
Field Tests on the Herbicide Tolerance of Various Maize Genotypes

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SUMMARY

Investigations were made in Martonvásár on the herbicide tolerance of 22 inbred maize lines and 3 parental single crosses when treated with one herbicide applied after sowing, prior to emergence, and with seven applied post-emergence in the 6-8-leaf stage. Visible damage was scored 14 days after the treatment.

An analysis of the phytotoxic effects led to the conclusion that a single dose of the tested herbicides did not cause any damage to the genotypes investigated, with the exception of one inbred line, which was extremely sensitive to herbicides of the sulphonyl carbamide type and moderately sensitive to both rates of dicamba. In many cases, a double dose of the herbicides caused mild or moderate symptoms on the maize lines.

INTRODUCTION

A quarter of the arable land in Hungary is occupied by maize. The climate and soil conditions make the country ideally suitable for field seed production. Depending on the demand, the necessary quantity of maize seed is grown on an area of 20,000-40,000 hectares each year. As is well known, the inbred lines used for the production of hybrid maize seed respond more sensitively to external environmental effects than the hybrids produced by crossing them. This greater sensitivity is manifested both in their habits and in their response to various stress factors. Inbred lines can only compete successfully for light, water, nutrients and carbon dioxide if they are adequately protected against their chief rivals, weeds. In order to keep the weed cover below the danger threshold, all possible means must be employed, including crop rotation, the use of a cultivator between the rows, and the application of herbicide. The use of chemicals is an important component of integrated weed management. The ever widening choice of herbicides and maize hybrids necessitates regular herbicide tolerance tests on maize hybrids and their parental lines.

For hybrid maize seed production, it is advisable to choose areas where there are no troublesome perennial weeds (Kádár, 1997). In practice, however, to ensure the required isolation distance and due to the needs of crop rotation, seed multiplication fields are often found on areas heavily infested with weeds, where weed control can only be achieved with special post-emergence herbicides that are less selective.

Many authors have reported on the different herbicide tolerance levels of various inbred maize lines. Eastin et al. (1964), Palmer and Grogan (1966) and Shimabukuro et al. (1971) observed sensitivity responses in maize lines after treatment with atrazine,

an active agent considered to be superselective for maize. Berzsenyi et al. (1994, 1997), Rowe and Penner (1990), Rowe et al. (1990) and Narsaiah and Harvey (1977) noted differences in the tolerance of inbred lines when testing with chloroacetanilides. Of 10 tested maize genotypes, Eberlein et al. (1989) found 3 to be very sensitive, 3 very tolerant and 4 moderately sensitive to herbicides belonging to the sulphonyl carbamide group. Green (1998), Green and Ulrich (1993, 1994), Harms et al. (1990), Kang (1993) and Widstrom and Dowler (1995) also reported that inbred lines exhibited different sensitivity responses after treatment with herbicides in the sulphonylurea group. When testing sulphonyl carbamides and other types of herbicides, Molnár et al. (2001) found that the response of maize hybrids to various active agents depended on their genetic backgrounds.

Due to this great diversity in the herbicide responses of different maize genotypes, the present experiments were aimed at testing the most important parental components in commercial Martonvásár maize hybrids for their tolerance to one pre-emergence and several post-emergence herbicides.

MATERIALS AND METHODS

Investigations were made in 2002 on the tolerance of 22 inbred maize lines and 3 parental single crosses grown on chernozem soil with forest residues (Calciustoll) in Martonvásár to one herbicide applied pre-emergence and 7 applied post-emergence. The experiment was set up in a two-factor split-plot design with two replications, with an untreated control plot for each treatment. The active agents in these herbicides were as follows: *flumioxazine*, *mezotrion*, *foramsulphuron* + *isoxadiphen-ethyl*, *foramsulphuron* + *isoxadiphen-ethyl* + *iodosulphuron-methyl-Na*, *rimsulphuron*, *nicosulphuron*, *dicamba*, *rimsulphuron* + *tiphensulphuron-methyl*. Of these herbicides, only *mezotrion* is authorised for use in maize seed production. However, due to the frequent appearance and multiplication of many troublesome weeds on seed production fields, it is important to test herbicides that are at present only authorised for use on fields sown for grain and silage, but which are effective against one or more of the troublesome weed species (such as *Sorghum halepense*, *Elymus repens*, *Abutilon theophrasti*). One of the herbicides was sprayed after sowing, prior to emergence, while the other seven were applied post-emergence, in the 6-8-leaf stage of maize, using the maximum dose permitted in the licence and double this dose. The

pre-emergence treatment was carried out 2 days after sowing. Shortly after spraying, 10 mm rain fell, followed by a further 5 mm over the next 2 weeks. No excessively hot days with temperatures of above 30°C were recorded prior to the post-emergence treatment or for the following 10 days, but on one of the days before treatment the minimum temperature dropped to below 10°C, exposing the maize plants to cold stress. This could have influenced the development of phytotoxic symptoms in the case of herbicides of the sulphonyl carbamide type. During the course of the vegetation period, visible phytotoxic damage was scored 14 days after the treatment using a 0-100 scale on which 0 indicated undamaged and 100 killed plants. The phytotoxicity percentage combines the number of killed plants and the extent of leaf damage due to scorching in a single parameter.

RESULTS

Averaged over the inbred lines and parental single crosses, the damage did not exceed the mild-moderate level (5%) when the single dose was applied. Genotypes treated with mezzotrion remained symptom-free. Based on the increasing severity of

the symptoms the compounds can be ranked as follows: mezzotrion ≤ dicamba ≤ flumioxazine < foramsulphuron + isoxadiphen-ethyl + iodiosulphuron-methyl-Na ≤ foramsulphuron + isoxadiphen-ethyl ≤ nicosulphuron ≤ rimsulphuron ≤ rimsulphuron + tiphensulphuron-methyl. The sign ≤ was used when there was no significant difference between the compounds as regards the extent of damage. At the double rate, due to the different interactions between the herbicides and the genotypes, this order was modified in places. Mezzotrion still caused the significantly lowest extent of damage, which was not significantly different from that caused by the single dose (*Table 1*). Averaged over the lines, the double dose of the compound containing flumioxazine induced the most severe symptoms, leading to a moderate level of damage (~20%) in the case of two lines.

Averaged over the herbicides, the various lines were well able to tolerate normal doses of the herbicides (*Table 2*). One inbred line exhibited extreme sensitivity to herbicides of the sulphonyl carbamide type and was completely destroyed by both doses. This same line exhibited moderate to severe symptoms (25-32.5%) when treated with dicamba (*Table 3*).

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Table 1

Extent of phytotoxic damage (%), averaged over the genotypes, in a herbicide tolerance experiment

	Flumioxazine	Mezzotrion	Foramsulphuron + Isoxadifen	Foramsulphuron + Iodosulphuron + Isoxadifen	Rimsulphuron	Nicosulphuron	Dicamba	Rimsulph. + Tiphensulph.
Single dose	1.4	0.0	3.5	3.4	3.8	3.7	1.1	4.1
Double dose	8.6	1.1	6.5	4.9	5.4	4.9	5.2	7.4

LSD_{5%} between any two combinations = 1.63

Table 2

Extent of phytotoxic damage (%) exhibited by the tested genotypes, averaged over the herbicide treatments

	Line numbers																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Single dose	0.6	0.6	0.0	0.0	0.0	0.0	2.8	0.6	0.0	53.8	0.0	0.0	0.6	0.0	0.0	1.3	0.0	0.0	0.6	0.0	0.0	0.6	0.0	1.9	2.2
Double dose	3.4	8.4	4.7	1.6	4.7	4.1	8.4	3.1	1.6	59.4	0.6	4.1	2.5	0.6	1.3	9.1	0.6	0.0	3.8	0.9	1.6	2.8	0.9	3.8	5.6
Mean	2.0	4.5	2.3	0.8	2.3	2.0	5.6	1.9	0.8	56.6	0.3	2.0	1.6	0.3	0.6	5.2	0.3	0.0	2.2	0.5	0.8	1.7	0.5	2.8	3.9
LSD _{5%} between any two combinations = 1.12																									

Table 3

Phytotoxic damage (%) caused by herbicide treatments in different genotypes

Herbicide	Dose	Line numbers																								
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Flumioxazine	single	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	5.0	0.0	0.0	5.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	10.0	0.0
	double	12.5	17.5	12.5	12.5	15.0	5.0	10.0	15.0	7.5	12.5	0.0	10.0	15.0	5.0	5.0	15.0	0.0	0.0	15.0	0.0	5.0	7.5	0.0	17.5	0.0
Mezotrion	single	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	double	5.0	7.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Foramsulphuron + Isoxadifen	single	0.0	0.0	0.0	0.0	0.0	0.0	7.5	0.0	0.0	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	double	0.0	15.0	7.5	0.0	5.0	0.0	17.5	10.0	0.0	85.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	5.0
Foramsulphuron + Iodosulphron + Isoxadifen	single	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
	double	5.0	5.0	0.0	0.0	5.0	7.5	5.0	0.0	5.0	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5
Rimsulphuron	single	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	double	5.0	0.0	0.0	0.0	5.0	0.0	10.0	0.0	0.0	90.0	5.0	0.0	0.0	0.0	0.0	10.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
Nicosulphuron	single	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.5	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0
	double	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	85.0	0.0	0.0	0.0	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	7.5	0.0
Dicamba	single	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.0
	double	0.0	12.5	0.0	0.0	7.5	15.0	10.0	0.0	0.0	32.5	0.0	5.0	0.0	0.0	5.0	15.0	0.0	0.0	0.0	0.0	0.0	7.5	7.5	0.0	12.5
Rimsulph. + Tiphensulph.	single	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	85.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5
	double	0.0	10.0	12.5	0.0	0.0	5.0	15.0	0.0	0.0	90.0	0.0	5.0	5.0	0.0	0.0	7.5	0.0	0.0	15.0	0.0	0.0	0.0	0.0	0.0	5.0
LSD _{5%} between any two combinations = 1.12																										