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Monitoring and Control of *Metcalfa pruinosa* (Say) (Hemiptera, Auchenorrhyncha: Flatidae) in Krasnodar Territory

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Abstract—*Metcalfa pruinosa* (Say) is an invasive planthopper species rapidly expanding its range in Europe and Southern Russia and acquiring new food plants, which makes it a potential threat to agriculture, including organic farming. The distribution and injuriousness of this species in Krasnodar Territory was analyzed, and the possibilities of monitoring and controlling *M. pruinosa* populations were studied. Yellow sticky traps were found to be unattractive to *M. pruinosa*. Among the preparations studied, Actara and Fitoverm proved to be the most toxic to the nymphs in the first three days after treatment.

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In recent years, due to the active introduction of foreign planting stock and probably under the influence of currently changing climatic conditions, the number of invasive insect species in the territory of Russia has been steadily increasing (Izhevskii and Maslyakov, 2008; Korotyaev, 2013). Of no small importance in the growing influx of foreign species is globalization and development of international trade (Mack et al., 2000). Billions of dollars are spent every year on prevention of introduction of such species as well as on extermination and control measures (Perrings et al., 2010). Many introduced species may have several generations a year; they are often characterized by high fecundity and a wide range of optimum abiotic conditions, in particular, the ability to withstand hot temperatures and drought.

Auchenorrhyncha make up a considerable part of recent invaders in the south of Russia. During the last 15 years 3 species new to the Russian fauna were recorded which are quarantine pests: *Edwardsiana iranicola* Zachvatkin, 1947, *Arboridia kakogawana* (Matsumura, 1932) of the family Cicadellidae, and *Metcalfa pruinosa* (Say, 1830) of the family Flatidae (Sugonyaev et al., 2004; Kotenev et al., 2007; Gnezdilov and Sugonyaev, 2009). The latter species was for the first time documented in Krasnodar Territory of Russia (Lazarevskoye Village) 5 years ago and since that time it has been expanding to the north of the territory.

Metcalfa pruinosa is native to North America (Metcalf and Bruner, 1948); it is a broad polyphage damaging over 200 plant species, including field crops and ornamental plants (Duso, 1987). In Europe, *M. pruinosa* was first spotted in 1979, in the environs of Treviso in the north of Italy (Zangheri and Donadini, 1980); now it is known in Austria, Bulgaria, Bosnia and Herzegovina, Spain, Romania, Serbia, Slovenia, France, Croatia, Czechia, Switzerland, Ukraine, and the Republic of Korea (Malumphy et al., 1994; Gogan et al., 2010; Lee and Wilson, 2010; Kim et al., 2011; Uzhevskaya et al., 2012).

Adults of *M. pruinosa* are on average 8 mm long, though specimens up to 15 mm long have been recorded (Colombo et al., 2009). They vary in color from dark reddish brown to gray, depending on the presence or absence of bluish-white waxy coating; the eyes are yellow (Figs. 1*a*, 1*b*). On the anterior part of the elytra there are characteristic dark spots. The vertical position of the broadly triangular elytra lends the insects a wedge-shaped appearance (Fig. 1*a*). The newly hatched adults are white and subsequently become darker (Fig. 1*b*). The nymphs pass through five instars and reach the length of 4 mm. They are covered with waxy filaments and coating (Figs. 1*c*, 1*d*) which lend them the whitish color. According to the American researchers, the species overwinters at the egg stage till the beginning of March. The female lays about 100 eggs singly under the bark of host plants. In

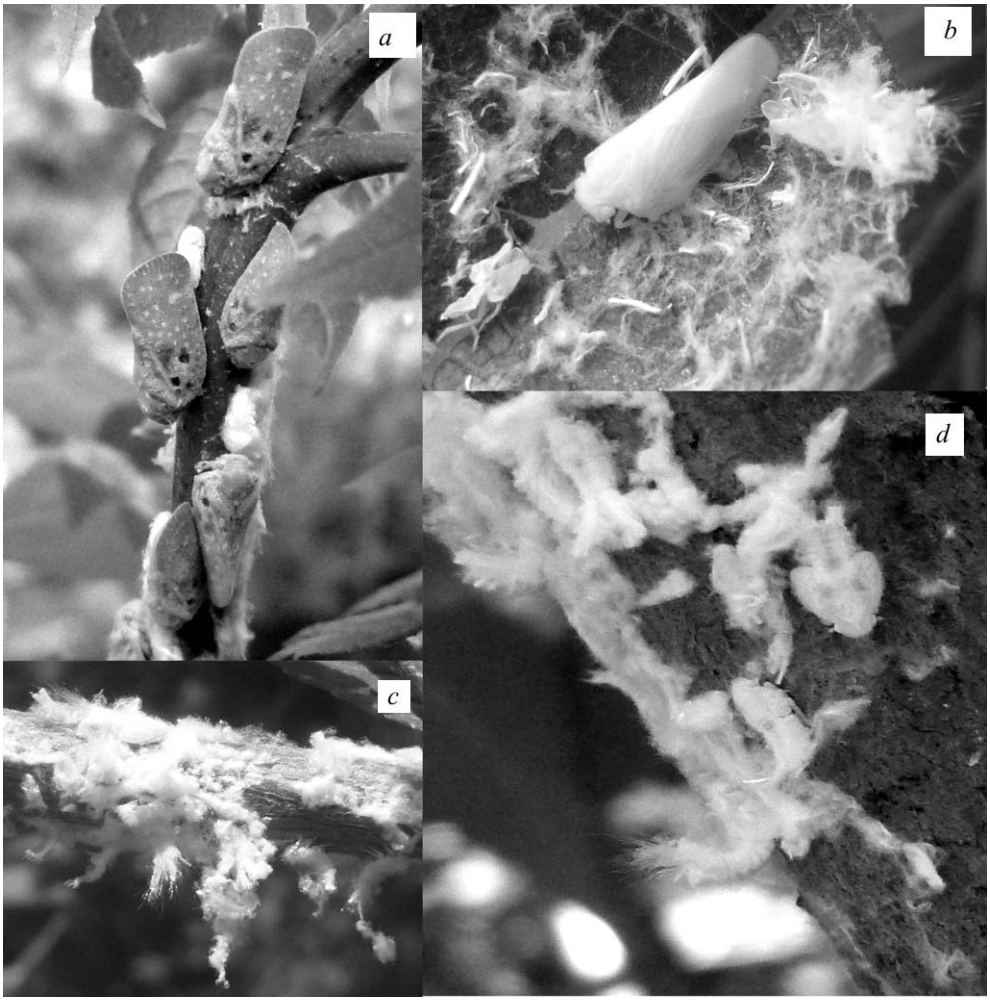

Fig. 1. Adults and nymphs of *Metcalfa pruinosa* (Say): (*a*) on the walnut shoot; (*b*) freshly emerged adult and its nymphal integument on a walnut leaf; (*c*, *d*) nymphs and an elm shoot covered with wax.

Texas, the first adults appear 69 days after nymphs hatching, and mass emergence takes place in June. In Florida, nymphs were recorded from April till June and adults, from May till October. In Canada, nymphs were recorded in sour cherry orchards from May to the end of July, adults, from the end of July to October (Dean and Bailey, 1961).

Colonies of *M. pruinosa* were discovered in 2010 in the Novorossiysk forestry, the landscaped areas of Krasnodar, and also in Ozereevka, Elizavetinskaya, and Ivanovskaya villages (Shchurov and Gninenko, 2010; Shchurov and Rakov, 2011). In July 2011, an outbreak of this species was recorded in Starokorsunskaya Vill., whereas by September of the same year it spread throughout forest belts as far as Ust-Labinsk (Zamotailov et al., 2011). In the opinion of the cited authors, the pest was introduced into the Russian Black Sea coast via Sochi and Novorossiysk ports. Further expansion to Krasnodar and more northeastern areas was most probably caused by accidental transportation by railway from Novorossiysk port, since the place of its discovery in Krasnodar is close to a large marshaling yard. The species has not been yet found in Tuapse District and Gelendzhik. Although the adults of *M. pruinosa* can fly very well, the rate of natural expansion of this species is only 0.2–0.5 km a year (Kahrer et al., 2009). Usually it gets into new localities by chance, together with plant material; however, there are records of intended introduction of *M. pruinosa* by bee keepers for the purpose of obtaining honeydew (Mihajlović, 2007).

In 2012, researchers from the All-Russia Research Institute of Biological Plant Protection (Krasnodar) observed a considerable rise in *M. pruinosa* abundance in the orchards of Znamensky Vill., near Krasnodar. The feeding of *M. pruinosa* caused drying up of young

Fig. 2. An elm branch with nymphs of *Metcalfa pruinosa* (Say): (*a*) before treatment with ecopreparations; (*b*) dead nymphs on the second day after treatment.

shoots on trees. In the mid-summer 2013, this species was found by the specialists of the Forest Protection Center of the Chechen Republic in forest areas (*News Report*..., 2013). Thus, within 4 years this invasive species spread throughout the Central and Anapa-Taman zones of Krasnodar Territory and the Chechen Republic, causing considerable damage to some private orchards.

Within its native range, *M. pruinosa* rarely does any economic harm; yet it has been noted that this species may seriously damage plants in the presence of some other weakening factors, such as cold spells (Wene, 1950; Wene and Riherd, 1953). In addition, this pest is the vector of the aster yellow (AY) (group Sr16I) phytoplasm (Weintraub and Beanland, 2006). The abundance of *M. pruinosa* in North America is usually limited by its natural enemy, the parasite *Neodryinus typhlocybae* (Ashmead) (Hymenoptera, Dryinidae) infesting its nymphs. However, in new territories where *M. pruinosa* is a new element for the native associations and has no limiting natural enemies, it may produce outbreaks with subsequent range extension (Hughes, 2000; Musolin, 2007). In their native ranges, invasive species often do not cause noticeable harm to either wild or cultivated vegetation and become mass pests only when they get into new territories; this is what happens now with *M. pruinosa* in Eurasia. For example, in the north of Italy the species caused loss of up to 40% of soya crops (Ciampolini et al., 1987). The density of the pest on plants is considerably higher in Europe than in the USA; in addition, the pest acquires new hosts among both native plants and those introduced from other regions (Bagnoli and Lucchi, 2000; Wilson and Lucchi, 2001). It was shown that foci of mass reproduction of most invasive species developed practically throughout all the newly formed ranges (Izhevskii, 2006). This is what happens at present in Russia where *M. pruinosa* is only exploring new areas, getting adapted to the climatic and cenotic conditions of Krasnodar Territory, but is already acquiring the status of a serious vineyard and orchard pest.

In spite of the evident harmfulness of this invasive phytophage, its biology and the possibilities of controlling its abundance in the south of Russia are practically unstudied. At present, this is one of the most important tasks, since usually researchers deal with such problems when the invasive species is already at the outbreak stage, doing considerable harm to plants, as it happened, for example, with the fall webworm *Hyphantria cunea* Drury (Lepidoptera, Arctiidae).

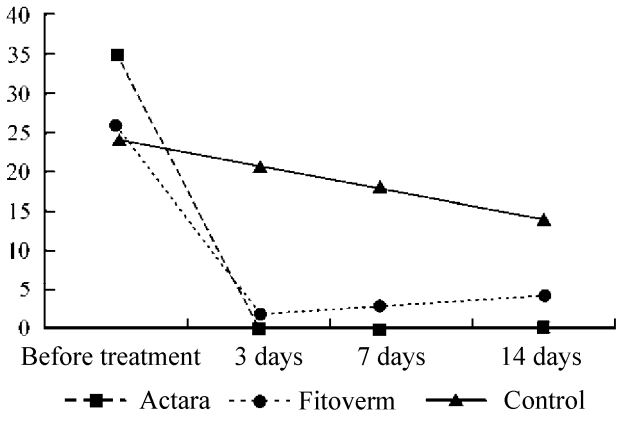

Fig. 3. The influence of Actara and Fitoverm on survival of older-instar nymphs of *Metcalfa pruinosa* (Say): Abscissa: time after treatment; ordinate: mean number of living nymphs.

In 2013, researchers from the Laboratory of agrocenotic arthropod control monitored the development of *M. pruinosa* in apple orchards of Krasnodar and its environs. It was noted that under the conditions of the Central zone of Krasnodar Territory the planthopper developed on the elm, ash, privet, vine, apple, plum, maple, bramble, and black walnut. It also damaged field crops, weeds, and ornamental plants.

The possibility of using color sticky traps for monitoring planthoppers was studied. The efficiency of yellow sticky traps was in particular demonstrated for *Arboridia kakogawana* (Matsumura), when up to 700 adults got into one trap during one week (Gnezdilov et al., 2007; Balakhnina et al., 2009). However, this method proved to be ineffective for *M. pruinosa*: only occasional individuals got into the traps (1 or 2 a week) though large colonies of the species were formed not more than 1 m away.

Nymphs of *M. pruinosa* were visually recorded from the 1st decade of May till the 1st decade of August in the immediate vicinity of the apple orchard plots of the Kuban research unit of Kuban State Agrarian University (Krasnodar). Adults were recorded from July to the end of August, with mass appearance in the 2nd and 3rd decades of July. Most of the captive adults died within a week after collection; the last living individuals were recorded on the 17th day after capture, which confirms the short life span of the species. The greatest danger is posed by nymphs whose activity leads to chlorosis, noticeable growth impediment, and sometimes to drying up of the plants. The planthopper sugary secretion (honeydew) facilitates the development of soot dew polluting the leaves and blocking gas exchange. In grapes, ripening and sugar accumulation in berries is delayed. The plants damaged by cold spells, other pests or pathogens suffer most of all. In some cases, the orchard crops are rendered unmarketable.

The recommended means of controlling this pest are mostly chemical. Among the preparations included in *The list of pesticides and agrochemicals allowed for use in the Russian Federation*, only three may be called low-hazard (Acarin, Fitoverm, and Actara), but their effectiveness against *M. pruinosa* is not yet studied and they are recommended only by analogy with other sap-sucking pests. In 2013, the biological efficacy of Fitoverm (1 l/ha) and Actara (0.2 kg/ha) for control of *M. pruinosa* under the conditions of ecological gardening was studied at All-Russia Research Institute of Biological Plant Protection. It was found that the dead nymphs lost their waxy covering after treatment (Fig. 2*b*). The preparation efficacy was calculated by Henderson-Tilton formula (Novozhilov et al., 1986) which takes into account the active migration of *M. pruinosa*:

$$E = 100 \times (1 - Ta \times Cb / Tb \times Ca),$$

where E is corrected efficacy (%); Tb is the number of live individuals before treatment in experiment; Ta is the number of live individuals after treatment in experiment; Cb is the number of live individuals in control during the preliminary count; Ca is the number of live individuals in control during the subsequent counts.

The preparations proved to be effective against nymphs during the first 3 days after treatment (Figs. 2, 3): Actara reduced their numbers by 100%, Fitoverm, by 86%. The efficacy of Actara and Fitoverm against adult planthoppers was 89% and 71%, respectively.

In July 2013, an outbreak of *M. pruinosa* reproduction was recorded at vineyard plots with an area of 6 ha in the environs of Abrau-Dyurso. The activity of the pest resulted in discoloration of the leaf laminae. Actara was used to reduce the numbers of the phytophage. Since most vineyards in the area lie close to villages in the resort zone of the Black Sea coast, chemical treatments are highly undesirable. There are no biopreparations recommended against this species and research in this field is inconsiderable; therefore there is urgent need of developing the means of control of *M. pruinosa*.

Metcalfa pruinosa poses a threat not only to vineyards but also to the developing organic agriculture in the south of Russia in which any synthetic preparations except pheromones are forbidden. Thus, further study of *M. pruinosa* is necessary in order to find the ways to prevent its outbreaks and to predict its harmfulness in forests and agroecosystems.

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