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Broomrape control and phytotoxicity of imidazolinone herbicide in IMI sunflower genotypes and influence on seed yield

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ABSTRACT

Imidazolinone herbicides are one of the most feasible method for broomrape control, especially in the intensive agriculture. In this trial we evaluated resistance of seven different sunflower genotypes of F_1 and F_2 generation and five commercial hybrids to imidazolinone herbicides and also their effect on broomrape control. The experiment was conducted in field conditions in Svetozar Miletić locality (North Serbia), at naturally highly infested plot. Race E was determinated in this region ten years ago for the first time in Serbia. The analysis of population, which was done by set of differential lines, showed that broomrape in that locality still belong to race E of the parasite.

Sunflower was treated with imidazolinone herbicide (Pulsar-40) with 1.2 l/ha (at concentration rate 0.25%) at three leaf stage. Control were the same non-treated genotypes and commercial hybrid NS-H-111 which is susceptible to broomrape and IMI herbicides. Evaluation of herbicide effect was done 14 days after application when sunflower plants were in the beginning of budding stage. The reaction of sunflower genotypes to applied herbicide was evaluated according to the reaction of plants. The phytotoxicity of herbicide was expressed by following symptoms: total plant deterioration, severe chlorosis and slightly yellowing. Intensity of phytotoxicity varied depending on the observed genotype. Percentage of dead plants ranged from 13-68%, plants with severe chlorosis and curly leaves ranged from 0-35% and symptoms of slightly chlorosis were observed on up to 20% percentages of evaluated plants. Plants which expressed susceptibility to applied herbicide such as chlorosis and yellowing totally recovered during the time but the phytotoxicity had influence on the yield and quality of seeds. Seed yield of plants with symptoms has been decreased from 43,7 to 90,1% related to control. Although we obtained good results in broomrape control in sunflower by one application of IMI-herbicide, we recommend two split applications of IMI herbicides.

Key words: broomrape – IMI-herbicides – sunflower – resistant genotypes

INTRODUCTION

Broomrapes (*Orobanche* spp) belong to the family *Orobanchaceae*, obligate parasitic flowering plants. Broomrapes (*Orobanche* spp.) are native primarily to the Mediterranean region (i.e. North Africa, the Middle East, and southern Europe), and western Asia, where they cause significant crop damage (Parker and Riches, 1993). With anticipated climatic changes taking the form in higher temperatures and drought in many areas of the world, *Orobanche* species could pose greater threats to agriculture by expanding their ranges farther north in Europe and elsewhere (Mohamed et al. 2006). According to Aćimović (1977) broomrape for the first time was described in Serbia in 1951 Since that period it has been appearing with varying intensity almost every year but since the 1990s broomrape has been causing significant damage in susceptible sunflower hybrids (Maširević and Medić-Pap, 2009). Yield losses depend on intensity of attack and they can range from 5 to 100 % (Maširević, 2001). All broomrape races can be successfully controlled by chemical means as well, namely by growing IMI-resistant hybrids (RIMI) in synchrony with the application of appropriate imidazolinone-based herbicides (Skorić and Jocić, 2005).

MATERIALS AND METHODS

Plant material

In this trial we evaluated resistance of male parental line A-B-IMI-1B, seven different sunflower genotypes of F_1 (AB-ORO-5B x AB-IMI-1B, AB-ORO-11B x AB-IMI-1B, AB-ORO-14B x AB-IMI-1B, AB-ORO-34B x AB-IMI-1, AB-ORO-39B x AB-IMI-1B, AB-ORO-40B x AB-IMI-1B, AB-ORO-43B x AB-IMI-1B) F_2 generation (F_1 5B x 1B, F_1 11B x 1B, F_1 14B x 1B, F_1 34B x 1B, F_1 39B x 1B, F_1 40B x 1B, F_1 43B x 1B), three commercial hybrids (MI-3-911, IMI-3-369 (AKA Argentina) PARAISO-120CL (NIDERA Argentina)) and two experimental hybrids (ATO301CL x RHA-1R3RF, ATO521CL x RHA-1R3RF) to imidazolinone herbicides and also their effect on broomrape control.

The experiment was conducted in field conditions in Svetozar Miletić locality (North Serbia), at naturally highly infested plot. This area is know as main foci of hazard. Hybrids and F_1 genotypes were sown in 4 rows and F_2 genotypes were sown in 8 rows (25 plants in row). Differential lines for determination of broomrape races were also sown in the experimental field.

Evaluation of imidazolinone herbicide effect

Sunflower was treated with imidazolinone herbicide (imazamox) (Pulsar-40) with 1.2 l/ha (at concentration rate 0.25%) at six leaves stage (figure 1.). Control were the same non-treated genotypes and commercial hybrid NS-H-111 which is susceptible to broomrape and IMI herbicides. Evaluation of herbicide effect was done 14 days after application when sunflower plants were in the beginning of budding stage. The reaction of sunflower genotypes to applied herbicide was evaluated according to the reaction of plants. Heads of the plants on which were noticed severe phytotoxic effect caused by herbicide were isolated in the purpose of yield measurment. Plants which did not express any symptoms of phytotoxicity were used as a control and their heads were also isolated. Reaction of sunflower genotypes was followed untill the end of vegetation period and finaly two medium rows of every genotype were taken for yield estimation.

Fig. 1. Experomental field (Svetozar Miletic,North Serbia)

Evaluation of intesity of broomrape attack

Observations of broomrape were evaluated as frequency (F), intensity (I) and attacking rate (AR). Frequency is a percent of plants with *Orobanche*. Intensity is the number of *Orobanche* in one infested plant and attak rate is the number of *Orobanche* in one plant in the row.

RESULTS AND DISCUSSION

The analysis of population, which was done by set of differential lines, showed that broomrape in Svetozar Miletić locality still belong to race E of the parasite.

In table 1. we showed only genotypes which were infected with broomrape. None of the experimental IMI resistant hybrids, F_1 and F_2 which were treated with Pulsar were infected with broomrape. Three out of seven F_2 genotypes which were not treated with Pulsar were infected with broomrape, but frequency and attacking rate in these genotypes were low. Frequency range from 1.56-6.63% and attacking rate ranged from 0.0003-0.12 (table 1). These genotypes can be classified as resistant according to Vranceanu *et al.*, 1980 and Maširević, 2002, the plants having 0-10% frequency and 0-1 AR values were accepted as resistant. The control genotype NS-H-111 has 31.25% of infected plants and 1.11 broomrapes per sunflower plant (attack rate) (figure 2.).

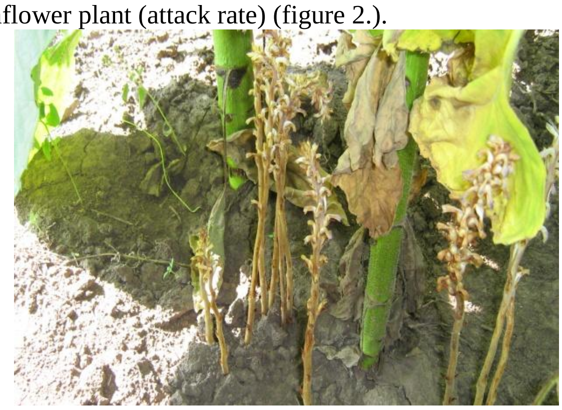

Fig. 2. Broomrape attack in suscetabile NS-H-111

Table 1. Broomrape observation in sunflower F_2 genotypes and control*

Hybrid	Frequency F (%)	Intensity I	Attack rate
F_1 11B X 1B**	2.75	0.25	0.03
F_1 14B X 1B**	1.56	0.5	0.0003
F_1 34B X 1B**	6.63	1.38	0.12
NS-H-111	31.25	14.9	1.11

*in table 1 we show only genotypes which have broomrape attack
** non treated F_2 genotypes

In our trial some sunflower plants treated with Pulsar expessed the symptoms of herbicide phytoxicity. Number of plants with symptoms in male line and F_1 and F_2 genotypes and experimental hybrids are shown in table 2. The phytotoxicity of herbicide was expressed by following symptoms: total plant deterioration, severe chlorosis (figure 3.) and slightly yellowing. Intensity of phytotoxicity varied depending on the observed genotype. According to Massing et al. (2005) the plants with less than 20% imazamox injury were classified as IMI-resistant.

Number of plants which expressed symptoms after herbicide treatment in experimental hybrids, male line and F_1 and F_2 were shown in table 2. Percentage of dead plants ranged from 13-68%, plants with severe chlorosis and curly leaves ranged from 0-35% and symptoms of slightly chlorosis were observed on up to 20% percentage of evaluated plants. Plants which expressed susceptibility to applied herbicide such as chlorosis and yellowing totally recovered during the time but the phytotoxicity had influence on the yield and quality of seeds. The male line A-B-IMI-1B has 99,20% healthy plants after herbicide treatment, so it can be concluded that these line is homozygous in resistance for IMI herbicides. The higest number of dead plants (over 50%) were found in three F_1 lines (AB-ORO-11B x AB-IMI-1B, AB-ORO-34B x AB-IMI-1B and AB-ORO-39B x AB-IMI-1B). Also in these genotypes there were no plants with sligth herbicide injuries and number of plants with severe symptoms were very low. In other four F_1 genotyopes the number of dead plants ranged from 12-32%. It is indicative that only in one F_1 line (AB-ORO-14B x AB-IMI-1B) slight herbicides injuries were recorded. Number of dead plants was uniform in four F_2 genotypes and was about 20% in other two genotypes it was about 14 and in one 28%. Sever injuries of hercides in F_2 genotypes were noticed from 5-35%. According to the obtained results (table 2.) in backcross generation 6 out of 7 genotypes have significant less dead plants than in F1 generation. So, plants in the first backcross generation showed higher degree of resistance.

It is very interesting that in one experimental hybrid IMI-3-396 we have one plant with severe symptoms of herbicide deterioration and in hybrid ATO301CL x RHA-1R3RF beside the a yellow curly sunflower plant there was one dead plant.

Fig. 3. Phytotoxicity symptoms on sunflower plants caused by herbicide treatment

Table 2. Phytotoxicity of herbicide in experimental hybrids, male line and F_1 and F_2 genotypes

Genotype	Number of plants with slight phytotoxicity symptoms (%)	Number of plants with severe phytotoxicity symptoms (yellow curly plants) (%)	Number of dead plants (%)	Number of healthy plants (%)
male line A-B-IMI-1B	0	0,80	0	99,20
AB-ORO-5B x AB-IMI-1B	0	7,69	12,82	79,49
F_1 5B x 1B	3,41	13,64	19,32	63,64
AB-ORO-11B x AB-IMI-1B	0	9,32	55.81	43,88
F_1 11B x 1B	20,75	15,09	28,30	35,85
AB-ORO-14B x AB-IMI-1B	7,31	7,31	31,71	53,66
F_1 14B x 1B	2,20	9,89	14,29	73,63
AB-ORO-34B x AB-IMI-1B	0	9,52	54,76	35,71
F_1 34B x 1B	0	16,47	20,00	63,53
AB-ORO-39B x AB-IMI-1B	0	0	68,29	31,71
F_1 39B x 1B	1,67	18,33	18,33	61,67
AB-ORO-40B x AB-IMI-1B	0	0	28,57	71,43
F_1 40B x 1B	0	35,56	20,00	44,44
AB-ORO-43B x AB-IMI-1B	0	0	25,00	75,00
F_1 43B x 1B	3,70	4,94	14,81	76,54
hybrids				
IMI-3-911	0	0	0	100
IMI-3-396	0	1.14	0	98.86
PARAISO 102CL	0	0	0	100
ATO301CL x RHA-1R3RF	0	1.14	1.14	97.73
ATO521CL x RHA-1R3RF	0	0	0	100

Yield of plants with or without symptoms of herbicide phytotoxicity are shown in table 3. Seed yield of plants with symptoms has been decreased from 43,7 to 100 % related to healthy plants. These results show that IMI herbicide inflences on sunflower plants and cause not only visible injuries but also it cause yield decrease.

Table 3. Yield of plants with or without symptoms of herbicide phytotoxicity

Genopyte	Yield per plant		Yield ratio
	plants with symptoms of herbicide phytotoxicity	plants without symptoms of herbicide phytotoxicity	(%)
F_1 5B x 1B	3.1	7.5	58.7
F_1 11B x 1B	0	11.5	100
F_1 14B x 1B	3.6	40.3	91.1
F_1 34B x 1B	7.5	15.8	52.5
F_1 40 x 1B	14.2	25.2	43.7

CONCLUSION

The analysis of population showed that broomrape in Serbia belongs to race E. Constant monitoring of broomrape population in Serbia is very important due to changes in race composition in neighboring countries. It is also very important to develop control measures for suppression of *Orobanche* in sunflower.

Strategy for broomrape control should be cultivation of resistant sunflower hybrids including IMI resistant hybrids and broomrape tolerant hybrids which suppressed and decreased weed population and epidemics.

In breeding process much less percent of dead plants were obtained in the first backcross generation. These results encourage, because the aim is to obtain broomrape resistant genotypes which are also resistant to the IMI herbicides.

The most of plants with symptoms of herbicide phytotoxicity recover, but the treatment has influence on their yield. As number of such plant is higher, the yield decreases more.

Although we obtained good results in broomrape control in sunflower by one application of IMI-herbicide, we recommend two split applications of IMI herbicides.

REFERENCES

1. Aćimović, M., 1977. Distribution of important sunflower diseses in Yugoslavia. Faculty of Agriculture, Institute of Field and Vegetable Crops, Novi Sad, Yugoslavia: 1-16.
2. Massinga R., Al-Khatib K., Amand St. Paul, Miller J. 2005. Relative fitness of imazamox-resistant common sunflower and prairie sunflower. Weed Science 53:166-174
3. Maširević S., Medić-Pap, S. (2009): Status of broomrape in Serbia from he occurence up to now-days. Helia 32, 51. 91-100.
4. Maširević, S., 2001. Širenje volovoda na suncokretu i analiza populacije parazita. Zbornik radova Naučnog Instituta za ratarstvo i povrtarstvo, Novi Sad. Sveska 35: 235-241.
5. Mohamed, K.I., Papes M., Williams R., Benz B. W., Peterson A. T., 2006. Global Invasive Potential of 10 Parasitic Witch weeds and Related *Orobanchaceae* AMBIO: A Journal of the Human Environment 35(6):281-288.
6. Parker, C. and Riches, C.R., 1993. Parasitic Weeds of the World: Biology and Control. Wallingford, UK: CAB International.
7. Skoric, D. and Jocic, S., 2005. Broomrape (*Orobanche cumana* Wallr.) and its possible control by genetic and chemical means Uljarstvo v. 36(1-2) p. 15-22.
8. Vranceanu, A.V., V.A. Tudor, F.M. Stonescu and N. Pirvu, 1980. Virulence groups of broomrape (*Orobanche cumana Wallr.)* differential hosts and resistance sources and genes in sunflower. In Proceedings of the 9th International Sunflower Conference. Torremolinos, Spain. June, 8-13: pp. 74-81.