SILKY BENT GRASS RESISTANCE TO HERBICIDES: ONE YEAR OF MONITORING IN BELGIUM

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SUMMARY

Silky bent grass *(Apera spica-venti* (L.) P. Beauv.) is a common weed of cereal crops widely spread in Northern and Easthern Europe (Germany, Czech Republic,...), Northern Asia, Siberia and Canada. Up to now, no resistant case has been detected in Belgium but some chemical weeding failures have been observed in Wallonia fields.
During summer 2011, 37 seed samples of *Apera spica-venti* were collected in Wallonia and submitted to resistance tests in controlled conditions. Three modes of action were tested: acetyl coenzyme-A carboxylase inhibitors (pinoxaden and cycloxydim), acetolactate synthase inhibitors (mesosulfuron+iodosulfuron, pyroxsulam and sulfometuron) and photosynthesis inhibitors (isoproturon). One susceptible standard population was included in the test in order to validate it and to permit wild populations classification according to “R” rating system developed by Moss *et al* (2007).
Most of populations were susceptible but some populations showed resistance to at least one of the three tested modes of action.

Key words: silky bent grass, herbicides, resistance.

INTRODUCTION

Weed resistance to herbicides is a growing phenomenon. 217 weed species spread all over the World are concerned by resistance. No mode of action is spared (Heap, 2013). Currently, in Europe, about 90% of the resistance cases are attributed to 4 modes of action. The most problematic weeds are mainly grasses.
Resistance is the natural and heritable ability of some indivuduals from a given population to survive an herbicide treatment that kills the other individuals of the population. Resistance is a genetic characteristic. Herbicide treatments don’t create resistance, they just reveal it by selecting individuals among a given population. These individuals find great benefit to survive and multiplicate. Therefore, the frequency of resistant individuals increases under the influence of the herbicide treatments.
Resistance mechanisms correspond to the way a plant by-pass the herbicide action. It exists two ways of by-passing. In the case of target-site resistance (TSR), the herbicide can’t fix to the targeted enzyme because the structure of the enzyme has changed. Generally, it results a high level of resistance. Cross resistance associated to that mechanism can occur but only with herbicides belonging to the same mode of action. The non target-site resistance (NTSR) is mainly enhanced metabolism resistance (EMR). A resistant plant detoxifies the herbicide quickly enough to avoid its effects. The resulting level of resistance is variable according to the rate with which the plant detoxifies the herbicide. In that mechanism, cross resistance is quite unpredictable and may concern several modes of action because it’s determined by the functionnal radicals of the herbicide molecule.

The main difficulty of cereals weeding consists in eliminating grass weeds: black-grass, ryegrass, silky bentgrass, wild oat,… Silky bent grass [*Apera spica-venti* (L.) BEAUV.] is very common and is the most problematic weed in Central and Easthern Europe (Soukup *et al.*, 2006 and Nordmeyer, 2009).
The use of chemical weeding, the simplification of crop management techniques and some agricultural practices led to the selection of resistant silky bent grass (Massa and Gerhards, 2011). Resistant silky bent grass has already been detected in Germany (Balgheim, 2009 and Massa *et al.*, 2011), Poland (Krysiak *et al.*, 2011) and Czech Republic (Novakova *et al.*, 2006 and Hamouzova *et al.*, 2011).
Nowadays, it's not rare to find silky bent grass ears emerging from Belgian cereal fields. In order to evaluate the problem in a global way, we have collected seed samples of silky bent grass during summer 2011. These populations have then been tested in standardized conditions (Moss *et al.*, 1998).

MATERIALS AND METHODS

Collect of seeds samples

Seed sample collection occurred in July 2011 when sikly bent grass seeds were mature. Samples came from cereal fields (winter wheat or winter barley) where chemical weeding failed. So, 39 seeds samples were collected.

Glasshouse screening assays

Silky bent grass seeds were sown in 9 cm pots containing silt loam (~3% organic matter). After germination, some shoots were removed from the pots to reach 6 shoots per pot. Plants were sprayed when they reached the three leaf stage (BBCH 13). Pots (4 replications by treatment and by population) were assessed 4-6 weeks after spraying by weighing fresh weight. As assays included a susceptible standard (supplied by Herbiseed), resistance classes were assigned according to the "R" rating system (Moss *et al.*, 2007). Three assays were performed including six herbicide treatments (Table 1).

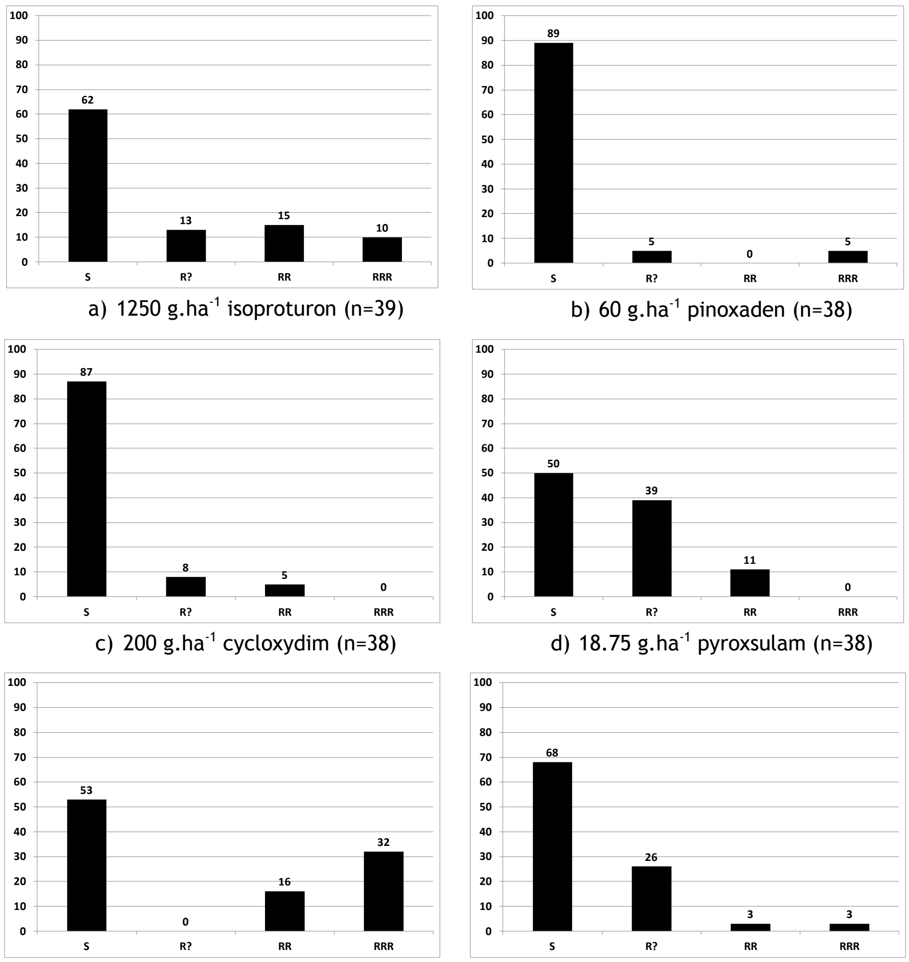
Table 1. Performed assays and actives used

			Test 1	Test 2	Test 3
Sowing date			12/01/12	9/03/12	5/02/13
Spraying date at BBCH 13			7/03/12	27/04/12	5/04/13
Weighing of silky bent grass			25/04/12	15/06/12	16/05/13
	Actives and rates	**Mode of action**			
Treatments	1250 $g.ha^{-1}$ isoproturon	PSII inhibitor	X	X	
	60 $g.ha^{-1}$ pinoxaden	ACCase inh.	X	X	
	200 $g.ha^{-1}$ cycloxydim	ACCase inh.	X		
	9 $g.ha^{-1}$ mesosulfuron + 1.8 $g.ha^{-1}$ iodosulfuron *	ALS inhibitor	X	X	X
	18.75 $g.ha^{-1}$ pyroxsulam *	ALS inhibitor	X		
	150 $g.ha^{-1}$ sulfometuron *	ALS inhibitor	X		
* Sprayed in tank mix with adjuvant					

RESULTS AND DISCUSSION

First test

Each herbicide modes of action showed a different resistance profile (Figure 1). For isoproturon (Figure 1a), a photosynthesis at photosystem II inhibitor, about 60% of the silky bent grass populations were sensitive and it remains 10 to 15% of the populations in the three resistance classes. The ACCase inhibitors, pinoxaden and cycloxydim (Figures 1b and 1c) showed quite similar profiles: about 90% of sensitive populations and some few resistant populations.



a) 1250 g.ha^{-1} isoproturon (n=39)

b) 60 g.ha^{-1} pinoxaden (n=38)

c) 200 g.ha^{-1} cycloxydim (n=38)

d) 18.75 g.ha^{-1} pyroxsulam (n=38)

e) 9 g.ha^{-1} mesosulfuron + 1.8 g.ha^{-1} iodosulfuron (n=38)

f) 150 g.ha^{-1} sulfometuron (n=38)

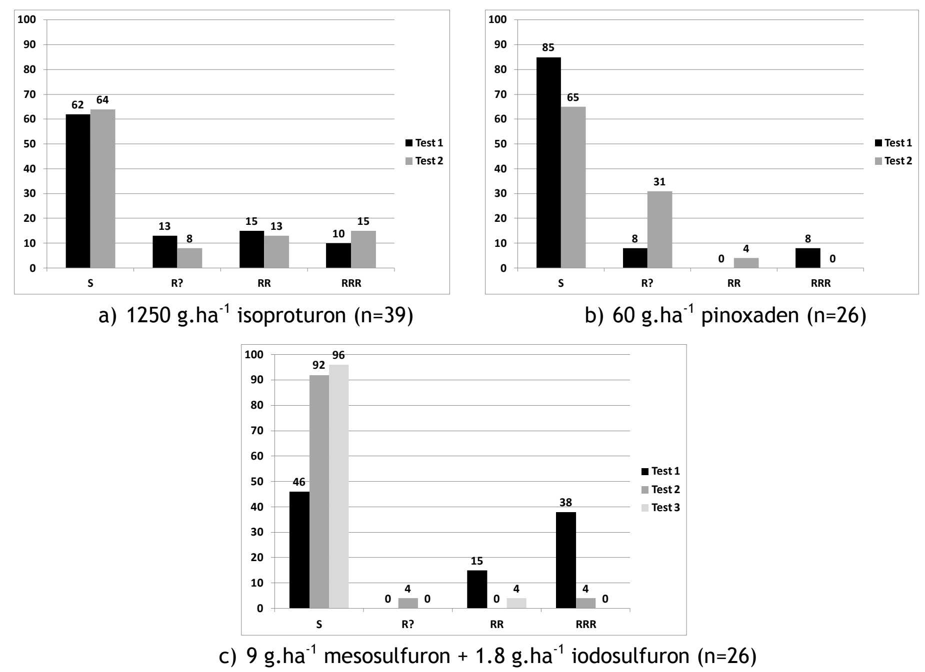
Figure 1. Distribution (%) of the populations according to the "R" rating system (Moss *et al.*, 2007).

Only 50 to 68% of the populations were sensitive to ALS inhibitors such as pyroxsulam, mesosulfuron + iodosulfuron and sulfometuron (Figures 1d, 1e and 1f, respectively) and the resistant classes showed high variability (0 to 39%).

ALS inhibitors results were bad and surprising: efficacies remained low, more than the populations expected were classified into resistant classes and the mesosulfuron + iodosulfuron profile (Figure 1e) seemed to be inconsistent. So, a second test was carried on with one active of each mode of action: isoproturon, pinoxaden and mesosulfuron + iodosulfuron.

Second and third test

Results obtained with first and second test were consistent for isoproturon (Figure 2a) and, to a lesser extent, pinoxaden (Figure 2b). It was not the case for mesosulfuron + iodosulfuron: first and second tests showed opposite profiles (Figure 2c). So, the second test presented a high percentage of sensitive populations (92%). A third test was performed and it confirmed the results of the second one (Figure 2c).



a) 1250 g.ha^{-1} isoproturon (n=39)

b) 60 g.ha^{-1} pinoxaden (n=26)

c) 9 g.ha^{-1} mesosulfuron + 1.8 g.ha^{-1} iodosulfuron (n=26)

Figure 2. Distribution (%) of the populations according to the "R" rating system (Moss *et al.*, 2007).

CONCLUSION

Considering the three tests in their entirety, it appears that the majority of the silky bent grass populations are sensitive to the various tested herbicides. However, it is possible to find silky bent grass populations that are difficult or resistant to the three tested modes of action. Inhibitors of photosynthesis at photosystem II, such as isoproturon, appear to be more affected. In Belgium, this has already been observed in the case of blackgrass (Henriet and Maréchal, 2009). The old age of this active, introduced to the market in the '70s, may partly explain this. ACCase-inhibiting herbicides (pinoxaden and cycloxydim) seemed unaffected by the problem, although some populations have proved resistance. Three tests were needed to ensure that the ALS-inhibiting herbicides were still effective against the silky bent grass. It has only been shown for the mesosulfuron + iodosulfuron (tested three times), but there is no reason to believe that it can't also be the case for pyroxsulam (tested once).

In such pot tests, the introduction of cycloxydim for ACCase inhibitors, and sulfometuron for ALS inhibitors, allow to identify the resistance mechanism involved: these two substances are not affected by the metabolic resistance. This feature has been shown for blackgrass (Moss *et al.*, 2003; Hull and Moss, 2007) and is also used with silky bent grass (Adamczewski and Matysiak, 2012). It seems that some tested populations presents target-site resistance to both modes of action. To confirm this, DNA analysis should be performed.

The repeatability of these resistance pots tests does not seem to be guarantee in the case of ALS inhibitors. Activity, very slow for this type of herbicides, combined with low biomass production by plants during the first test could explain the inconsistent observed results.

The samples were taken at random, without knowing the history of the field and the actives applied two or three months before (usually just after winter). Still, why are there so many chemical weeding failures while the majority of the collected populations are sensitive to the tested herbicides? It is possible that the farmer did not apply grass weeds herbicides or has misapplied them (without oil, for example). Poor weather conditions can also cause failures. At last, the silky bent grass is a winter weed but can also germinate in the spring. It is therefore likely that all individuals were not present or sprayed during application.

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