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STØTTET AF

Promilleafgiftsfonden for landbrug

XI Herbicide susceptibility of different populations of Canada thistle

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The objective of the study was to examine whether populations of Canada thistle (*Cirsium arvense*) from fields where herbicides have been used regularly for a long period were more tolerant to herbicides than populations from an organic field which had not been sprayed with herbicides for 10 years.

Seedlings of Canada thistle were collected in five different fields in the autumn 2015. In four of the fields herbicides had been used for control of thistles for several years, whereas one field had been cultivated organically for 10 years. The conventional fields were managed in a crop rotation including sugar beet, spring barley and winter wheat, and thistle control was carried out with different intensities (Table 1).

Healthy plants with root fragments were transplanted into 8-L pots in a potting mixture. The pots were placed in a glasshouse. Unfortunately, only few plants sprouted the following spring. Therefore, the plants were vegetatively propagated by dividing each plant into sections of single seedlings with root fragment which were planted into 8-L pots. The plants were maintained in an outdoor semifield area until the autumn 2016 and subsequently placed in a cold glasshouse for the winter. In spring 2017 the aboveground plant material was cut at soil level and the pots were placed in an outdoor semifield area.

Table 1. Crop rotation and herbicides used for control of thistles in the conventional fields. Field 4 is organic (no herbicides).

Year	Field 1		Field 2		Field 3		Field 5	
	Crop	Herbicide	Crop	Herbicide	Crop	Herbicide	Crop	Herbicide
2010	Winter wheat	Glyphosate (pre-harvest)	Winter wheat	MCPA Glyphosate (stubble)	Spring barley	Glyphosate (pre-harvest)	Winter wheat	Glyphosate (pre-harvest)
2011	Spring barley	Glyphosate (stubble)	Spring barley	MCPA Glyphosate (stubble)	Sugar beet	Clopyralid	Spring barley	MCPA
2012	Sugar beet		Sugar beet		Winter wheat	Glyphosate (pre-harvest)	Sugar beet	
2013	Winter wheat	Glyphosate (pre-harvest)	Winter wheat	MCPA Glyphosate (stubble)	Spring barley	Glyphosate (pre-harvest)	Winter wheat	Glyphosate (pre-harvest))
2014	Spring barley	Glyphosate (stubble)	Spring barley	MCPA Glyphosate (stubble)	Sugar beet	Clopyralid	Spring barley	Mustang Forte
2015	Sugar beet		Sugar beet		Winter wheat		Sugar beet	

Herbicide treatments were carried out at the flower bud stage in June 2017. The following four herbicides were applied: Roundup Flex (480 g/L glyphosate; 1 N= 1080 g a.i./ha), Metaxon (750 g/L MCPA; 1 N=750 g a.i./ha), Express Gold SX (222.2 g/kg tribenuron-methyl + 111.1 g/kg metsulfuron-methyl; 1 N= 6 g a.i./ha) and Mustang Forte (180 g/L 2,4-D + 10 g/L aminopyralid + 5 g/L florasulam, 1 N= 146.3 g a.i./ha). Express Gold was applied in mixture with 0.1% Contact. Each herbicide was applied in five doses: 1/16 N, 1/8 N, 1/4 N, 1/2 N and 1 N with four replicates per treatment and 8 replicates of untreated. Herbicide treatments were carried out in a cabinet sprayer equipped with two Hardi ISO F-02 nozzles, a pressure of 3 bars and a speed of 5.2 km/h, delivering a spray volume of 178 L/ha.

The reduction in biomass in each pot was visually assessed 12, 20, 28 and 34 days after treatment (DAT). Each plant was given a score between 0 and 10 (0= no effect, 10= full effect). The plants were cut at the soil surface after the last assessment. Fresh and dry weight of regrowth was measured 10 weeks later.

Roundup Flex

For all populations the responses to the doses of glyphosate varied from no effect to full desiccation. At the last assessment the score for biomass reduction following the two highest doses of glyphosate varied between 9.0 and 10 (Figure 1). In accordance, the responses on regrowth of plants also represented the whole dose response curve. A non-linear model was fitted to the fresh weight data for regrowth and the ED_{50} doses were estimated (Table 2). The results showed that the ED_{50} doses of populations 3 and 4 were significantly lower compared to those of populations 1, 2 and 5. The two highest doses of glyphosate (540 and 1080 g a.i./ha) prevented regrowth from all populations except population 2.

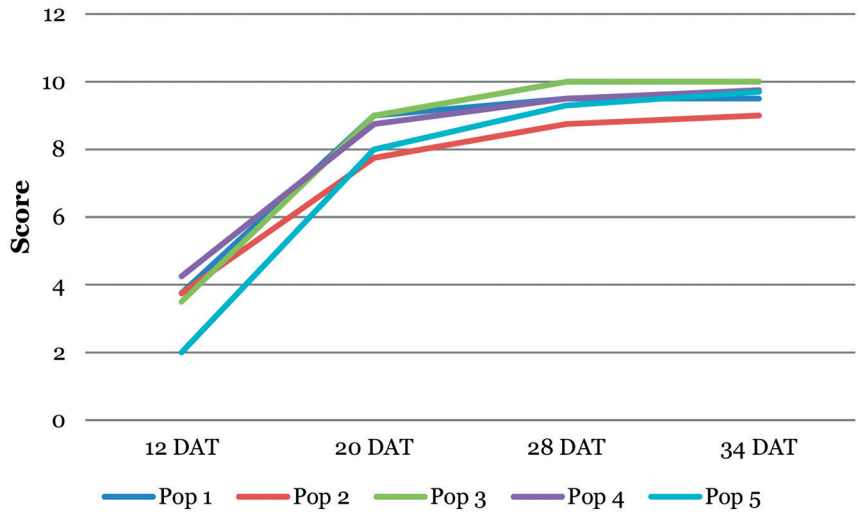

Figure 1. Scores of each population in visual assessments following treatment with Roundup Flex (540 g/ha glyphosate).

Table 2. Susceptibility of Canada thistle populations to glyphosate shown as the doses required to provide 50% reduction in regrowth (ED_{50}).

Population	ED50 (g a.i.ha)	95% confidence intervals
1	272	229-314
2	485	246-724
3	133	68-196
4	157	98-216
5	297	234-360

Metaxon

Treatments with MCPA had low effect on plant desiccation. The scores obtained with the highest dose (750 g a.i./ha) showed no development during the period in which the visual assessments were made. At the last assessment the scores following the treatment with 750 g/ha MCPA varied between 3.75 and 6.5 (Figure 2). The mean score of all doses showed that population 2 was less susceptible to MCPA than populations 3, 4 and 5 from 20 DAT. No significant effects on regrowth were found even at the highest dose.

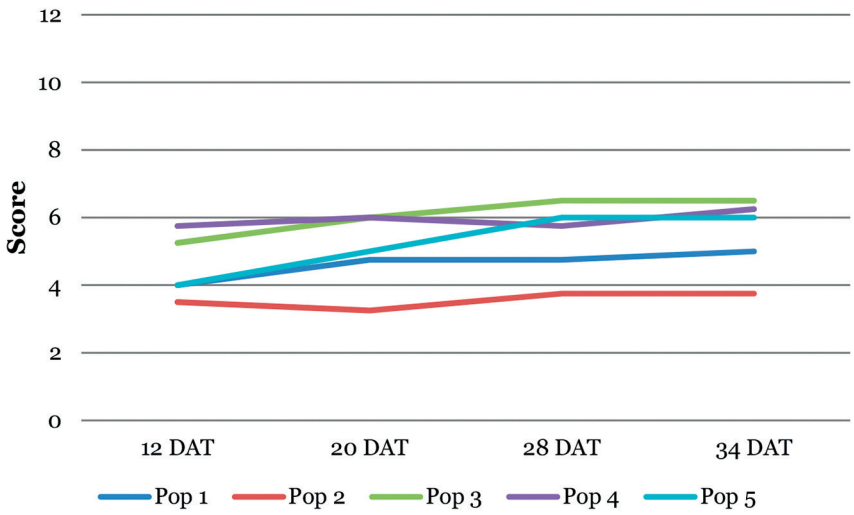

Figure 2. Scores of each population in visual assessments following treatment with Metaxon (750 g/ha MCPA).

Express Gold SX

The applied doses of Express Gold SX had low effects on plant desiccation illustrated by the scores of plants treated with the highest dose varying between 2 and 3 at the last assessment with no differences between populations (Figure 3). The applied doses of Express Gold SX had no effect on regrowth.

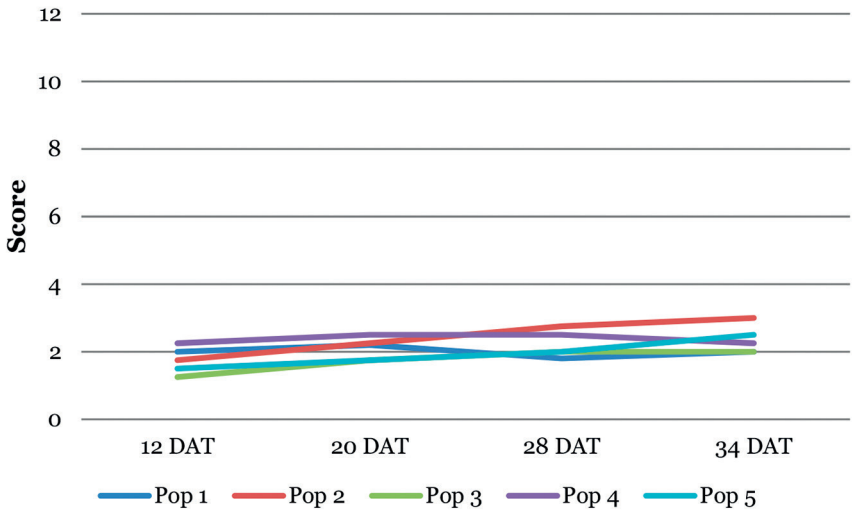

Figure 3. Scores of each population in visual assessments following treatment with Express Gold SX (18 g/ha) + 0.1% Contact.

Mustang Forte

The effects on plant desiccation were of similar sizes as those obtained with MCPA with scores between 4 and 6 at the last assessment after treatment with 0.75 L/ha Mustang Forte (Figure 4). Only the highest dose of Mustang Forte had an effect on regrowth and showed that population 2 was significantly more tolerant to 0.75 L/ha than the other populations (Figure 5).

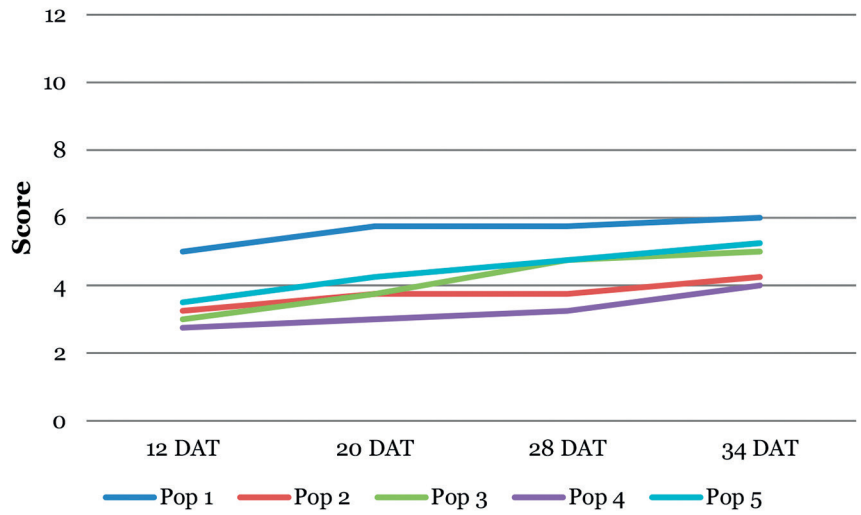

Figure 4. Scores of each population in visual assessments following treatment with Mustang Forte (0.75 L/ha).

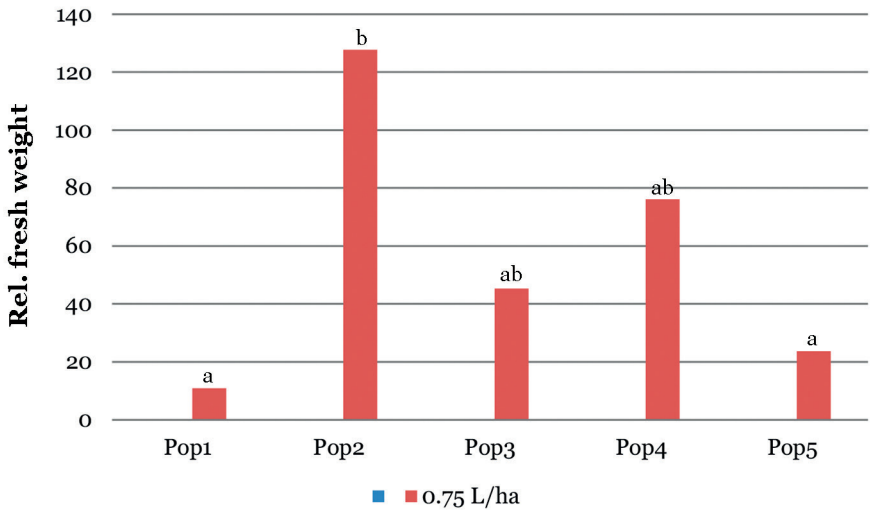

Figure 5. Effect of 0.75 L/ha Mustang Forte on regrowth (relative fresh weight compared untreated) of Canada thistle.

Overall, the applied doses of Metaxon, Express Gold SX and Mustang Forte were not sufficient to control the thistles, nor the regrowth of treated plants. In contrast, glyphosate at doses from 540 g/ha provided high effects on the sprayed plants and prevented regrowth.

A previous study found a higher tolerance to MCPA in thistle populations collected in fields which had been intensively sprayed compared to populations from areas with extensive or no use of MCPA (Fogelfors & Lundkvist, 2008). Our experiment did not confirm a population of thistles from an organic field (population 4) being more susceptible to herbicides than four populations from regularly sprayed fields. However, the results indicated that population 2 was less susceptible to Roundup Flex, Metaxon and Mustang Forte than populations 3 and 4. Apparently herbicide use had been more intensive in field 2 compared to the other fields suggesting a selection pressure towards more tolerant individuals. However, Mustang Forte had not been introduced in field 2 and the higher tolerance could alternatively be related to a natural variation within the Canada thistle populations.

References

Fogelfors, H. and A. Lundkvist (2008). Selection in *Cirsium arvense* (L) Scop. and *Sonchus arvensis* L: Susceptibility to MCPA on different types of farmland in Sweden. Acta Agriculturae Scandinavica Section B – Soil and Plant Science 58: 82-87.