Assessment of the decorative qualities of species of the genus P**in**us L. in the conditions of the European part of Russia

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Abstract. The paper presents the results of a study of the decorativeness of pines, which are actively grown on the territory of the European part of Russia. Decorativeness is based on the visual perception of plant habitus. The state of the habitus depends on the genotype and adaptive characteristics in certain growing conditions. The study examined 25 decorative features of 56 species. 24 traits were related to vegetative and generative organs. 1 trait was assessed by the method of weight taxonomy as an indicator of originality of all species for 24 traits. Studies have shown that the total score on a 100-point scale of decorativeness in the studied pines varies from 40 in *Pinus heldreichii* Chirst and *Pinus waschoensis* Mason & Stockwell to 68 in *Pinus patula* Schltdl. & Cham. The research results can be applied when choosing species for cultivation on landscaping objects to increase their aesthetic appeal.

1. Introduction

Currently, there is an increasing need for growing woody plants, which are particularly decorative [1, 2], at urban and private landscaping facilities. Representatives of the Pinaceae family are distinguished by special decorative qualities throughout the year [3]. The genus *Pinus* L. includes about 119 species. Currently, many species are particularly popular, which is expressed in the widespread use of species of plants and their varieties. Environmental factors have a huge impact on the development of pine, its appearance, size, decorativeness and durability [4]. Often introduced species and forms are habitually very similar to local species and forms (*P. uncinata* and *P. sylvestris*). These circumstances lead to the need for a comprehensive study of the morphological characters of the species of this genus, which determine the decorative qualities. Determination of the decorative qualities of pines structurizes the idea of decorativeness, and the assessment of the decorative qualities of the species will reveal the most decorative ones for the conditions of the European part of Russia. Thus, the selection of the most ornamental species is one of the components of modern cultivation technologies on landscaping objects [5].

2. Materials and methods

The material for the study was the species of pine trees growing in botanical gardens, arboretums and tree nurseries located in the Central part of Russia: the Dendrariy Park, the Yuzhnye Kultury
Arboretum, the Kuban Subtropical Botanical Garden, located in Sochi, the Arboretum n.a. R.I. Schroeder, Plant nursery "Resony", Nursery for exotic trees "Resinosa", Plant nursery "Evropa Park", Plant nursery "Imperial Garden", Fruit station of RSAU-Moscow Agricultural Academy, GBS RAS n.a. N.V. Tsitsin located in the Moscow region. In total, the work considered 56 species of pine trees according to 25 characteristics, assessed on a point scale, where each state of the characteristic is ranked in accordance with the contribution to decorativeness in ascending order [6].

Crown density is the percentage of free space in the lateral projection of the crown. 3 points – the crown is transparent and more than 60% free from branches; 6 points – a crown of medium density and is 30-59% free from branches; 9 points – the crown is dense and less than 30% free of branches.

Crown architectonics is the degree of difference from the typical crown shape. 3 points – unexpressed, no tiering, typical crown shape, typical branching; 7 points – pronounced, characteristic branching, pronounced tiering, distinct crown [4, 5].

The color of the bark of the trunk is the degree of difference from the most typical manifestation of the trait. 2 points – gray; 4 points – black or brown; 6 points – pinkish, gray-green, reddish.

The structure of the bark is the degree of difference from the most typical manifestation and contribution to decorativeness. 2 points – finely fractured, longitudinally fractured, fractured; 4 points – strongly cracked or smooth; 6 points – deeply longitudinally fractured, longitudinally transversely fractured, smooth.

The contrast in the color of annual shoots is a contrast in comparison with the color of the leaf, emphasizing the architectonics of the crown. 1 point – low contrast: yellow, dirty yellow or yellow-green; 2 points – medium contrast: dirty green, pinkish, gray; 3 points – high contrast: dark red, brown or blackish, as well as pink.

Pubescence of an annual shoot is a sign that determines the presence or absence of pubescence. 0 points – no pubescence; 3 points – pubescence is present to one degree or another.

The color contrast of 2-5 year old shoots is a contrast in comparison with the color of assimilating leaves, emphasizing the architectonics of the crown. 2 points – non-contrasting: light green, yellow-green, yellowish-brown; 4 points – high contrast (brown).

The number of leaves on the brachyblast is the number of assimilating leaves in the shortened shoots. An increase in the number of leaves in brachyblasts increases the decorative effect of the species. 1 point – 2 assimilating sheets; 2 points – 2-3 assimilating leaves; 3 points – 5-8 assimilating leaves.

The color of assimilating leaves in summer and winter may differ. Leaf color in summer is a sign that characterizes the richness of color of assimilating leaves in summer. 1 point – gray-green, dull, unsaturated; 2 points – bright green, herbaceous green, rich green color of the assimilating leaf.

The intensity of leaf color in winter is a sign that characterizes the richness of the color of assimilating leaves in winter. 1 point – gray-green, dull, unsaturated; 3 points – bright green, grassy green.

Color change from summer to winter is a sign that characterizes the degree of color change from summer to winter. 0 points – the color does not change during the year; 2 point – the color changes slightly.

Leaf curl is a sign that determines the presence or absence of curl of assimilating leaves on the brachyblast. 0 points – absent; 1 point – present.

The color quality of cataphylls of annual shoots is an indicator that determines the intensity of the color of scaly leaves on annual growths. 0 points – no cataphill; 1 point – dark gray, dirty gray; 2 points – yellowish, reddish, translucent.

The curvature of the cataphylls of the one-year shoot is a sign that determines the degree of curl of the cataphylls on the annual shoots. 0 points – no cataphill; 1 point – unbent cataphylls; 2 points – bent or twisted cataphylls.

Leaf length (mm) is an indicator that determines the length classes of assimilating leaves. 1 point – <70 mm; 2 points – 70-100 mm; 3 points – >100 mm.

The orientation of the leaves relative to the shoot is the degree of drooping of the assimilating
leaves. 1 point – sticking out leaves; 4 points – hanging leaves.

Pressedness of the scale leaves is the degree of protrusion of the scale leaves. 0 points – pressed; 1 point – protruding.

The contrast of the color of the scale leaves relative to the color of a bud is the degree of difference in the color of the scale leaves relative to the color of the bud itself. 0 points – non-contrasting; 1 point contrasting.

Bud resinification is the degree of bud resinification. 0 points – absent; 1 point – weak, 2 points – strong.

Cone symmetry is an indicator that determines the symmetry of the buds. 0 points – no cones; 1 point – cones are symmetrical; 2 points – cones are asymmetric (unequal).

The size of the cone is a sign showing the length of the cone in mm. 0 points – no cones; 1 point – a cone is less than 100 mm long; 2 points – a cone is not less than 100 mm long.

The intensity of the color of lignified scales is a sign that determines the degree of color intensity of the lignified scales of cones. 0 points – no cones; 1 point – dull, matte; 3 points – brilliant, intense.

Contrast of color of megastrobil relative to leaf color is the degree of contrast of a mature female cone color relative to assimilating leaves. 0 points – no cones; 1 point – low contrast; 2 points strong contrast.

The cone shape is the shape of a mature female cone. 0 points – no cones; 1 point – cones are oval or round; 2 points – cylindrical cones.

Originality is an indicator obtained on the basis of Smirnov’s taxonomic analysis of pine species according to the totality of the considered decorative features. The obtained values of the coefficients are allocated to the classes of originality, where 4 points (0.5430-0.8430) get non-original species, 8 points (0.8431-1.1431) get poorly original species, 12 points (1.1432-1.4432) get those with average originality, 16 points (1.4433-1.7433) get original species, 20 points (1.7434-2.0434) get very original species [7].

3. Determination of decorativeness of species in a hundred-point scale

Evaluation of the decorativeness of 56 species of pines based on 25 features determined the most decorative ones. As a result of the assessment for the complex of decorative features according to Table 1, it was revealed that the total decorativeness score varies from 40 (Pinus leucodermis and Pinus waschoensis) to 68 (Pinus patula). The highest scores determine the potential for growing in landscaping objects.

| No. | Species                   | Decorativeness points | Originality | Total decorativeness points |
|-----|--------------------------|-----------------------|-------------|-----------------------------|
| 1   | Pinus leucodermis        | 36                    | 4           | 40                          |
| 2   | Pinus waschoensis        | 36                    | 4           | 40                          |
| 3   | Pinus hartwegii          | 38                    | 4           | 42                          |
| 4   | Pinus sabiniana          | 38                    | 4           | 42                          |
| 5   | Pinus taeda              | 38                    | 4           | 42                          |
| 6   | Pinus durangensis        | 39                    | 4           | 43                          |
| 7   | Pinus strobus            | 36                    | 8           | 44                          |
| 8   | Pinus tabulaeformis var. mukdensis | 40                  | 4           | 44                          |
| 9   | Pinus thunbergiana       | 40                    | 4           | 44                          |
| 10  | Pinus arizonica var. cooperi | 41                | 4           | 45                          |
| 11  | Pinus resinosa           | 41                    | 4           | 45                          |
| 12  | Pinus brutia var. pendulifolia | 42                | 4           | 46                          |
| No. | Species                                | Num. | Age | Zone |
|-----|----------------------------------------|------|-----|------|
| 13  | Pinus elliottii                        | 42   | 4   | 46   |
| 14  | Pinus muricata                         | 38   | 8   | 46   |
| 15  | **Pinus nigra ssp. nigra**             | 42   | 4   | 46   |
| 16  | Pinus densiflora                       | 43   | 4   | 47   |
| 17  | Pinus halepensis                       | 43   | 4   | 47   |
| 18  | Pinus massoniana                       | 43   | 4   | 47   |
| 19  | Pinus uncinata                         | 39   | 8   | 47   |
| 20  | Pinus rigida                           | 36   | 12  | 48   |
| 21  | **Pinus brutia var. pityusa**          | 45   | 4   | 49   |
| 22  | Pinus leiophylla                       | 41   | 8   | 49   |
| 23  | **Pinus nigra ssp. nigra var. pallasiana** | 45   | 4   | 49   |
| 24  | Pinus echinata                         | 46   | 4   | 50   |
| 25  | Pinus parviflora                       | 46   | 4   | 50   |
| 26  | Pinus radiata                          | 42   | 8   | 50   |
| 27  | Pinus gerardiana                       | 47   | 4   | 51   |
| 28  | Pinus armandii                         | 44   | 8   | 52   |
| 29  | Pinus attenuata                        | 44   | 8   | 52   |
| 30  | Pinus jeffreyi                         | 44   | 8   | 52   |
| 31  | Pinus ponderosa                        | 40   | 12  | 52   |
| 32  | Pinus sylvestris                       | 40   | 12  | 52   |
| 33  | Pinus wallichiana                      | 44   | 8   | 52   |
| 34  | **Pinus mugo ssp. Mughus**             | 45   | 8   | 53   |
| 35  | Pinus pinea                            | 49   | 4   | 53   |
| 36  | Pinus banksiana                        | 39   | 16  | 55   |
| 37  | Pinus contorta                         | 43   | 12  | 55   |
| 38  | Pinus devoniana                        | 51   | 4   | 55   |
| 39  | Pinus pinaster                         | 51   | 4   | 55   |
| 40  | Pinus strobusiformis                   | 35   | 20  | 55   |
| 41  | Pinus roxburghii                       | 48   | 8   | 56   |
| 42  | Pinus cembra                           | 45   | 12  | 57   |
| 43  | Pinus coulteri                         | 37   | 20  | 57   |
| 44  | Pinus montezumae                       | 49   | 8   | 57   |
| 45  | Pinus bungeana                         | 51   | 8   | 59   |
| 46  | Pinus koraiensis                       | 47   | 12  | 59   |
| 47  | **Pinus mugo ssp. pumilio**            | 51   | 8   | 59   |
| 48  | Pinus peuce                            | 47   | 12  | 59   |
| 49  | Pinus canariensis                      | 52   | 8   | 60   |
| 50  | Pinus sibirica                         | 48   | 12  | 60   |
| 51  | Pinus ayacahuike                       | 50   | 12  | 62   |
| 52  | Pinus flexilis                         | 42   | 20  | 62   |
| 53  | Pinus palustris                        | 46   | 16  | 62   |
| 54  | Pinus pumila                           | 46   | 16  | 62   |
| 55  | Pinus oocarpa                          | 48   | 20  | 67   |
| 56  | Pinus patula                           | 56   | 12  | 68   |
The main reason for the low decorativeness of species is their uniformity of habitus, while in garden forms, decorativeness is much higher (decorative forms are not presented in this work). The indicator of decorativeness in some cases has become a subjective way of assessing the overall decorativeness, since some species lack the ability to form female cones, which gives rare modalities. Hence the high originality of some species (*Pinus oocarpa*). It should be noted that the decorativeness of the species was assessed in various climatic zones. When selecting species, it is necessary to consider them in the most characteristic growing conditions.

4. Conclusion

Having carried out a study of the decorative qualities of pines cultivated in the European part of Russia, it was found that species plants did not get the maximum points of decorativeness, which suggests the uniformity of the habitus of species plants. Nevertheless, among all the considered species, the greatest decorativeness was found in *Pinus oocarpa* and *Pinus patula*, which amounted to 67 and 68 points, respectively. Due to some subjectivity of the method, some species (*Pinus oocarpa*) had overestimated decorative scores. The smallest decorativeness score was found in *Pinus leucodermis* and *Pinus waschoensis*. Thus, when selecting species for cultivation on landscaping objects in these climatic conditions, it is possible to use the results of a point assessment of decorativeness.

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