

Phytophagous insects – pests of industrial plantations of willows *Salix* L. (Salicaceae) in Lithuania

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More than 80 species of insects trophically related to willows (*Salix* L.) were registered in a cultural agrocenosis in 1996–2003. Of these, 17 species were considered as harmful to industrial plantations of willows. The peculiarities of distribution of the most dangerous insects were evaluated in sections, species and lower taxa of *Salix* L. The character and level of injury of taxa and clones of *Salix purpurea* L. were described. The species of willows possessing the highest and the lowest resistance to insect injuries were analysed. The biggest complex of phytophagous insects was found on *Salix* L. belonging to the Purpureae (A. Skvorts.) section.

Key words: Coleoptera, Diptera, Gracillariidae, Hymenoptera, Lepidoptera, pests, *Salix* L.

INTRODUCTION

The cultivation of willows (*Salix* L.) has increased during the last decade. Willows are important crops as wickers, they are used for tannin extraction and preservation of shores against erosion. There are some attempts to use willows for energy production. Some industrial plantations of willows of different size were established in Lithuania.

Seventeen species of willows are native to Lithuania. In total, there are 26 species (including the introduced ones) of willows in our country. A huge botanical variety of willows was developed in Lithuania. It consists of 11 subspecies, 12 botanical varieties, 67 forms and 31 hybrids (Smaliukas, 1996). Most varieties are used for cultivation.

The ecological balance of habitats is changed when willows are cultivated in plantations, so different problems arise. During the second and third years of growth, plants are infected with fungous diseases, dominant insect species become characteristic and form a more or less stabile complex of phytophagous pests in a plantation. It is necessary to study such changes in the plantation in order to avoid the effect of monoculture mentioned above.

The objective of the present research was to establish the species of phytophagous insects that are harmful to willows growing in industrial plantations, to analyze the peculiarities of trophical relationships in different taxa of *Salix* L., and to estimate the intensity of injury of plants, as well as to select the most perspective taxa and clones of willows.

MATERIALS AND METHODS

The studies were carried out in Miroslavas (Alytus district) at the industrial willow plantations belonging to the joint-stock company “Vilda” and in the VPU field collection from 1996 till 2003.

To study the species composition of phytophagous insects, standard entomological methods were used: “haying”, hunting with net, examination of plants or soil, shaking of branches, identification of injuries and observation of traces of insects. Some of the material was collected with the help of light traps using 250 W UV light with DRL spectrum.

The registration of insects was done during June, July, August and September as the majority of pest species are active during this season.

The identification of species was performed using an MBS-10 binocular microscope according to the conformable guides of Kazlauskas (1984), Pileckis, Monsevičius (1998), Лопатин (1986), Зерова и др. (1988), Коломоец и др. (1989).

Six common willows species and hybrids (*Salix alba* L., *S. molissima* L., *S. viminalis* L., *S. dasycardos* Wimm., *S. purpurea* L., and *S. integra* × *S. kochiana* (Shaburov) and 84 forms, cultivars and clones belonging to 5 sections were studied during 8 years in the industrial plantations and collections with the aim to determine the resistance of several taxa to pests (Table 1).

Fifty samples per each *Salix* L. taxon were studied in order to evaluate the level of injury of leaves and stems. The level of injuries was expressed in

Table 1. *Salix* L. taxa and the number of their clones cultivated and investigated in the Vilnius Pedagogical University field collections (1996–2003)

| Taxon | Number of clones |
|---|------------------|
| <i>Salix viminalis</i> | 4 |
| <i>S. viminalis</i> 'Americana' | 5 |
| <i>S. purpurea</i> f. <i>purpurea</i> | 13 |
| <i>S. purpurea</i> 'Gracilis' | 9 |
| <i>S. purpurea</i> f. <i>majak</i> | 3 |
| <i>S. purpurea</i> 'Rubra' | 3 |
| <i>S. purpurea</i> 'Lutea' | 2 |
| <i>S. purpurea</i> f. <i>busulukensis</i> | 1 |
| <i>S. purpurea</i> f. <i>hastata</i> | 2 |
| <i>S. purpurea</i> × <i>S. viminalis</i> | 5 |
| <i>S. alba</i> ssp. <i>alba</i> | 3 |
| <i>S. alba</i> ssp. <i>coerulea</i> | 3 |
| <i>S. alba</i> × <i>S. fragilis</i> | 1 |
| <i>S. alba</i> × <i>S. triandra</i> | 1 |
| <i>S. integra</i> × <i>S. kochiana</i> | 9 |
| <i>S.</i> × <i>vimole</i> | 2 |
| <i>S. mollissima</i> | 1 |
| <i>S. acutifolia</i> | 1 |
| <i>S. dasyclados</i> | 3 |
| <i>S. dasyclados</i> Tobolsk clone | 1 |
| <i>S. dasyclados</i> × <i>S. triandra</i> | 2 |
| <i>S. daphnoides</i> | 3 |
| <i>S. triandra</i> ssp. <i>triandra</i> | 2 |
| <i>S. triandra</i> ssp. <i>amygdalina</i> | 2 |
| <i>S. triandra</i> Orienburg clone | 1 |
| <i>S. ledebouriana</i> | 2 |
| <i>S. schwerinii</i> × <i>S. udensis</i> | 1 |
| <i>S. schwerinii</i> × <i>S. dasyclados</i> | 1 |
| In total: | 84 |

percentage. It denotes the amount of injured shrubs in the field, injured shoots in a shrub and the amount of injured leaves on one shoot.

RESULTS AND DISCUSSION

Most numerous and harmful species of phytophagous insects in industrial plantations and in the field collection

Willows growing in a natural biocenosis are very sensitive to injuries due to the specific chemical composition and lots of proteins in green tissues. It means that they have a large and stabile complex of trophically related insects. More than 80 species of insects belonging to 8 orders and trophically related with different taxa of willows were registered in the agrobiocenoses studied. The most important and economically dangerous species of phytophagous insects specialized to form trophical complexes with *Salix* L. belong to the Lepidoptera, Coleoptera and Hymenoptera orders.

Seventeen species (*Phyllopertha horticola* L., *Chrysomela populi* L., *Ch. saliceti* Wse., *Ch. vigintipuncta-*

ta L., *Lochmaea caprae* L., *Melolontha melolontha* L., *Cryptorrhynchus lapathi* (L.) (Coleoptera), *Phyllocnistis saliga* (L.), *Caloptilia stigmatella* (F.) *Earias chlorana* L., *Hedya salictella* (L.), *Cnephasia stephensiana* (Doubleday), *Scoliopteryx libatrix* (L.) (Lepidoptera), *Pontania vesicator* (Bremi), *P. proxima* (Lepel.) (Hymenoptera), *Dasineura marginematorquens* (Bremi), and *D. salicis* (Schrank) (Diptera)) are harmful to cultivated willows.

Phytophagous insects registered on willows impose different levels of damage. Some species are not numerous in natural biocenoses. However, populations of such insects may increase in plantations with favourable living conditions. Such kind of pest species registered in the willow plantation are *Phyllocnistis saligna* (Z.) (Gracillariidae), *Earias chlorana*, (L.) (Noctuidae), *Phyllopertha horticola* L., *Chrysomela populi* L. (Chrysomelidae), *Dasineura marginematorquens* (Bremi), *D. salicis* (Schrank) (Cecidomyiidae), and *Pontania vesicator* (Bremi) (Tenthredinidae). It was noticed that the insect species whose development took place under epidermal or deeper layers of leaves and shoots were most dangerous for willows cultivated in plantations. Species of insects whose caterpillars or larvae develop endobiotically were most dangerous for industrial plantations and field collections of willows.

The distribution of the most dangerous species of phytophagous insects in different *Salix* L. taxa

A regular distribution of some insects trophically related to willows belonging to different sections of *Salix* L. was revealed. Insects making galls (*Pontania vesicator* (Bremi) injure leaves, and *Dasineura salicis* (Schrank) shoots) were registered only in the Purpureae (A. Skvorts.) section. *Pontania proxima* (Lepel.) was characteristic only of the *Salix* (Sect. *Albae* Bor.) section. *Earias chlorana* (L.) was broadly specialized on taxa from the *Vimen* Dum. section and was rare on taxa of the *Amygdaline* Koch, *Vetrix* Dumort and *Daphnella* Ser. et Duby. sections. This species did not make notable injuries on taxa belonging to the Purpureae (A. Skvorts.) section. The oligophagous miner *Phyllocnistis saligna* (Z.) is trophically related to almost all taxa of willows belonging to the Purpureae (A. Skvorts.) section and with the cultivar *S. viminalis* 'Americana' and hybrid *S. alba* × *S. fragilis* from other sections. The clones of *S. purpurea* 'Gracilis' belonging to the Purpureae (A. Skvorts.) section were most sensitive to the miner *Ph. saligna* (Z.).

The forms of the purple willow *S. purpurea* 'Lutea' and 'Rubra' belonging to the Purpureae section were registered in 1992 (Í î ääéâ, Ñî äëþèãñ, 1996). These forms are resistant to *Pontania vesicator* (Bremi) which provokes gall formation. *P. vesicator* (Bremi) makes weak injuries, so it is very valuable in industrial plantations. The quality of wickers produced by these forms is similar to that of other taxa of willows used for trade. However, clones of 'Lutea'

Table 2. The proportion of sprouts of the local population of *Salix purpurea* L. injured by *Pontania vesicator* (Bremer) in 2000–2003

| Age of bushes, yrs | Number of sprouts per bush, (u) | Injured bushes, % | Injured sprouts per bush, % | Approximate number of injured leaves per sprout, (u) |
|--------------------|---------------------------------|-------------------|-----------------------------|--|
| 1 | 4.1 | 29.3 | 12.2 | 3.2 |
| 2 | 9.8 | 55.6 | 23.7 | 6.7 |
| 3 | 16.2 | 68.1 | 31.3 | 19.4 |
| 4 | 23.7 | 79.2 | 37.8 | 21.1 |
| 5 | 28.4 | 95.1 | 40.4 | 22.5 |

and 'Purpurea' are strongly injured by caterpillars of the leaf miner *Phyllocnistis saligna* (Z.) and slightly by the leaf beetle *Chrysomella saliceti* Wse. The level of injury of different *S. purpurea* L. taxa by larvae of the sawfly *Pontania vesicator* (Bremer) was found to depend on the age of a plant (Table 2).

The amount of injured sprouts per bush increased twice in the second year of cultivation. However, the amount of injured leaves almost did not change. It is possible that females of *Pontania vesicator* (Bremer) do not lay eggs on *S. purpurea* randomly. They choose more or less fixed places of shoots. It confirms the fact that injuries made by larvae are fixed in foliage of sprouts. The intensity of photosynthesis and vigour of growing do not decrease noticeably even the plants were injured by this pest (Норейка, СМАЛЮКАС, 1996). However, the weight of galls is the reason of crooking and splitting of branches.

The species *D. marginematorquens* (Bremer) was registered on all taxa of the Vimen Dum. and Amygdalinae Koch sections and on some hybrids belonging to the Purpureae (A. Skvorts.) section. *Caloptilia stigmatella* (F.) was not found on willows belonging to the SALIX section. It was revealed that leaf beetles *Chrysomela populi* (L.), *Ch. saliceti* (L.), and *Phyllopertha horticola* (L.) were trophically related with all studied taxa of willows belonging to 6 sections, and *S. purpurea* f. *majak*, *S. integra* × *S. kochiana* and *S. dasyclados* (local population) were the most sensitive species. *S. viminalis* 'Americana' and *S. dasyclados* (clone introduced from Tobolsk) where the most resistant to larvae of the above mentioned beetles.

The weevil *Cryptorhynchus lapathi* (L.) was registered only on willows belonging to the Vimen Dum. section. The clones of *S. viminalis* 'Americana', especially of local origin, were the most injured. This species of weevil is not frequent in natural biotopes of Lithuania (Pileckis, Monsevičius, 1997). However, the concentration of this insect can be found almost every year in industrial plantations. The larvae of the beetle develops inside the shoots and injured sprouts dry out. Less injured sprouts become inappropriate for trading.

Caterpillars of the white moth *Phyllocnistis saligna* (Z.) are dangerous for all taxons of *S. purpurea*

(L.). They make mines in the epidermal layer of shoots and leaves. Such conditions are very favourable for fungous infections (especially for *Septomyxa piceae*). 83% of shoots were injured by caterpillars of the first generation of this species during the third year of cultivation in 2000. However, only 6%

of shoots infected by the fungus were not injured by caterpillars. Clones of *S. purpurea* 'Gracilis' were the most sensitive to the caterpillars of *Ph. saligna* (Z.). 100% of plants were injured during the second year of cultivation.

All *S. viminalis* and *S. dasyclados* taxa were attacked by the owl-moth *Earias chlorana* (L.). Caterpillars of this species eat tops of shoots, so growing of sprouts stops and branching begins.

Gall flies *Dasineura maginematorquens* (Bremer) (Diptera, Cecidomyiidae) were very abundant in plantations of different taxa belonging to the Vimen Dum. section in 1998. Females of *D. marginematorquens* (Bremer) put eggs near the underside edge of a leaf. The leaf turns down and usually becomes thick during the development of larvae. Larvae are orange and their length is 2–3 mm. They form cocoons and spend the winter time in the ground. Adult insects start flying in May.

Sprouts of *S. purpurea* f. *hastata*, *S. purpurea* f. *majak*, *S. purpurea* × *S. viminalis* and especially of *S. purpurea* 'Gracilis' growing in the field collection were strongly injured by larvae of the gall making species *Dasineura salicis* (Schrank) (Diptera, Cecidomyiidae) (Table 3).

This species was registered on other species of willows belonging to the Purpureae (A. Skvorts.) section too. Polythalamous galls 10 mm in height and 10–30 mm in length are formed in the place of the injury. One yellow larva (2–3 mm in length) develops in every thalamus. This gall-making species is the most dangerous among 4 species found in the field collection and among 6 species registered in industrial plantations Its larvae offend wood, so sprouts become unsuitable for the trade of wickers. *D. salicis* (Schrank) injured approximately 38.4% of shrubs of clones derived from *S. purpurea* f. 'Gracilis' and 98% of shrubs of clones derived from *S. purpurea* f. *hastata* in the field collection in 2001. It means that resistant *S. purpurea* taxa should be selected for industrial cultivation.

The forms and cultivars of the same willow species differ in resistance to species of phytophagous insects, e.g. clones of *S. purpurea* 'Gracilis' are injured by more than half of the registered species

Table 3. The level of injuries of different *Salix purpurea* L. taxa by *Dasineura salicis* (Schrank) in the fifth year of cultivation in 2003

| Taxon | Injured bushes, (u) | Injured bushes, % | Injured sprouts per bush, % |
|--|---------------------|-------------------|-----------------------------|
| <i>Salix purpurea</i> 'Gracilis' cl. 9607 | 46.1 ± 4.0 | 74.2 | 37.4 |
| <i>Salix purpurea</i> 'Gracilis' cl. 9606 | 52.3 ± 3.2 | 88.7 | 38.1 |
| <i>Salix purpurea</i> 'Gracilis' cl. 9603 | 60.3 ± 3.1 | 98.1 | 33.4 |
| <i>Salix purpurea</i> 'Gracilis' cl. 9605 | 16.8 ± 2.5 | 96.2 | 48.7 |
| <i>Salix purpurea</i> 'Gracilis' cl. 9604 | 41.8 ± 5.0 | 100 | 42.2 |
| <i>Salix purpurea</i> 'Rubra' cl. 9617 | 15.5 ± 1.2 | 28.1 | 8.3 |
| <i>Salix purpurea</i> f. majak Nr. 1 cl. 9603 | 5.3 ± 0.9 | 100 | 92.6 |
| <i>Salix purpurea</i> f. majak Nr. 1 cl. 9604 | 8.3 ± 0.8 | 26.3 | 13.8 |
| <i>Salix purpurea</i> 'Lutea' cl. 9615 | 19.9 ± 0.8 | 12.0 | 2.8 |
| <i>Salix purpurea</i> 'Lutea' cl. 9613 | 13.8 ± 0.4 | 11.0 | 2.4 |
| <i>Salix purpurea</i> f. busulukensis cl. 9621 | 16.2 ± 0.2 | 26.4 | 4.0 |

living on different taxa from the Purpureae (A. Skvorts.) section. It was revealed that willow clones derived from local populations possess a larger complex of phytophagous insects. It means that such taxa should be avoided while setting new industrial plantations.

CONCLUSIONS

1. 84 taxa of *Salix* L. cultivated in plantations were studied and more than 80 species of phytophagous insects trophically related to different ranges of *Salix* L. taxa were registered. 17 species of insects belonging to Lepidoptera, Coleoptera, Hymenoptera and Diptera orders were considered as pests.

2. The Purpureae (A. Skvorts.) section had the biggest complex of phytophagous insects related to *Salix* L.

3. The most harmful phytophagous species of insects for industrial willow plantations were *Dasineura salicis* (Schrank), *Earias chlorana* (L.), *Cryptorrhynchus lapathi* (L.) (injure stems), *Phyllocnistis saligna* (Z.), *Pontania vesicator* (Bremi) and *Chrysomela populi* (L.) (injure leaves).

4. The clones of *S. purpurea* 'Lutea' and *S. purpurea* f. majak cultivated in industrial plantations were most resistant to phytophagous insects, while the clones of *Salix purpurea* 'Gracilis' were most sensitive.

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VABZDÞIAI FITOFAGAI – KULTÛRINIØ GLUOSNIØ *SALIX* L. (SALICACEAE) PLANTACIJØ KENKËJAI LIETUVOJE

Santrauka

Tirtose kultûrinëse gluosniø agrocenoze 1996–2003 m. aptikta per 80 vabzdþiø rūðiø, trofiðkai susijusiø su *Salix* L. genties augalais; 17 ið jø konstatuotos kaip þalingos kultûrinëms gluosniø plantacijoms. Nustatyti þalingiausiø vabzdþiø fitofagø trofinio pasiskirstymo ypatumai *Salix* L. gentyje sekciøj, rūðiø ir þemesnio rango taksonø lygyje. Ávertintas ávairiø *Salix purpurea* L. taksonø bei jø klonø pãeidimø lygis ir pobûdis. Iðãiðkintos stipriausiai ir silpniausiai pãeidþiamos kultûrinio plantacijø gluosniø rūðys. Didþiausi ir gausiausi þalingø vabzdþiø fitofagø kompleksai *Salix* L. gentyje nustatyti Purpureae sekcijoje.

Raktaþodþiai: *Coleoptera*, *Diptera*, *Gracillariidae*, *Hymenoptera*, *Lepidoptera*, *Salix* L., vabzdþiai kenkëjai