

Sveriges lantbruksuniversitet Swedish University of Agricultural Sciences

# Tests of herbicides and alternative methods for weed control on railways



#### Who am I?





- Researcher at the Swedish University of Agricultural Sciences
- Completed my PhD in 2006 on "The Microbiology of Railway Tracks – Towards a Rational Use of Herbicides on Swedish Railways"
- Since 2006 I have been responsible for a research program evaluating herbicides for use on Swedish railways



## **Herbicide use on Swedish railways**





#### **Ultimate aims of test program**



Sites of field experiments 2006-2015

Identify herbicides, mixture of herbicides or alternative methods that can be used to:

- enhance weed control
- reduce dose and environmental impact
- replace glyphosate/be used for resistance management



#### **Proximate aims of test program**



- Assess weed control efficacy of herbicides/metods – evaluation in the field
- Assess environmental fate
   evaluation in both field
  and lab studies



# **Typical experimental design**



Evaluation of weed control effect in entire plot by visual assessment according to a 5-step scale

Assessment of weed surface coverage (%) by image analysis



8.4% coverage



## MCPA



MOA: synthetic auxin

Use: post-emergent control broadleaf weeds

MCPA can enhance weed control when mixed with glyphosate radation is relatively  $x (T\frac{1}{2} = 18 \pm 13 \text{ days})$ 20 mol field studies) and can be accelerated Very high mobility – findings of high concentrations of MCPA in groundwater under the track



## Fluroxypyr



MOA: synthetic auxin

Use: post-emergent control broadleaf weeds

- Weed control effect similar to that of MCPA
- Degradation is relatively
  purck, two degradation
- victs forms, one
- Was approved for railway use
  - High mobility findings of fluroxypyr in groundwater under the track in environmental monitoring program

Cederlund et al. 2012. J. Env. Qual. 41: 1884-1892



#### **Glufosinate-ammonium**



- Glufosinate has a broad spectrum but inited longterm efficience
   + Marconifers
   + Marconif
- Results from mobility tests
  somewhat contradictory
- Not registred in Sweden anymore



# **Diflufenican (DFF)**

 DFF often coformulated -F with glypb sate DFFen compared to sn't kill the N vphosate in field NH studies MOA: inhibition of ca Degradation is very slow – synthesis not always possible to Use: predetermine a half-life érgent control of brandleaves ○ Mobility is very low – DFF

mainly found in the top few centimeters of the railway



## **Carfentrazone-ethyl**



MOA: PPO-inhibitor

Use: control of broadleak dessication

 Carfentrazone in mix with glyphosate sometimes enhances efficacy (if the eather is good) st step in degradation Maybe √ery quick, second step rather quick, further degradation not studied Mobility of carfentrazone Ο or degradation products has not been studied



#### Flazasulfuron

	• Flazasulfuron in mix with
N F	glyphosate thance
H <sub>3</sub> C-O O S F F	weed
	o istre environmental
H <sub>3</sub> C—O	
MOA: ALS-inhibitor	Compound not yet
aut !	registered in Northern
Use: control or of V	zone of EU
varius site	
May	



# Acetic acid





 Limited long-term efficacy, requires wigh dose to be efficiency igh dose to be efficiency of the second reatment is repeated in one season – also kills conifers

Corrosive – might not be a good idea on a railway

control

12% HAc



#### Hot water – with foam





#### What about the foam?



**Typical APG** 

- The foam consists of alkyl polyglucosides (APGs)
- The APGs are readily biodegradable
- Some concern that APGs could affect the mobility of contaminants in the railway



#### How can APGs affect mobility?



- APGs are surface active compounds (surfactants)
- At low concentrations surfactants are found mostly at the water surface (lowering surface tension)
- When concentration is high enough micelles start forming – this point is known as the *Critical Micelle Concentration* (CMC)
- The micelles may enclose organic contaminants and enhance their water solubility -> increased leaching



## **Determination of the CMC**



- Surface tension measured by tensiometer -> determination of CMC
- CMC at about 0.15 % APG concentration
- Foam formation maximum at about 0.3-0.4 % concentration
- Recommended concentration of NCC Spuma is 0.2-0.3 %



## Conclusions



- In the lab, we studied the effects of APGs on water solubility, adsorption and leaching of glyphosate, diuron and PAHs
- If used according to recommendation (0.2-0.3%) the APGs are unlikely to increase leaching of organic contaminants
- Higher concentrations could potentially be a problem
- Which concentration and what dose that is actually applied in the field is not entirely clear

Cederlund & Börjesson, 2016. J. Hazard. Mater. 314: 312-317



#### **Overall conclusions**

- Glyphosate cannot be used forever – irrespective of if it is approved in the EU or not (not as the only active)
- No obvious candidate for replacement of glyphosate available today
- Some substances can be suitable as mixing partners

- Alternative methods are only suitable for smaller areas (but can potentially work)
- Very few new substances are introduced



#### **My partners in crime**



Elisabet Börjesson has been responsible for analysis of pesticides and Carl Westberg has been in charge of the spraying equipment



STOP

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Thank you for your attention! harald.cederlund@slu.se