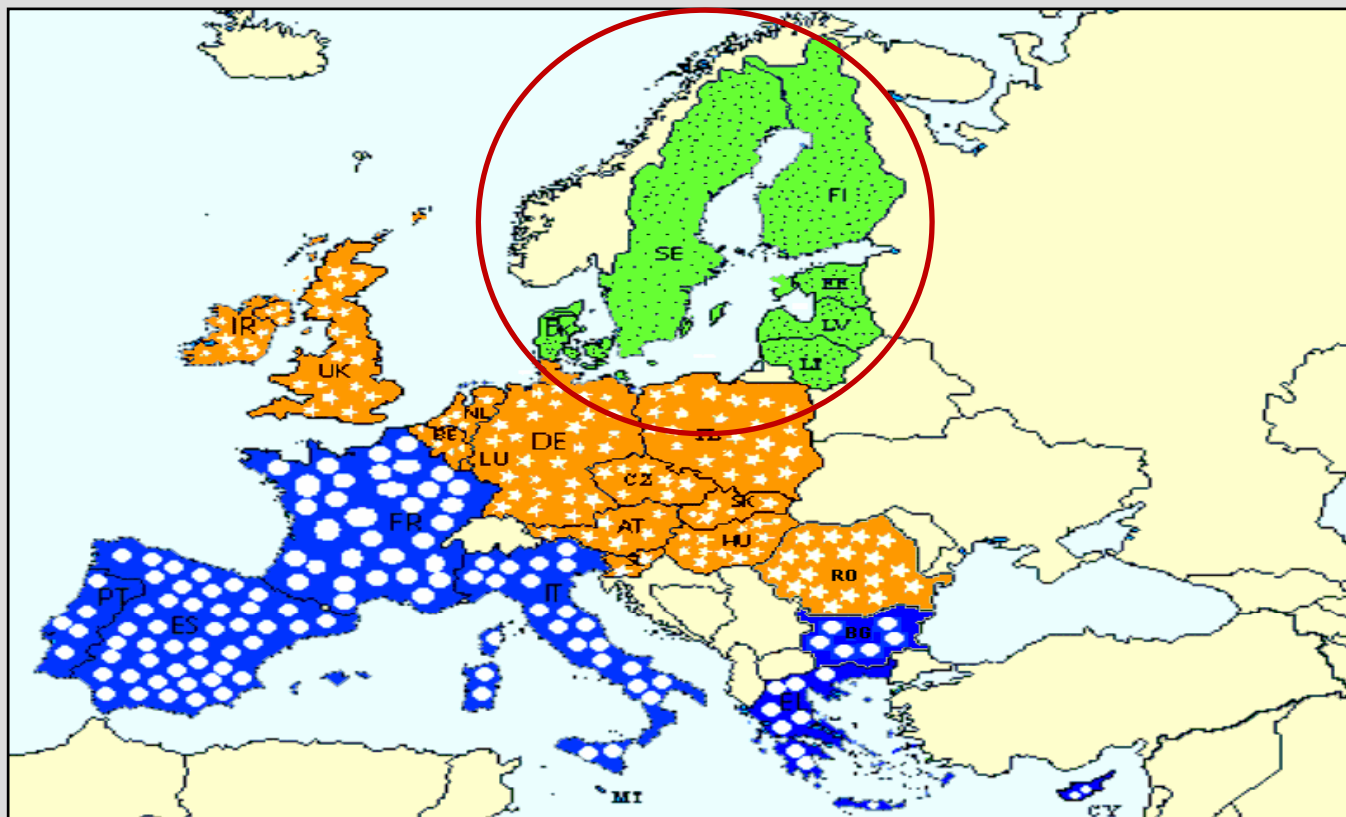
Herbicide resistance mapping in the EU Northern Zone

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EU authorization zones



North Zone: SE, FI, DK, EE, LV, LT

Central Zone: BE, CZ, DE, IR, LU, HU, NL, AU, PL, RO, SL, SK, UK

South Zone: BG, ES, EL, FR, IT, CY, MT, PT



General statements

Resistance is less widespread in NZ compared to the other EU registration zones

**No systematic monitoring has been conducted
- resistance cases are more or less based on herbicide failure**

How can we map herbicide resistance?



NORBARAG



NORBARAG is a resistance action group for the Nordic and Baltic countries

Members from Denmark, Estonia, Finland, Latvia, Lithuania, Norway and Sweden

Annual meetings with participants from industry, research units and advisory service



NORBARAG



- information exchange
- **verification and listing of cases of resistance in the Nordic-Baltic region**
- to discuss strategies to avoid resistance and to manage resistant populations
- to define research needs, discuss test methodologies and agree on standards
- to promote collaboration on resistance screening and other research topics related to pesticide resistance
- to promote awareness on pesticide resistance issues e.g. by producing educational material
- to maintain contacts to similar groups in other countries



NORBARAG



- During our annual meetings we inform and discuss new cases of resistance
- Resistance cases are recorded in a simple excel database
- Not an alternative to 'The international survey of herbicide resistant weeds' but a simple path to keep us updated within the registration zone





Resistance status in NZ



STE ME
ALOMY
LOLMU
PAPRH
APESV
MATIN
GAESP
CHYSE
CAPBP

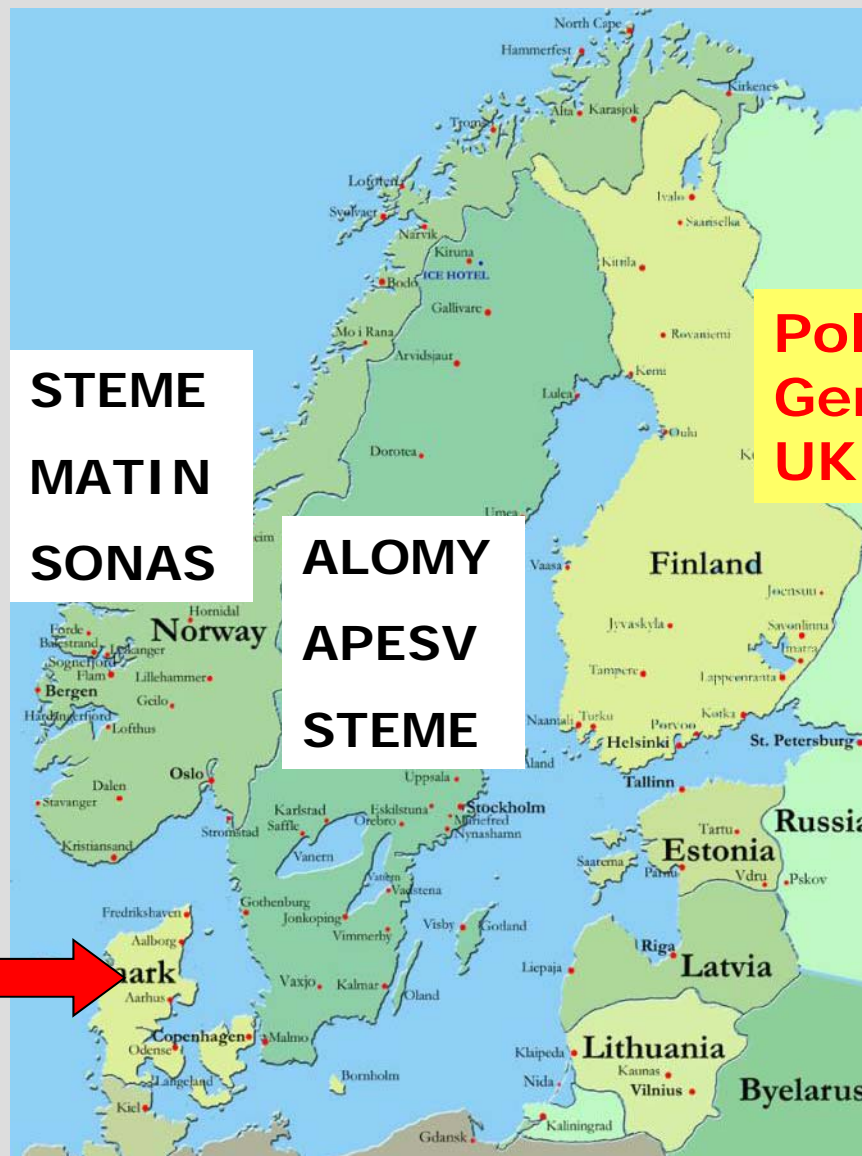


Temporal evolution of resistance - Denmark

Weed species	First case	Total no. of cases, 2014
STEME	1991	26
GAESP	1999	1
ALOMY	2001	53
PAPRH	2003	8
LOLMU	2009	18
MATIN	2010	13
CHRSE	2010	2
APESV	2010	5
CAPBP	2011	1



Resistance status



Poland: 21 species
Germany: 31 species
UK: 23 species

STEME
MATIN
SONAS

ALOMY
APESV
STEME

STEME
ALOMY
LOLMU
PAPRH
MATIN
APESV



Resistance - MoA



ALS inhibitors

- broadleaved species in NO, SE, DK, FI
- ALOMY (DK, SE), APESV (DK, SE, LT), LOLMU (DK)

ACCase inhibitors

- ALOMY (DK, SE), LOLMU (DK)

Photosystem II

- APESV (SE), CHEAL (NO, FI, SE), POAAN (NO)



NORBARAG database



Documented cases of resistance to herbicides in Nordic-Baltic countries

(Practical resistance and/or detection of resistant strains)										
Active ingredient	Main group/primary site of action	Chemical subgroup or active ingredient	Commercial name of product used in test	Weed	Weed	Crop	Crop	Country	Locality	UTM coordinates
	HRACs mode of action classification	HRACs mode of action classification		Latin name	English name	Latin name	English name		Municipality, county	
Tribenuron-methyl	B. ALS-inhibitors	Sulfonylurea	Express	Stellaria media	Common chickweed	Hordeum vulgare	Barley	Norway	8 locations, t.e.Vestby, Akershus	-
Tribenuron-methyl	B. ALS-inhibitors	Sulfonylurea	Express	Papaver rhoeas	Common poppy	Hordeum vulgare	Barley	Denmark	8 locations	
Tribenuron-methyl, odosulfuron	B. ALS-inhibitors	Sulfonylurea	Express, Hussar OD	Stellaria media	Common chickweed	Hordeum vulgare	Barley	Denmark	>23 locations, 3 new cases in 2012	
Tribenuron-methyl, odosulfuron	B. ALS-inhibitors	Sulfonylurea	Express, Hussar OD	Tripleurospermum inodora	Mayweed	Hordeum vulgare	Barley	Denmark	3 locations + 1 new 2012	
tribenuronmethyl	B. ALS-inhibitors	Sulfonylureas	Express	Galeopsis spp.	Hemp-nettle	Hordeum vulgare	Springbarley	Sweden	1 location; Vallrum,	
	B. ALS-inhibitors	Sulfonylureas	Salsa	Stellaria media	Common chickweed	Brassica raba	S.turnip rape	Finland	1 location	
	B. ALS-inhibitors	Sulfonylureas	Ratio	Stellaria media	Common chickweed	Hordeum vulgare	S.barley	Finland	1 location	
	B. ALS-inhibitors	Sulfonylureas		Sonchus arvensis	Sowthistles			Norway	8 locations	
	B. ALS-inhibitors	Sulfonylureas		Tripleurospermum inodora	Mayweed			Norway	8 locations	
	B. ALS-inhibitors	Sulfonylureas		Spergula arvensis	Corn spurrey			Norway	2 locations	
	B. ALS-inhibitors	Sulfonylureas	Harmony Plus, Express ST,	Papaver rhoeas	Common poppy			Sweden		
Florasulam	B. ALS-inhibitors		Primus	Stellaria media	Common chickweed			Denmark	1 location	
Metamitron, Metribuzin	C1. Photosystem II-inhibitors	Triazinones	Goltix, Sencor	Chenopodium album	Fat hen	Beta vulgaris	Sugar beet	Sweden	4 locations	
Metamitron	C1. Photosystem II-inhibitors	Triazinones	Goltix	Chenopodium album	Fat hen	Beta vulgaris	Sugar beet	Sweden	3 locations	
Fenoxaprop	A. ACCase inhibitors	Aryloxyphenoxy-propionate	Primera Super	Alopecurus myosuroides	Blackgrass	Triticum aestivum	Winter wheat	Denmark	>39 locations	
Clodinafop	A. ACCase inhibitors	Aryloxyphenoxy-propionate	Topik	Alopecurus myosuroides	Blackgrass	Triticum aestivum	Winter wheat	Denmark	> 39 locations	
Lexus	B. ALS-inhibitors	Sulfonylurea	Flupyr-sulfuron	Alopecurus myosuroides	Blackgrass	Triticum aestivum	Winter wheat	Denmark	>39 locations	
Fenoxaprop-P-ethyl	A. ACCase inhibitors	Aryloxyphenoxy-propionate	Event Super	Alopecurus myosuroides	Black grass	Triticum aestivum	Winter wheat	Sweden	14 locations	
Fenoxaprop-P-ethyl	A. ACCase inhibitors	Aryloxyphenoxy-propionate	Event Super	Alopecurus myosuroides	Black grass	Triticum aestivum	Winter wheat	Sweden	4 locations new	
Fenoxaprop-P-ethyl	A. ACCase inhibitors	Aryloxyphenoxy-propionate	Event Super	Alopecurus myosuroides	Black grass	Triticum aestivum	Winter wheat	Sweden	4 locations new	
Fenoxaprop-P-ethyl	A. ACCase inhibitors	Aryloxyphenoxy-propionate	Event Super	Alopecurus myosuroides	Black grass	Triticum aestivum	Winter wheat	Sweden	7 locations new	

https://portal.mtt.fi/portal/page/portal/www_en/Projects/Norbarag/subgroups/herbicides

NORBARAG database



HRAC mode of action	Active ingredient	Weed <i>Latin name</i>	Crop <i>Latin name</i>	Country	Location Municipality, county
ALS inhibitor	Tribenuron-methyl	<i>Stellaria media</i>	<i>Hordeum vulgare</i>	Norway	8 locations, t.e.Vestby, Akershus
ALS inhibitor	Tribenuron-methyl	<i>Papaver rhoeas</i>	<i>Hordeum vulgare</i>	Denmark	8 locations
ALS inhibitor	Tribenuron-methyl	<i>Stellaria media</i>	<i>Hordeum vulgare</i>	Denmark	>23 locations, 3 new cases in 2012
ALS inhibitor	Tribenuron-methyl	<i>Tripleurospermum inodora</i>	<i>Hordeum vulgare</i>	Denmark	3 locations + 1 new 2012
ALS inhibitor	Tribenuron-methyl	<i>Galeopsis spp.</i>	<i>Hordeum vulgare</i>	Sweden	1 location; Vallrum, Sala

https://portal.mtt.fi/portal/page/portal/www_en/Projects/Norbarag/subgroups/herbicides

NORBARAG database



Test method

Resistance level

Practical documentation

References



NORBARAG



Problems

- Required documentation to confirm resistance?
- Who performs resistance tests? Common standards? Who pays?
- Who is responsible of updating the database?
- Who reports to the international survey?



Factors affecting resistance development



- Weed species and densities
- Crop rotation
- Soil tillage
- Herbicide choice (and dose?)
- Alternative weed control methods – IPM





Occurrence of resistant weed species

- Grass weed species in winter cereals (ALOMY, APESV, LOLMU)
- Broadleaved weed species in winter and spring cereals (STEME, PAPRH, MATIN, SONAS, SPEAR, GAESP, CENCY)
- CHEAL in sugar beets



Available herbicides for grass weed control



		Denmark	Sweden	Lithuania
A	ALS inhibitors	X*	X	X
B	ACCase inhibitors	X	X	X
C1	IPU		X	X
F1	Flurtamone		X	
N	Prosulfocarb	X	X	X
K1	Pendimethalin Propyzamide	X *	X	X
K3	Flufenacet			X

*Dose restrictions to limit maximum deposition on soil

Factors affecting resistance development in Norway



Pesticide tax introduced in 2003 → increased use of SU herbicides

ALS resistance evolved over 5 years at conventional tillage – and even faster at reduced tillage





Factors affecting resistance development

Crops/cropping history and herbicide use are main factors

Additional factors:

- **Herbicide availability**
- **Political factors**
- **Awareness (monitoring)**



Pesticide tax introduced in DK, 2013



Herbicide (active ingredient)	Change in costs (%)
Atlantis OD (Iodosulfuron+mesosulfuron)	-22
Express ST (Tribenuron)	-21
Topik (Clodinafop)	-18
Primera Super (Fenoxaprop-P)	-17
Diflufenican	+6
Starane XL (Fluroxypyr)	+3
Glyphosate	+61
Oxitril CM (Ioxynil+bromoxynil)	+90
Boxer (Prosulfocarb)	+117
Stomp (Pendimethalin)	+121
MCPA 750	+133

A status for herbicide resistance in Denmark, 2013-14



Semi-randomised monitoring – seed sampling
from untreated plots in all herbicide trials (appr.
300 trials)

Weed species:

- **ALOMY, APESV, LOLMU**
- **PAPRH, MATIN, STEME, CENCY**



FLAKKEBJERG

**Thank you for your
attention**

