Rational nature management of urban flora in urban floristry

M A Dogadina and N I Botuz
Orel State Agrarian University named after N V Parakhin, 69, General Rodin Str.,
Orel, 302019, Russia

E-mail: marinadogadina@yandex.ru

Abstract. Recently rational nature management of the urban flora in the sphere of the influence of anthropogenic factor on the life state of plants has become one of the urgent problems of the environmental protection. The urban flora used in urban floristry should include the adapted species resistant to abiotic and biotic stress factors, as well as to damage by entomological and phytopathological agents. The assessment of flowering shrubs-introducents and native species in the urban environment of the city of Orel allowed us to rank the plantings of general and limited use and plantings for special purpose according to their life state for the tolerance to stress factors. The promising species for the urban floristry are: Berberis thunbergii, Chaenomeles japonica, Lonicera caprifolium, Physocarpus opulifolius, Philadelphia coronaries, Sorbaria Sorbifolia, Syringa velutina and Weigela florida.

1. Introduction
In the modern urban greening the leading role belongs to flowering shrubs. In landscape design they are of particular importance due to the high decorative value, sanitizing and sound insulation ability, short juvenile period [1,2,3]. The decorative plants together with shrubs create favorable microclimatic, sanitary and hygienic conditions in the urban environment, reduce stress-emotional state of a person, determine the architectural and artistic look of the city [4,5]. But in the modern urban environment decorative plants are under constant stress of abiotic and biotic factors. The greatest anthropogenic contribution to stress loads belongs to vehicular and industrial pollution. But in the modern urban environment decorative plants are under constant stress of abiotic and biotic factors. The greatest anthropogenic contribution to stress loads belongs to vehicular and industrial pollution. The state of decorative plants in the urban environment is influenced by the quality of artificial soil (lack of nutrition, soil compaction, contamination with toxic substances, lack of soil moisture, temperature conditions, etc.), damage by pests and diseases, unfavorable weather conditions [6,7,8]. As a result of complex negative influence the decorative value, productivity and resistance of decorative plants sharply decreases. The question of assessing the life state of flowering shrubs in the urban environment has become relevant because of the urban growth and reduction of natural plantings [9,10]. The objectives of the study aimed to analyze the life state of flowering shrubs and to assess the damage of flowering shrubs by entomological and phytopathogenic agents in the urban environment.

2. Material and research methods
The object of the research was flowering shrubs used as additional assortment in the landscape design of urban ecosystems: Thunberg barberry (Berberis thunbergii), blood-red hawthorn (Crataegus sanguinea),
flowering weigela (Weigela florida), bigleaf hydrangea (Hydrangea macrophylla), goat-leaf honeysuckle (Lonicera caprifolium), prairie weed (Potentilla fruticosa), Oregon grape (Mahonia aquifolium), common almonds (Prunus dulcis), dwarf ninebark (Physocarpus opulifolius), Ural false spiraea (Sorbaria Sorbifolia), common lilac (Syringa vulgaris), Hungarian lilac (Syringa josikaea), velvet lilac (Syringa velutina), Bumald Spiraea (Spiraea bumalda), philadelphus coronarius (Philadelphus coronarius), dwarf Japanese quince (Chaenomeles japonica).

For the description of shrubs in the urban environment, the generally accepted methodology developed by V. A. Alekseev (1990) was used [11], according to which the assessment is done on a five-point scale. The five-point scale of the assessment of shrubs: 1 - healthy shrubs (no signs of disease and damage by pests); without mechanical damage, have normal development, foliose, with normal color and size of leaves; 2 - damaged (sick) plant. Shrubs with signs of slow growth, with wilting branches (up to 10-15%), changing the shape of the crown, damaged by pests; 3 - severely damaged (severely weakened) plant. Shrubs with signs of slow growth, with drying out branches (from 25 to 50%), thin-crowned, crown shape is changed, annual growth reduced by more than half compared to normal; 4 - dying plant. Shrubs are overgrown, weakened (with small leaves, no growth), with drying out crown more than 50%, with signs of diseases and pests; 5a - fresh deadwood. Leaves are sphacelated, withered or fell down too early, crown is sphacelated, but small twigs and bark are preserved; 5b - old deadwood. Leaves fell down, crown is sphacelated, small twigs and part of the branches fell off, bark is damaged or fell down from most of the branches.

Life state index equals \[ \text{LSI} = \frac{100n_1 + 70n_2 + 40n_3 + 5n_4}{N} \] where LSI – life state index of the shrubs; \( n_1 \) – the number of healthy (without signs of weakening) shrubs, \( n_2 \) – weakened, \( n_3 \) – severely weakened, \( n_4 \) – drying out; 100, 70, 40, 5 – coefficients expressing (as %) the relative life state of healthy, weakened, severely weakened and dying shrubs, respectively; \( N \) – the total number of shrubs (including deadwood).

3. Results and their discussion
Some authors [2,9,12] believe that many flowering shrubs are relatively unpretentious and resistant. Ieronova V V (2018), Ibrahimova A H (2016) are of opposite opinion and believe that due to the deterioration of the environmental situation in the past 20-30 years, decorative flowering shrubs have become exposed to various diseases. The susceptibility of flowering shrubs to unfavorable environmental factors and damage by pests should also be taken into consideration. The decrease in the resistance of plants to a complex of unfavorable factors is connected with aggressive conditions of the urban environment for the plants: dust and gas pollution of the atmosphere, pollution of hydro - and pedosphere, processes of halogenesis, a high density of utility devices located in the root zone, imbalance in nutrients, as well as low-quality characteristics of artificial soil, including various construction admixtures, use of the weakly resistant plants in urban greening. It should be noted that the decorative plants used in urban greening are exposed to intense vehicle and industrial pollution because they are located along the roads, to the influence of electric fields of tram and trolleybus lines.

The extensive analysis of flowering shrubs aimed to see the damage by pests and diseases, mechanical damage, their growth and development, decorative value and allowed to rank them and assess their general life state in the urban environment (table 1).

**Table 1.** Analysis of the life state of flowering shrubs in the urban environment (the city of Orel as an example).

| Species                | Ranking of shrubs according to the assessment of life state, % of the number of plantings | Life state index, % |
|------------------------|-------------------------------------------------------------------------------------------|---------------------|
|                        |                                                                                           | Score               |
|                        |                                                                                           | 1 | 2 | 3 | 4 | 5a/5b |
| Berberis thunbergii    |                                                                                           | a+ | a1 | a+ | a1 | a+ | a+ | a1 | a+ | a1 |
| Chaenomeles japonica   |                                                                                           | 71 | 65 | 27 | 27 | 2  | 6  | 0  | 0  | 92 | 83 |
|                        |                                                                                           | 63 | 51 | 31 | 35 | 4  | 7  | 2  | 6  | 1  | 79 | 65 |
The data in table 1 show the response of flowering shrubs growing in the urban ecosystem to the complex technogenic impact of aggressive factors of a modern city. In plantings for special purpose (plantings along roads, highways) the decorative value and resistance of plants can be decreased. The most sensitive to extreme technogenic conditions were: Hydrangea macrophylla, Mahonia aquifolium, Potentilla fruticosa, Prunus dulcis, Spiraea bumalda and Syringa vulgaris.

In recent years, the species composition of pests has varied, the harmfulness of phytophages, which previously had no significant value, has increased. The emergence of new native species and their spread is connected with long-term multi-species plantings, enabling the formation, reproduction, spread and accumulation of phytophages population; lack of measures for the formation of plantings in the urban environment; decrease of plant resistance under the influence of anthropogenic factors; disruption of ecological balance of urban ecosystems (table 2).

**Table 2. Damaging to flowering shrubs by pests.**

| Phytophagous / damaged organ | Syringa vulgaris | Syringa josikaeae | Syringa velutina | Spiraea bumalda | Philadelphia coronarius |
|-----------------------------|-----------------|-----------------|-----------------|----------------|------------------------|
| Aphis spiraepapha L.        | 0,2             | 0,5             | 0,7             | 3,1            | 2,9                    |
| leaves, shoots, pedicles    |                 |                 |                 |                |                        |
| Archips rosana L.           | 0               | 0               | 0               | 1,1            | 0                      |
| leaves                      |                 |                 |                 |                |                        |
| Agromyza spiracae L.        | 0               | 0               | 0               | 0,3            | 0                      |
| leaves                      |                 |                 |                 |                |                        |
| Edwardsiana rosei L.        | 1,9             | 1,8             | 1,2             | 0              | 0                      |
| / leaves                    |                 |                 |                 |                |                        |
| Eriophyes loewi L.          | 0,5             | 1,2             | 0               | 0              | 0                      |
| leaves                      |                 |                 |                 |                |                        |
| Gracilariya syringella L.   | 2,1             | 2,0             | 1,5             | 0              | 0                      |
| leaves                      |                 |                 |                 |                |                        |
| Lepidosaphes ulmi           | 1,9             | 1,7             | 0               | 0              | 0,7                    |
| shoots, trunk, leaves       |                 |                 |                 |                |                        |
| Parthenolecanium corni Bouche | 0,7             | 0,6             | 0,1             | 0              | 0                      |
| leaves, shoots              |                 |                 |                 |                |                        |

a* - plantings of general and limited use (plantings in the streets and at public institutions); 
1 - plantings of the special purpose (plantings along streets, highways).

The assessment was done in plantings of general and limited use, at some distance from highways (350-700m) and plantings of special purpose (mainly roadside plantings).
The studies show that plantings of flowering shrubs were significantly damaged by the sucking pests: Aphis spirae phaga, Hercinothris femoralis and Tetranychus urticae, the score of damage is from 2.1 to 3.5. The sucking pests are the most dangerous as they cause bad decorative value of flowering shrubs, inhibition of their growth, development, physiological state and blossoming, decrease of frost-, thermal and drought resistance, change of their life state. Sucking pests are agents of viral diseases. The weakened plant is more intensively exposed to various stress factors of the urban environment, to a complex of non-infectious and infectious diseases.

Infectious diseases cause a number of factors that enhance their effect in the urban environment: extreme weather conditions, unfavorable soil environments, exposure to toxic gases and solid impurities in the air: tire dust, soot, coal, etc., which when settling on plants, worsen various physiological and biochemical processes. The direct action of pollutants leads to a decrease of the plant resistance as a whole, premature drying of leaves, decrease decorative value and productivity. A weakened plant becomes more susceptible to infection, as a result of indirect effect of pollutants. The non-infectious diseases: necrosis, chlorosis, leaf-roll and the infectious ones: spot, true mildew, downy mildew are common for flowering shrubs which are used in greening the urban environment.

4. Conclusion

The complex analysis of flowering shrubs allowed to assess their life state and identify the most resistant species in conditions of a modern city. The greatest resistance in plantings for special purpose (plantings along roads, highways) can be found in thunbergii Berberis, Chamaemelus japonica, Lonicera caprifolium, Physocarpus opulifolius, Philadelphus coronaries, Sorbaria Sorbifolia, Syringa velutina and Weigela florida, and for general and limited use (plantings in the streets and at public institutions) - Berberis thunbergii, Crataegus sanguinea, Physocarpus opulifolius and Weigela florida.

The phytosanitary examination of the damage of flowering shrubs by entomological and phytopathogenic agents in the urban environment resulted in the following assessment. 23 pests damaging various organs of plants were identified; non-infectious diseases, as well as infectious diseases caused by fungi and viruses were revealed. The dominant phytophages were sucking pests: Aphis spirae phaga, Hercinothris femoralis and Tetranychus urticae; non-infectious diseases are necrosis, chlorosis and leaf-roll diseases: infectious ones are spot, mildew, downy mildew.

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