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ASSESSMENT OF BIOLOGICAL EFFICIENCY OF EXISTENT INSECTICIDES AGAINST FOREST PESTS

The results of testing and assessment of biological efficiency of several current insecticides from neonicotinoids against pests of forest stands are reviewed. Their high efficiency against biting and suctorial pests of coniferous and deciduous stands is revealed. Application of the insecticides has led to reduction of pine stands damage caused by different groups of pests by 69.9–100%, of birch stands against aphides 100%. Obtained data are given to the firms for registration of the insecticides in the forest stands.

Introduction. At present many forest-regeneration and forest-growing activities are being implemented including on the former agricultural lands that were transferred to the jurisdiction of the Ministry of Forestry. Very often good-quality forest stands are badly affected by pests, primarily phytophagans. Therefore necessary pest control measures should be indispensable for forest planting. The State Register of plant-protecting agents (pesticides) and fertilizers allows application of 13 insecticides, 8 fungicides and 9 biological preparations for forestry activities in the territory of the Republic of Belarus. These numbers fall short of the corresponding number of pesticides allowed for use to keep agricultural crops such as wheat, barley, potato, sugar beet, raps, cucumber, tomato, apple and pear trees free from pests. The state forestry enterprises undergoing or undergone forest management and utilization certification by the standards of Forest Stewardship Council (FSC) are not allowed to apply whole groups of pest control preparations as this contravenes the FSC policy. Thus, such insecticides as BI-58 new, Vitan, Grizzly, Detsis profi, Karate zeon, Fastak are to be excluded from the State Register of plant-protecting agents allowed for use in forestry. As a result currently only 7 insecticides can be applied in forestry which makes it very difficult to rotate them in the system of protective measures. Besides, out of this range only one insecticide, which is Aktara, is allowed and registered to be applied to forest plantations.

Analysis of similar lists of the registered pesticides in the CIS countries (Russia and Ukraine) showed that they experience comparable problems in the field of forest pest control. In Russia, they allow application of two biological insecticides to forest plantations and of eight synthetic organic pesticides, some of them, however, being forbidden by FSC. In Ukraine, the group of registered insecticides to be applied to forest plantations includes three virus biological preparations and six synthetic organic insecticides, the most common of them are Virins, being applied by aerosol spraying. The other insecticides, except for two neonicotinoids, fall into the category of pyrethroids which are forbidden by FSC. Based on the analysis of the insecticides range applied in forestry in the neighbouring countries, we should make a point that it is rather limited and similarly to Belarus not adequate for forestry needs as it does include preparations against all ecological groups of forest pests.

Therefore, selection and testing of forestry insecticides, determination of biological efficiency of some current phytophagan insecticides and their inscription in the State Register of plant-protecting agents are of special importance to the development of a system of protective measures.

To expand the range and applications of the registered agricultural insecticides and those forestry insecticides of the State Register that comply with the policy of Forest Stewardship Council (FSC), we have carried out a screening study of the insecticides produced by the companies that are interested in promoting their products in the Belarusian market.

Main part. We have evaluated the efficiency of the following insecticides: Imidor, BPK (imidacloprid, 200 g/l, CJSC "Shchelkovo Agrokhim", Russia) and Tanrek, BPK (imidacloprid, 200 g/l, CJSC "Avgust", Russia) of broad-spectrum neonicotinoid class. These modern pesticides are characterized by an expressed systemic activity. Their active ingredient, i.e. imidacloprid, affects the nervous system of insects suppressing the signal transduction through the pests central nervous system thus making the insects incapable to move. The Aktara VDG insecticide (thiamethoxam, 250 g/kg, "Singenta Crop Protection AG", Switzerland) was used as a reference preparation. This is a gut-contact insecticide of neonicotinoid class characterized by a systemic activity. These insecticides have been registered in Belarus, the Aktara preparation allowed for forestry applications.

The insecticides were tested in 2013 as recommended rates of application for other crops:

Imidor – 0.5 and 0.8 l/ha, Tanrek – 0.4 and 0.5 l/ha. The rate of Aktara application is 0.4 l/ha. Each testing scenario was three-fold. The rate of working fluid was 500 l/ha [1].

The field tests of insecticides against double shoot moth (*Rhyacionia duplana*) were carried out on an area of sound pine plantations within the shoot moth centre in Zaluzhskoye forestry station which is under the jurisdiction of Starodorozhski experimental forestry. The treatment against the shoot moth proved most efficient in the period when larvae hatch and start moving from the last year's shoots to the May shoots of the current year [2]. Adult emergence and batch of eggs were controlled by pheromone traps [4].

It is a common forestry practice when monitoring, study and abundance of shoot moth are assessed by a 4-grade scale of health categories. The damaged trees were assessed before the invasion and damage of May shoots by larvae previous to their pesticide treatment. The trees of health categories III and IV were subject to cutting [3].

We summarized the assessment data on the stands damage for the previous years, their health category being II,7 (Table 1). After the treatment had been done, the May shoots of the current year were assessed for damage (Table 2).

Based on the data from Table 2, the percentage of unpromising trees to be removed is distributed among different scenarios as follows: reference area – 92%, Aktara (reference preparation) – 46.1%, Tanrek – 19.0%, Imidor, 0.5 l/ha – 20.8%, Imidor, 0.8 l/ha – 0.0%.

Taking into consideration the fact that shoot moth larvae tend to have a latent way of life starting from the second year, the treatment results can be controlled by a protective effect (Table 3). This can be calculated according to the formula

$$E_z = 100 - 100 \cdot \frac{P_c}{P_r},$$

where E_z – reduced damage intensity, %; P_c – the number of trees of categories III and IV by testing scenarios, %; P_r – the number of trees of categories III and IV on the reference area, %.

Table 1

Forest stands damage by double shoot moth

Trees, pcs./%	Trees by health categories, pcs./%			
	I	II	III	IV
130/100.0	10/7.7	42/32.3	60/46.1	18/13.9

According to the existent assessment of protective effect it proved to be excellent for Imidor, 0.8 l/ha, good for Tanrek and Imidor, 0.5 l/ha, weak for Aktara. Thus the resistance of Imidor and Tanrek to the shoot moth is higher than that of the reference preparation.

Testing of insecticides against the pine bark bug (*Aradus cinnamomeus*) was carried out on an area of sound pine plantations in Centralnoye forestry section of Negoreloye forestry experimental station (Table 4). The abundance of the bugs was assessed by larvae and adult calculation under the bark scales on the most populated internode shoot [2–4].

Table 2

Assessment of efficiency of protective measures

Testing scenario	Total number of trees, pcs./%	Trees by health categories, pcs./%				Weighted average category
		I	II	III	IV	
Reference area	25/100.0	0/0.0	2/8.0	14/56.0	9/36.0	III.3
Aktara (reference preparation), 0.4 l/ha	26/100.0	5/19.2	9/34.7	7/26.9	5/19.2	III.2
Tanrek, 0.4 l/ha	21/100.0	4/19.0	13/62.0	4/19.0	0/0.0	II.0
Imidor, 0.5 l/ha	24/100.0	8/33.3	11/45.9	5/20.8	0/0.0	I.9
Imidor, 0.8 l/ha	24/100.0	16/66.7	8/33.3	0/0.0	0/0.0	I.3

Table 3

Reduced intensity of pine stands damage by shoot moth

Testing scenario	Rate of application, l/ha; kg/ha	Weighted average trees colonization, points		Reduced intensity of damage	
		before treatment	after treatment	trees to be removed (балл III and IV), %	protective effect, %
Reference area (no insecticide applied)	–	III.3	III.3	92.0	–
Aktara, VDG (reference preparation)	0.4	III.3	III.2	46.1	49.9
Imidor, BPK	0.5	III.3	I.9	20.8	77.8
Imidor, BPK	0.8	III.3	I.3	0.0	100.0
Tanrek, BPK	0.4	III.3	II.0	19.0	79.3

Biological efficiency corrected to checking against the pine bark bug having a latent way of life was 71.6% for Tanrek, 69.9% for Imidor, 0.5 l/ha, 84.9% for Imidor, 0.8 l/ha. As for the testing scenarios, their efficiency proved to be considerably higher than that of Aktara, i.e. reference preparation, which is recommended by the State Register of plant-protecting agents.

Testing of insecticides against the large pine aphid and the beech blight aphid was carried out in forest plantations of Negoreloye forestry experimental station in triplicate using the existent technique [4]. Table 5 shows the testing results of insecticides against large pine aphid (*Cinarapinea*).

All testing scenarios revealed high biological efficiency of 100%, which is a little higher than that of the reference preparation.

The abundance of aphids on deciduous trees was accounted by the available technique [4]. Table 6 shows the efficiency evaluation of Imidor and Tanrek against beech blight aphid *Glyphina betulae*).

Tanrek and Imidor applied against beech blight aphids demonstrated 100% biological efficiency. For all scenarios their biological efficicncy can be comparable to the reference preparation, i.e. Aktara, which is recommended by the State Register of plant-protecting agents as a forest pest control agent.

Table 4

Biological efficiency of preparations against the pine bark bug

Testing scenario	Bug population, ind./dm^2			Biological efficiency (mortality), %		
	before treatment	after treatment		3rd day	7th day	
		3rd day	7th day		total	corrected
Reference area (no insecticide applied)	0.53	0.38	0.44	28.3	17.0	–
Aktara, VDG (reference preparation), 0.4 l/ha	1.15	0.78	0.75	32.2	35.1	21.8
Imidor, BPK, 0.5 l/ha	0.47	0.15	0.12	68.1	75.0	69.9
Imidor, BPK, 0.8 l/ha	0.33	0.09	0.04	72.7	87.5	84.9
Tanrek, BPK, 0.5 l/ha	1.44	0.43	0.34	70.1	764	71.6

Table 5

Biological efficiency of preparations against the large pine aphid

Testing scenario	Aphid population per 1 m of shoot, ind.			Biological efficiency (mortality), %		
	before treatment	after treatment		3rd day	7th day	
		3rd day	7th day		total	corrected
Reference area (no insecticide applied)	71.2	69.8	64.6	2.0	9.3	–
Aktara, VDG (reference preparation), 0.4 l/ha	64.0	4.8	14	92.5	97.8	97.6
Imidor, BPK, 0.5 l/ha	68.4	1.2	0	98.2	100.0	100.0
Imidor, BPK, 0.8 l/ha	76.6	0	0	100.0	100.0	100.0
Tanrek, BPK, 0.5 l/ha	802	2.0	0	97.4	100.0	100.0

Table 6

Biological efficiency of preparations against the beech blight aphid

Testing scenario	Aphid population per 2 m of branch, ind.			Biological efficiency (mortality), %		
	Before treatment	after treatment		3rd day	7th day	
		3rd day	7th day		total	corrected
Reference area (no insecticide applied)	56.2	57.4	52.2	–	7.1	–
Aktara, VDG (reference preparation), 0.4 l/ha	48.8	1.2	0	97.4	100.0	100.0
Imidor, BPK, 0.5 l/ha	46.4	1.6	0	96.5	100.0	100.0
Imidor, BPK, 0.8 l/ha	42.2	0	0	100.0	100.0	100.0
Tanrek, BPK, 0.5 l/ha	52.6	1.3	0	97.5	100.0	100.0

Conclusion. Application of Imidor BPK insecticide resulted in reduced damage intensity of pine plantations (protective effect) by the shoot moth, the rate of Imidor application being 0.5 l/ha (by 77.8%), 0.8 l/ha (100%). Biological efficiency against sucking pests (the pine bark bug) was 69.9% on the 7th day (corrected) for Imidor, 0.5 l/ha, 84.9% – for Imidor, 0.8 l/ha. Imidor proved to be 100% efficient against the aphids attacking pine plantations. Besides its efficiency is higher than that of the reference preparation Aktara, which is recommended by the State Register of plant-protecting agents as a forest pest control agent.

Application of Imidor, BPK insecticide against the aphids showed 100% biological efficiency in deciduous plantations. For all scenarios the biological efficiency of Imidor is quite comparable to that of the recommended Aktara.

Application of Tanrek, BPK (rate of application being 0.4 l/ha) resulted in reduced damage intensity (protective effect) in coniferous plantations attacked by the shoot moth (79.3%). Biological efficiency of Tanrek, 0.5 l/ha against bugs was 71.6%. Application of Tanrek, 0.4 l/ha against aphids showed 100% biological efficiency. Thus, its efficiency is even slightly higher than that of the reference preparation, i.e. Aktara.

The reporting documents on testing of Imidor, BPK and Tanrek, BPK insecticides were communicated to related companies for their registration and inclusion in the State Register of plant-protecting agents.

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