STRESS RESPONSES OF THE CHERRY DWARF ROOTSTOCK GISELA 5 (Prunus cerasus L. × Prunus canescens L.) AFTER TREATMENT WITH SOIL HERBICIDES: II. EFFECT ON THE GROWTH AND PHOTOSYNTHETIC PIGMENTS

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Abstract

The aim of the present study was to investigate the stress responses of the vegetative rootstock Gisela 5 after treatment with soil herbicides under the conditions of a model pot experiment. The following variants were set: 1. control (untreated); 2. pendimethalin – Stomp 33 EC – 400 ml/da; 3. isoxaflutole – Merlin 750 WG – 5.0 g/da; 4. oxyfluorfen – Goal 2E – 200 ml/da. The herbicide rates were recalculated according to the area of the plant pots. Visual observations for the appearance of external symptoms of herbicide phytotoxicity were carried out weekly. The biometric characteristics – growth increment, mean weight of a plant, mean number of leaves and nodes and chlorophyll content, were reported on the 70th day. The obtained results showed that the soil herbicide isoxaflutole caused white chlorosis and lower content of leaf pigments in the cherry rootstock Gisela 5.

Key words: phytotoxicity, vegetative rootstocks.

INTRODUCTION

Herbicides are widely used to protect crops against adventitious plants. Nevertheless, a massive introduction of those molecules in the fields can generate negative effects on the environment. Since increasingly more consumers are becoming aware of the agricultural practices and their impact on the environment and food quality, pesticide toxicity on non-target crop species is a topic that needs to be investigated. Moreover, herbicide treatments may have secondary adverse effects on non-target plants. Many authors have reported that some herbicides such as 2,4-D, glyphosate, chlorsulfuron or trichloroacetate may cause severe damages to crops by inducing leaf necrosis, an increase in stomatal resistance, inhibition of shoot growth, decrease in germination, accumulation of reactive oxygen species or reduction of net photosynthesis (Bhatti et al., 1997, 1998; Radetski et al., 2000). However, while little is known about the effects of newly synthesized
herbicides on crop species, the presence of such molecules
in the foliage of non-target crops and in soil was reported
(Jame et al., 1999). Herbicide application in the fruit tree
nursery quite often might be risky for the appearance of
phytotoxic symptoms in plants (Wazbinska, 1997; Kaufman
and Libek, 2000; Rankova et al., 2004; Rankova, 2006;
Rankova et al., 2006). That is why preliminary studies are
needed to estimate the effect of different herbicides on the
vegetative habits of the rootstocks.

The aim of the present work was to evaluate the
stress response of the cherry dwarf rootstock Gisela 5
(Prunus cerasus L. × Prunus canescens L.) after treatment
with the soil herbicides pendimethalin, isoxaflutole and
oxyfluorfen.

MATERIAL AND METHODS
Plant Material
The experiment was carried out with in vitro
propagated and acclimatized to ex vitro conditions plants
of the vegetative cherry dwarf rootstock Gisela 5, under
the conditions of a model pot experiment.

The following variants were set:
1. Control (untreated);
2. Pendimethalin – Stomp 33 EC – 400 ml/da;
3. Isoxaflutole – Merlin 750 WG – 5,0 g/da;

The rates of the herbicides were recalculated
according to the area of the plant pots.

The initial height of all the plants was measured.

The plants were cultivated for 70 days in the greenhouse.
Visual observations for the appearance of external
symptoms of herbicide phytotoxicity were carried out
weekly. At the end of the period (on the 70th day) the
following biometric indices were reported – growth
increment (cm), mean plant weight (g), mean weight of the
leaves (g), number of newly developed nodes and mean
number of leaves per plant.

Chlorophyll Content

The plastid pigments (chlorophyll and carotenoids)
content was determined spectrophotometrically in 80%
acetone extract. The amount of the leaf pigments was
calculated according to the Lichtenthaler and Wellburn
formula (1983).

Data Analysis

Twelve plants in four replications were set for each
variant of herbicide treatment. The results obtained were
processed by the dispersion analysis method.

RESULTS

External symptoms of phytotoxicity – chlorosis,
necrosis or growth suppression were not observed in the
plants treated with pendimethalin (Variant 2). The plants in
that variant did not differ in external characteristics from
those of the untreated control.

On the 7th day, slight white chlorosis was observed
in the lower leaves of the plants treated with isoxaflutole
(Variant 3). Those symptoms did not appear in the apical
leaves. 30 days after treatment those symptoms of
phytotoxicity were not observed. The new growth was
vigor and, showing that the plants had overcome the stress
of the herbicide treatment.

On the 10th–15th day slight necrosis appeared in the
leaves of the plants in Variant 4 (oxyfluorfen – Goal
2E).

White chlorosis is a typical symptom of phytotoxicity
in plants susceptible to isoxaflutole. In previous studies,
very strong white chlorosis was detected, leading to
whitening of the entire plants of yellow plum after treatment
with Merlin 750 WG - 5,0 g/da under in vitro conditions
(Rankova et al., 2004). The phytotoxic effect of isoxaflutole
was established in the cotyledons and leaves of
embryocultures of yellow plum and it was due to the
mechanism of its herbicide effect. It is absorbed by the
young germs and roots and attacks the meristem tissues.
The active substance can attack the enzymes responsible
for the synthesis of chlorophyll and carotenoids (Tonev,
2000).

On the 70th day, growth depression and withering of
the vegetative tip were not observed in the plants of the
treated variants.

The vegetative tip in all the plants was fresh and
vigorously growing. That gave the grounds to conclude that
the soil herbicides included in the present study, did not
cause external symptoms of growth suppression in the
vegetative rootstock Gisela 5 (Fig. 1).

The results of the biometric analysis are presented in
Fig. 2 and 3. The plants of the variants treated with
herbicides, had growth increment values similar or higher
compared to the control. The highest increment length was
reported in the plants of Variant 4 – oxyfluorfen – Goal 2E
– 200 ml/da, the differences to the control being statistically
highly significant. Similar results were obtained about the
effect of the studied soil herbicides on plant weight (Fig.3).

The plants in Variants 2 and 3 showed a tendency
to a lower value of the above-ground plant weight compared
to the control. The differences were statistically insignificant.
That allows drawing the conclusion that the soil herbicides
included in the study, do not suppress the growth of the
vegetative rootstock Gisela 5.

A significant effect of the soil herbicides on the
number of internodes and the mean number of leaves per
plant was not reported, confirming the lack of a depressing
effect on that characteristic, exerted by the active
substances (Fig. 4).

Data about the content of leaf pigments are
presented in Table 1. Lower values of leaf pigment contents
were reported in the plants of Variant 3 – isoxaflutole –
Merlin 750 WG – 5,0 g/da. It was probably due to the

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Fig. 1. Effect of some soil herbicides on growth of Gisela 5 plants. Variants: 1. Control (untreated); 2. Pendimethalin – Stomp 33 EC – 400 ml/da; 3. Isoxaflutole – Merlin 750 WG – 5,0 g/da; 4. Oxyfluorfen – Goal 2E – 200 ml/da

Fig. 2. Effect of some soil herbicides on growth increment (cm) of Gisela 5 plants. Variants: 1. Control (untreated); 2. Pendimethalin – Stomp 33 EC – 400 ml/da; 3. Isoxaflutole – Merlin 750 WG – 5,0 g/da; 4. Oxyfluorfen – Goal 2E – 200 ml/da

Table 1. Effect of the soil herbicides on the content of plastid pigments (chlorophyll and carotenoids) in the leaves of Gisela 5 plants

<table>
<thead>
<tr>
<th>Variants</th>
<th>Absolute dry matter, %</th>
<th>Chlorophyll content (mg/g DW)</th>
<th>Carotenoids content (mg/ g DW)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>b</td>
<td>a+b</td>
</tr>
<tr>
<td>1</td>
<td>25,55</td>
<td>6,16</td>
<td>3,11</td>
</tr>
<tr>
<td>2</td>
<td>25,49</td>
<td>6,75</td>
<td>2,93</td>
</tr>
<tr>
<td>3</td>
<td>22,92</td>
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<td>2,59</td>
</tr>
<tr>
<td>4</td>
<td>24,10</td>
<td>7,56</td>
<td>3,29</td>
</tr>
</tbody>
</table>

LSD 5% – 0,5; 1% – 0,7; 0,1% – 1,0
Fig. 3. Effect of some soil herbicides on the mean plant weight (g) of Gisela 5 plants.


LSD 5% - 0,7; 1% - 1,0; 0,1% - 1,4

Fig. 4. Effect of some soil herbicides on the number of newly developed nodes and on the mean number of leaves per plant.


number of newly developed nodes - LSD 5% - 1,6; 1% - 2,2; 0,1% - 3,3
mean number of leaves per plant - LSD 5% - 2,3; 1% - 3,3; 0,1% - 4,6
mechanism of action of the active substance and its capacity to attack the enzymes responsible for the synthesis of chlorophyll and carotenoids.

In Variant 2 the leaf pigment values were close to those in the control. The highest content of chlorophyll a, b, (a+b) and carotenoids was reported for the plants in Variant 4 – oxyfluorfen – Goal 2E – 200 ml/da. Most probably it was due to the contact mode of action of oxyfluorfen and the lack of an effect on the formation of leaf pigments.

CONCLUSIONS
1. Treatment with soil herbicides pendimethalin and oxyfluorfen did not cause external symptoms of phytotoxicity. Application of isoxaflutole (Merlin 750 WG – 5.0 g/da) caused the appearance of external symptoms of phytotoxicity (white chlorosis), which was overcome about 30 days after treatment;
2. Vegetative growth depression was not established in the cherry rootstock Gisela 5 after treatment with the soil herbicides pendimethalin, isoxaflutole and oxyfluorfen at the applied rates;
3. Lower values of leaf pigments content was established after treatment with isoxaflutole.

REFERENCES

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