Studies of weed resistance to herbicides in Serbia

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INTRODUCTION

Herbicide resistant weeds are having a major impact on world agriculture. Research done over the past decade in Serbia shows that many weed species/populations show initial stages of resistance to certain groups of herbicides. The goal of the study was explain the resistant weed situation in Serbia.

MATERIAL AND METHODS

Depending on the herbicide group in question, relevant methods of analysis have been used: whole plant bioassay in the field and under controlled conditions, chlorophyll fluorescence, testing of ALS enzyme activity in vitro and in vivo, bioassay in Petri dishes, chlorophyll content, transpiration intensity, analysis of shikimic acid content, monitoring of anatomical changes by using light and transmission electron microscopes and PCR analysis.

Numerous weed species: *Chenopodium album (Figure 2), Amaranthus retroflexus, Abutilon theophrasti (Table 3), Helianthus annus var. ruderale (Table 1), Datura stramonium, Ambrosia artemisiifolia, Ambrosia trifida, Xanthium strumarium (Figure 1), Sorghum halepense (Table 2) Panicum crus-galli, Solanum nigrum and Setaria viridis* have been tested on the effects of photosynthesis inhibitor, ALS and EPSP enzyme inhibitor herbicides.

The plants were grown under controlled conditions and treated with diferent herbicides (glyphosate, atrazine, ALS inhibitors). The chlorophyll content was measured prior to plant-destroying procedure for measurement of shikimic acid and extraction of chlorophyll with methanol. The shikimic acid content was analysed by HPLC and chlorophyll extraction was done with methanol and DMF. Chlorophyll reading determined by SPAD meter. Chlorophyll fluorescence measured with fluorimeter PAM 2100.

Spray chamber

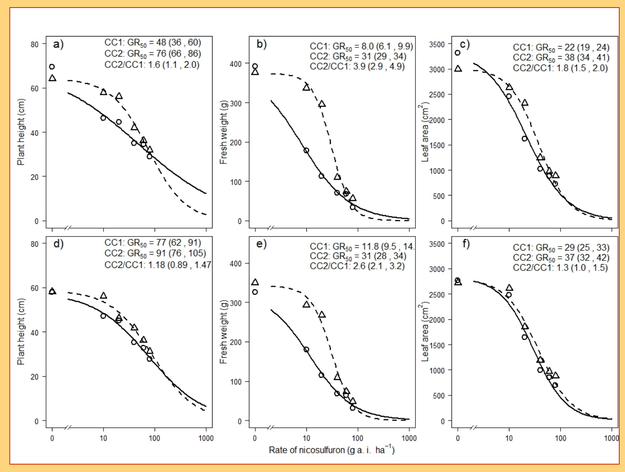

Fig. 1. Field trial: Effect of increasing rates of nicosulfuron in 2008 on: a) plant height, b) fresh weight, c) leaf area and in 2009 on: d) plant height, e) fresh weight, f) leaf area of CC1 (-o-) and CC2 (-Δ-) common cocklebur populations.

RESULTS

Of the species which have been tested, *A. retroflexus, A. theophrasti*, *D. stramonium* and *S. halepense* present the biggest problem in maize crop. The obtained indexes of resistance (IR) were quite low: *C. album, A. retroflexus* and *A. theophrasti* to atrazine based on the amount of chlorophyll 5, 7 and 11 and based on chlorophyll fluorescence 3, 7 and 1 respectively; *X. strumarium* to nicosulphuron IR was 1.8 based on fresh weight and 1.33 based on ALS activity; *S. halepense* to nicosulphuron IR was 3.5 based on dry weight and 1.9 based on leaf area. As a result of chlorophyll readings by SPAD meter and extraction by dimethylphormamide (DMF) it was possible to determine which weeds are resistant to photosistem II inhibitor herbicides, but there is no correlation between the parameters of chlorophyll fluorescence and chlorophyll content. Also, the value of the calculated IR (to atrazine) was higher when the SPAD method was used (*C. album* IR (DMF) 1.3; *A. retroflexus* IR (DMF) 1.7; *C. album* IR (SPAD) 1.4; *A. retroflexus* IR (DMF) 2.8).

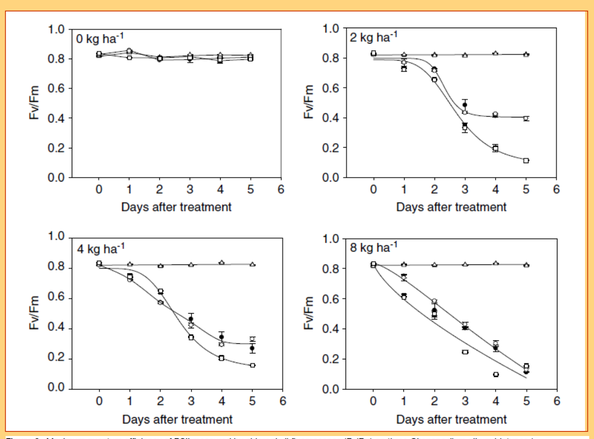

Figure 2. Maximum quantum efficiency of PSII measured by chlorophyll fluorescence (*Fv/Fm*) on three *Chenopodium album* biotypes (■, □ atrazine-susceptible; ▲, △ atrazine-resistant; ●, ○ collected near Veliki Crljeni, Serbia) at various days after treatment (DAT) with different atrazine rates. Open and closed symbols refer to replicated experiments, and vertical bars within data points are ± SE.


Weedy sunflower


Xanthium strumarium

Tab.1. Indices of resistance (IR) of R1 and R2 weedy sunflower populations to nicosulfuron.

		Parameter	IR SE	
			R_1:S	R_2:S
Controllled environment		Fresh weight (g)	2.55 1.05	1.08 0.49
		Dry weight (g)	1.55 0.71	0.81 0.52
		Leaf area (cm^2)	1.70 0.48	0.95 0.31
Field experiments	2008.	Plant height(g)	1.97 0.49	2.04 0.50
		Fresh weight (g)	25.41 25.37	37.62 37.51
		Leaf area (cm^2)	6.16 1.85	11.80 3.50
	2009.	Plant height (g)	1.86 0.36	1.82 0.35
		Fresh weight (g)	23.37 14.77	32.98 20.81
		Leaf area (cm^2)	6.11 1.73	11.08 3.10

TABLE 2 - *Indexes of resistance for R and S johnsongrass populations for morphometric parameters.*

recorded parameters	GR_{50} (g a.i. ha^{-1}) R	S	population R:S
plant height	24.89	21.83	1.14
average leaf length	13.16	12.41	1.06
average leaf width	7.02	6.44	1.09
fresh weight	7.56	7.29	1.04
dry weight	7.86	7.38	1.07
total leaf area	3.21	3.21	1.00

Table 3: Index of resistance for morphological parameters of *A. theophrasti* populations Rgr, Rvc and Sps, treated with atrazine.

Parameters	Populations Rvc:Rgr	Rvc:Sps	Rgr:Sps
Number of leaves per plant	2.5	14.8	5.8
Total average of leaf area	-	17	7.7
Total average weight of leaves	2.9	6.4	2.2
Average of fresh weight of shoot	4	15.9	3.9
Average of dry weight of shoot	4	14.7	3.6

Rgr - presumable resistant pop. Glogonjski rit, presumable resistant Rvc - pop. Veliki Crljeni, Sps - susceptible pop. Padinska Skela, Level of differences between the tested populations expressed as IR-index of resistance, ratio LD_{50} of presumable resistant pop. and susceptible pop. for morphological parameters. The highest differences between pop. Veliki Crljeni and Padinska Skela for all parameters are shown except total average weight of leaves.