

Screening of phytopathogens and phytophages on *Chaenomeles* (CHAENOMELES LINDL.) cultivars

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Abstract. The pathogenic microflora and entomofauna were studied on the *Chaenomeles* Lindl. cultivars (Maloideae, Rosaceae). In central Russia, the multi-year systematic monitoring of pathogens and phytophages was carried out on plants *Ch. japonica*, *Ch. cathayensis*, *Ch. ×superba*. Among the identified pathogens, the micromycetes belonging to genera *Botrytis*, *Cytospora*, *Diplocarpon*, *Entomosporium*, *Gloeosporium*, *Monilia*, *Neonectria*, *Penicillium*, *Pestalotia*, *Phomopsis*, *Phyllosticta*, *Septoria* and *Sphaeropsis* were found to be injurious. With age, the accumulation of infectious background, including viral diseases and the damaging entomofauna was noted in the plantings of fruit crop *Chaenomeles*. The species composition of phytophages is mainly represented by autochthonous species (polyphages and oligophages), preferring the plants of Rosaceae family. Despite the abundance of species in the phytophage complex, it has a little effect on the decorativeness of *Ch. japonica*, *Ch. cathayensis* and *Ch. ×superba*.

1 Introduction

The species of genus *Chaenomeles* Lindl. (Maloideae, Rosaceae) come from Japan and China and are valued in decorative gardening. Such cultivars as *Ch. speciosa* (Sweet) Nakai, *Ch. cathayensis* (Hemsl.) C.K. Schneid., *Ch. japonica* (Thunb.) Lindl. ex Spach, as well as garden hybrids – *Ch. ×superba* (Frahm) Rehder (*Ch. japonica* × *Ch. speciosa*) and others [1, 2] were used to obtain flowering varieties.

In the climatic conditions of Russia, the most stable species is *Ch. japonica* (Thunb.) Lindl. ex Spach. This species is interesting for its highly vitaminized, fragrant fruits and it attracts attention of foreign [3] and Russian [4–8] breeders.

Although it is believed that *Chaenomeles* species are disease-resistant, it is known from the literature that, in China, the representatives of genera *Phoma* sp. and *Phyllosticta* sp. [9] settle on these plant bushes. Many pathogens were found on *Chaenomeles* plant species surfaces in Europe [3] and those of *Aphis pomi* in Iran [10].

The purpose of this study was to research and identify representatives of pathogenic microflora and harmful entomofauna on the *Chaenomeles* cultivars in the regions of central Russia.

2 Material and method

The study of phytopathogens and phytophages on the *Chaenomeles* cultivars was carried out in the Tambov

region, Moscow region and in the arboretum of N.V. Tsitsin Main Botanical Garden.

In 2007–2009, the endophytic microflora was tested on the cultivars, forms and types of *Ch. japonica* and *Ch. Cathayensis* in the Tambov region. Crops taken from annual shoots were placed in sterile tubes and Petri dishes with 2 variants of nutrient media from agar-agar (15 g): in the 1st variant – with intoxicating (hop) wort (1 l), in the 2nd – with potato (1 l).

The analysis and registration of fungal and bacterial microflora colonies was carried out under the microscope “Biomed-4” and expressed in (%) of the total number of tests [1].

In 2010–2017, the monitoring, including the analysis of leaves and fruits on *Chaenomeles* samples with the symptoms of phytopathogen lesions and phytophagous damage, was carried out in field conditions. The identification of fungi was performed by standard methods [11].

The arthropods specific composition (*Arthropoda*) was determined by damages, larvae and imago [4, 5].

3 Results and discussion

The breeding of *Chaenomeles* has been realized on the base of Michurinsk Agrarian University in the Tambov region since 2003.

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3.1 The stability of the Russian cultivars of *Chaenomeles*

New varieties Flagman, Voshod, Sharm, Michurinsky Vitamin, Alur and Albatros have flowers of original color, the corolla diameter of 3.5–5.8 cm, and their shoots are without spikes (Table 1). They were entered in the State register of the Russian Federation.

Table 1. Characteristics of *Chaenomeles* cvs.

Cultivar	Bush average height, cm	Corolla color	Corolla average diameter, mm	Fruits average diameter, mm	Pericarp average thickness, mm
Voshod	90	pale	43	50	19
Flagman	40	bright-raspberry	35	50	20
Sharm	70	light-orange	40	48	15
Michurinsky Vitamin	65	orange-cream	45	42	20
Allur	80	orange	58	55	18
Albatros	70	white	38	45	14

The selected forms and varieties of *Chaenomeles*, tested in the Tambov region for the resistance to endophytic microflora, showed their high degree of plant viability [9]. The bacterial microbiota prevailed and varied greatly. The fungal microflora was less abundant during the testing and was represented by the species of genera *Alternaria* sp. (Fig. 1), *Penicillium* sp., *Stemfillium* sp., *Cladosporium* sp. and *Fusarium* sp. The long-term monitoring of 6 *Chaenomeles* cultivars in the Michurin breeding under field conditions revealed 4 types of phytopathogens with a minimal degree of plant susceptibility (Table 2).

Septoria cydoniicola Thüm was most often recorded on *Chaenomeles* cultivars. At the beginning of summer, numerous whitish-gray round spots with dark rims are formed on the leaves. The cultivars were disease-affected at 1 point, but the most resistant cultivar is Voshod.

The drying and premature falling of leaves having brown spots with light middles are caused by *Phyllosticta cydoniae* var. *cydoniicola* (Allesch.) Cif Phyllostictaceae). Entomosporiosis, the causative agents of which are *Entomosporium eriobotryae* S.Takim. and *Diplocarpon mespili* (Sorauer) B.Sutton, syn. *Entomosporium maculatum* f. *maculatum* Lev., identified in the cultivar Albatros (1 point), can also be a cause of the appearance of brown spots.

More seldom, *Alternaria alternata* (Fr.) Keissl (Pleosporaceae) was encountered in *Chaenomeles* cultivars at the end of spring. Small rounded dark brown spots with dark purple-red borders are visible on the leaves; later the spots merge. Heart-shaped rot appears in the course of the disease development. Cultivars Voshod, Sharm, Albatros and Michurinsky Vitamin are the most resistant to altarnariosis.



Fig. 1. Pure culture *Alternaria* sp. in a Petri dish on a wort nutrient medium. – Oder Fig. 1. *Alternaria alternata* on *Chaenomeles* leaves

Table 2. Affection of *Chaenomeles* cvs. by pathogenic microflora during 2010–2016, points

Cultivars and forms	<i>Septoria cydoniicola</i>	<i>Alternaria alternata</i>	<i>Phyllosticta cydoniae</i> var. <i>cydoniaeicola</i>	<i>Diplocarpon mespili</i>
Voshod	0	0	1	0
Flagman	1	1	0	0
Sharm	1	0	0	0
Michurinsky Vitamin	1	0	0	0
Allur	1	1	1	0
Albatros	1	0	0	1

3.2 Potentially dangerous microflora

According to our observations, the pathogenic mycoflora on *Chaenomeles* plants is represented much wider and is capable of damaging leaves, flowers and fruits, causing the drying of branches and the death of entire bushes. *Monilia fructigena*, which affects *Ch. japonica* and *Ch. cathayensis* (2–3 points), is most often noted in the collection plantings in Moscow (SBG of RAS). Brownish-yellow pads of conidia sporification (Fig. 9) appear on the fruit surface during the disease development. Later, the fruit loses its taste and nutritional qualities, and its mummification comes. *M. cydoniae* Schell., from which leaves, flowers and ovaries fall off in summer, can be the causative agent of moniliosis. Old *Ch. japonica* bushes are affected at 2 points.

As a result of quince anthracnose, the causative agent of *Gloeosporium cydoniae* Mont. (Dermateaceae) dark brown spots appear (3 points) on the leaves of *Ch. japonica*. Premature yellowing and leaf fall (2–3 points) are caused by *Pestalotia breviseta* Sacc. To a lesser extent (1 point), the fruit crop is affected by *Phyllosticta velata* Bubák.

The following diseases are often encountered (1–2 points) on old *Chaenomeles* bushes. Quince cytosporosis, that makes shrub branches shrink, is the causative agent of *Cytospora cydoniae* Bubák & Kabát. (Valsaceae). Tubercular necrosis is the causative agent of *Nectria cinnabarina* Fr. (Nectriaceae). It begins with the bark necrosis on the shoots and branches, but leads to

the death of entire plants. European cancer, caused by *Neonectria galligena* (Bres.) Rossman & Samuels, syn. *Nectria galligena* Bres. (Nectriaceae), is found rarely; it causes the death of leaves, fruits and whole branches. Black quince cancer, caused by *Sphaeropsis cydoniae* Cooke & Ellis (Aplosporellaceae), damages the fruits of *Ch. japonica* and *Ch. Cathayensis*. It leads to cracking and drying of branches bark.

Part of the *Chaenomeles* harvest may be lost (1–2 points) as a result of botrytiosis, penicilliosis and fomopsis, which are noticeably manifested during the storage of fruits. Botrytiosis, which is found everywhere, caused by *Botrytis cinerea* (Sclerotiniaceae), affects *Chaenomeles* flowers and fruits. First, brown spots with clear reddish edges appear. Then the fruits rot and prematurely fall. The rotting of fallen fruits is accelerated by the contact with soil, since *Penicillium expansum* Link and *P. cyclopium* Westling (Trichomaceae) penetrate their surface. *Phomopsis* is caused by pathogens *Phomopsis mali* Roberts, *Ph. perniciosus* Grove and *Ph. ambigua* (Nitschke) Traverso (Diaporthaceae) and is accompanied by dark brown spots on the leaves, leaf fall and rotting of *Chaenomeles* fruits.

The single tomato annular blotch virus (ToRSV), the symptoms of which are expressed in the form of chlorosis, wrinkling and necrotic leaf blotch with a characteristic alternation of dark and light areas, was observed on *Chaenomeles* fruits.

3.3 Damaging entomofauna complex

A complex of entomofauna representatives was revealed on *Chaenomeles* plants in the regions of central Russia (Table3). It should be noted that almost all groups of Insecta are rare and in a single amount (≥ 1 point), with the exception of colony-forming aphids (1–2 points).

The most dangerous are migrating species *Aphis fabae*, which are black insects, and the non-migrating species *A. pomi* (Homoptera: Aphididae), which is common on Rosaceae fruit crops. Although they are not observed in *Chaenomeles* every year, these insects are carriers of viral diseases. The polyphage *Palomena prasina* (Homoptera: Pentatomidae) and *Edwardsiana rosae* L. (Homoptera: Cicadellidae), the phytophage of fam. Rosaceae, were pointed out in the complex of sucking species of the Moscow region.

The polyphagous bug *Acanthosoma haemorrhoidalis* L. (Hemiptera: Acanthosomatidae), usually feeding on deciduous cultures of the families Rosaceae, Betulaceae, Salicaceae, Tiliaceae, etc., was found in both regions. Gnawing phyllophages are diverse, although they appear sporadically. But they are capable of worsening the decorative appearance of a bush. The gray-green caterpillar *Cladius pallipes* Lep., Syn. *Priophorus padi* L. (Hymenoptera: Tenthredinidae), capable of skeletonizing *Chaenomeles* leaves, is especially active at the beginning of summer. *Archips variegana* Schiff. and *A. rosana* L., syn. *Ccoecia rosana* L., feeding on deciduous plants, including those from the Rosaceae family, are noticeable out of leafworms (Lepidoptera:

Tortricidae). The second type not only turns leaves into a tube, cigar-shaped or lumpy, but also damages ovaries and fruits, gnawing holes in the pulp to the seed chamber.

An especially active development of caterpillars *Acleris variegana* Den. et Schiff. was noticed in 2016 in the Tambov region on the Albatross cultivar, when they were eating out fruit buds and buds, skeletonizing the leaves and wrapping them into a bundle of cobwebs. Green brown head caterpillar *Exapate congelatella* Cl. also gnaws into the buds and leaves, forming a lump. The small wormhole, the crenellate lunate *Ancylis selenana* Gn., common on Rosaceae fruit crops, was noted during the monitoring on *Ch. japonica* in the arboretum of the MBG RAS on *Ch. × superba* (1–2 points). Greenish-yellow caterpillars (up to 1 cm long) skeletonize leaves, fold them in half along the central vein and, then, they gnaw them.

Table 3. Occurrence of entomofauna representatives in Central Russia

Insecta	Moscow region	Tambov region
Homoptera	<i>Aphis fabae</i> , <i>A. pomi</i> , <i>Palomena prasina</i> , <i>Edwardsiana rosae</i>	<i>Aphis fabae</i>
Hemiptera	<i>Acanthosoma haemorrhoidalis</i>	<i>Acanthosoma haemorrhoidalis</i>
Hymenoptera	<i>Cladius pallipes</i> , <i>Hoplocampa testudinea</i> , <i>Vespa crabro</i>	
Lepidoptera	<i>Nepticula malella</i> , <i>Stigmella pomella</i> <i>Archips variegana</i> , <i>A. rosana</i> , <i>Laspeyresia pomonella</i> , <i>Exapate congelatella</i> , <i>Ancylis selenana</i> , <i>Diloba coeruleocephala</i>	<i>Acleris variegana</i> , <i>Exapate congelatella</i> , <i>Stigmella pomella</i>
Coleoptera	<i>Rhynchites bacchus</i> , <i>Coenorrhinus pauxillus</i> , <i>Phyllobius urticae</i> , <i>Agriotes obscurus</i>	<i>Rhynchites bacchus</i> , <i>Coenorrhinus pauxillus</i> , <i>Otiorrhynchus ligustici</i>

The gnawing phytophages of *Chaenomeles* include the blue-headed scoop *Diloba coeruleocephala* L., syn. *Episema coeruleocephala* L. (Lepidoptera: Noctuidae) and alfalfa skosar *Otiorrhynchus ligustici* L. (Coleoptera: Curculionidae), which feeds on buds and gnaws young leaves.

The beetle *Agriotes obscurus* L. (Coleoptera: Elateridae), that usually prefers cereal leaves, is found on *Chaenomeles* fruits; small beetle *Phyllobius urticae* Deg., syn. *Phyllobius pomaceus* Gyllenhal (Coleoptera: Curculionidae) is a polyphage found on this plant of the families of Urticaceae and Rosaceae.

Nepticula malella Stainton (syn. *Stigmella malella* Stt.), leaving serpentine mines extended in the middle, is marked among mining phyllophages; *Stigmella pomella* Vaugh. (Lepidoptera: Nepticulidae) has characteristic thin mines.

Chaenomeles fruits can damage several carpophages typical of the Rosaceae family. *Rhynchites bacchus* L.

and *Coenorhinus pauxillus* Germ, consuming young leaves and flowers of *Chaenomeles*, are found everywhere. (Coleoptera: Rhynchitidae). The caterpillar *Laspeyresia pomonella* L., syn. *Carpocapsa pomonella* L. (Lepidoptera: Tortricidae), gnawing a ripe fruit, is seldom noticed.

The seed chambers in the fruits of *Ch. japonica* are destroyed by *Hoplocampa testudinea* Clug. (Hymenoptera: Tenthredinidae) frequently observed on apple trees. European hornet – *Vespa crabro* L. (Hymenoptera: Vespidae) usually feeds on the nectar of flowers, juice and fruit pulp. Adults eat the flesh of ripe *Chaenomeles* fruits, and that accelerates their rotting.

4 Conclusion

Many years have been spent to implement the systematic monitoring of pathogens and phytophages on plants *Ch. japonica*, *Ch. cathayensis*, *Ch. ×superba* and multi-purpose varieties in central Russia. Among the identified pathogens, the most harmful pathogens are *Alternaria alternata*, *Septoria cydoniicola*, *Entomosporium eriobotryae*, *Phyllosticta cydoniae* var. *cydoniicola*, *Diplocarpon mespili*, *Gloeosporium cydoniae*, *Monilia cydoniae*, *M. fructigena*; smaller *Pestalotia breviseta* and *Phyllosticta velata*, *Penicillium expansum* and *P. cyclopium*. Filoplan mushrooms are widely spread.

With age, the increase in the infectious background and the accumulation of damaging phytophages (*Botrytis cinerea*, *Phomopsis mali*, *Ph. Perniciosa* and *Ph. ambigua*), including the viral disease (ToRSV), are noticed in plantings. *Cytospora cydoniae*, *Sphaeropsis cydoniae*, *Nectria cinnabarina* and *Neonectria galligena*, causing the drying of branches and death of entire bushes, are marked on country-age plantings. *Chaenomeles* plants have a complex of sucking, gnawing and mining phytophages. The following gnawing insects prevail among entomofauna representatives: phyllophagous – *Archips variegana*, *A. rosana*, *Acleris variegana*, *Exapate congelatella*, *Cladius pallipes*, *Ancylic selenana*, *Diloba coeruleocephala*, *Agriotes obscurus*, *Phyllobius urticae*, *Otiorrhynchus ligustici*, and also carpophages – *Rhynchites bacchus*, *Coenorhinus pauxillus*, *Laspeyresia pomonella*, *Hoplocampa testudinea*, *Vespa crabro*. Sucking insects (*Palomena prasina*, *Edwardsiana rosae*, *Acanthosoma haemorrhoidalis*) are dangerous, especially *Aphis fabae* and *pomi*, which are carriers of phytoviruses. Phytophage miners (*Nepticula malella* and *Stigmella pomella*) are few in number and have almost no effect on the decorativeness of bushes. Cochlea-in stonemason *Helicigona lapicida* L. (Gastropoda: Helicidae), that feeds on leaves and, less often, fruits in dense plantings, is seldom observed on *Ch. Japonica* plants.

The analysis of phytophages composition shows that these are mainly autochthonous species, both polyphages and oligophages, preferring plants of the Rosaceae family. Probably, this set is due to the close proximity of the experimental *Chaenomeles* plants with the plantings of Rosaceae family fruit crops, and it facilitates the expansion of food links and favors the creation of new

potentially dangerous “introduced species-pathogen” complexes.

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