On the state of the ground cover of shaded areas in urban landscaping objects

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Abstract. It has been established that in municipal forestry of Stavropol (streets, squares, boulevards, parks) mixed plantations of broad-leaved tree species *Tilia cordata* Mill., *Acer pseudoplatanus* L., *A. platanoides* L., *Aesculus hippocastanum* L., *Fraxinus excelsior* L., *Quercus robur* L., prevail, which increases the shading conditions for lawns arranged under their canopy. With sparse and single-row planting of trees, lawn grass is in conditions of temporary shading and does not significantly suffer (lawns of good and satisfactory quality). In places with multi-row and group placement of tree plantations, the grass of lawns is in conditions of both temporary and permanent shading and is thinned up to 40–60 %, the relative amount of sunlight (RAS) is 2.1–9.2 % (mediocre and poor lawns). In conditions of constant intensive shading with a RAS of 0.6–2.6 %, turf grasses completely fall out, a dead cover forms, which reduces the quality of greening. Usually sparse grass are sown with fast-growing turf grasses annually. The issue of turfing of the shaded areas of parks with local forest grasses *Brachypodium sylvaticum* (Huds.) P. Beauv., *Dactylis polygama* Horvat., *Festuca gigantea* (L.) Vill., *Poa nemoralis* L. (RAS 2.1–5.8 %) and sedge *Carex divulsa* Stokes, (RAS 1.0–4.2 %) and the conservation of forest herbaceous cenoses is discussed. In shady parks, the use of ground cover introduced species *Vinca minor* L., *Hedera helix* L., and the herbaceous perennial *Helleborus caucasicus* A. Braun (RAS 1.2–7.4 %) is promising.

1. Introduction

Every year the need for improving the urban ecology and the quality of municipal forestry increases. One of the problems of planting greenery is the lack of an assortment of plants for creating a ground cover in areas shaded by tree crowns. Lawn grasses used for these purposes are often gradually thinned out, lose their decorative effect, and in the case of strong shading they fall out, forming dead coverings [1]. In accordance with the gradient of solar radiation, a significant proportion of PAR (photosynthetically active radiation) is absorbed by the leaves of the crown and it reaches the plants of the ground cover not only weakened, but also strongly depleted in terms of the most valuable rays for plants. The light changes its spectral composition: it is depleted in blue (BL) and red rays (RL) and enriched in green (GL) and far red rays (FRL). In the shade, the RL/FRL and BL/GL ratios also decrease. Shaded plants undergo a number of physiological and morphological changes [2–4]. In ornamental horticulture in many countries of Western and Eastern Europe, North America, ground cover plants from the local flora are widely used to create ground coverings in shading conditions – dwarf creeping herbaceous and shrub species – heathers, periwinkle, Mahonia, campanula. Regular work on introducing forest perennials to gardens and parks for landscaping shady areas began in Russia in the second half of the 19th century by E. Regel. Collections of such plants are available in the botanical gardens of St. Petersburg, Moscow, Yalta, Kirov, Tomsk, Vladivostok [5, 6].

The purpose of the study was to investigate the light regime of the ground vegetation cover of the...
territories of urban forestry shaded by tree crowns. Assessment of the influence of light conditions on the quality indicators of the herbage of lawn grasses in situ. Characteristics of natural vegetation cover adapted to shading conditions; local species, sciophytes, growing in the conditions of city parks. Study of the assortment of plant species that are promising for the creation of ground coverings in the shaded areas of urban forestry.

2. Methods and Equipment

Parks (Central, Aleksandrovskii) were studied as objects of planting greenery; squares (Teatralnyi, In Memory of Fellow Countrymen Who Died in Battles During the Performance of Military Duty, square next to Lyceum No. 8); boulevard named after Ermolov; streets (Mira, Lenina) of Stavropol (300–660 m above sea level; III soil-climatic zone of unstable moisture; GTK = 1.00–1.09; \(\Sigma t^\circ >10 \, ^\circ C = 3300–3650 \, ^\circ C\); soil – leached degraded chernozem; average annual precipitation 720 mm, average annual temperature +7.5 \(^\circ C\); coldest month – January –4.9 \(^\circ C\); warmest month – July 19.6 \(^\circ C\); absolute temperature minimum –31 \(^\circ C\), absolute maximum + 37 \(^\circ C\)). The counts of the natural vegetation of the parks were carried out on 100 m² plots indicating the abundance of species according to the Brown-Blanquet scale, in three to five replicates. The quality of lawn grass herbage was assessed using a comprehensive 30-point scale [7]. Parallel measurements of the illumination value on the surface of lawns and ground plants in shaded conditions and in unshaded areas during the summer months were carried out using a TKA-LUX light meter, only in clear weather at 8, 13 and 17 hours. The illumination in a given place, expressed as a percentage of the total amount of light coming from outside, was taken as the value of the relative amount of sunlight (RAS). The introduction research was carried out in the Stavropol Botanical Garden.

3. Results

In objects of urban greenery such as streets, parks, squares, boulevards, lawns are most often sown with perennial turf-forming grasses *Poa pratensis* L., *Lolium perenne* L., *Festuca rubra* L., *F. ovina* L., *F. arundinacea* Schreb. In open, unshaded areas, these turf formers form high-quality, highly decorative long-lived lawn coverings, assessed as excellent and good quality herbage. However, finding themselves under the crowns of growing tree plantations under conditions of varying degrees of intensity and duration of shading, these heliophyte grasses gradually thin out, lose their decorative effect, and in conditions of strong shading they fall out, forming dead soil cover areas. Permanent shading has a depressing effect on the formation of leaves of lawn grasses, leads to a slowdown in the maturation of axillary buds, a decrease in the mass of aboveground and underground organs, and a sharp weakening of the tillering process. Leaves become short and thin, generative shoots are not formed, plants die within one or two growing seasons.

Our studies have shown that the lawns of city landscaping objects in conditions of periodic shading and relative amount of sunlight (RAS) – 2.1–9.2 %, during daylight hours had a projective cover of 40–70 %, which corresponds to the assessment – lawn of mediocre quality. With RAS of 2.2–6.5 % and permanent shading conditions, there is a strong thinning of lawns, their projective cover decreases to 20–50 % (lawns of poor quality), and in particularly shaded conditions (RAS 0.6–2.6 %) the plants completely dropped out.

The shading conditions of terrestrial herbage are influenced by tree species: the crowns of broad-leaved species and gymnosperms with dense needles give more intense shade than small-leaved ones. The amount of shading also depends on the planting density, the age of the trees, the degree of development, the height of the location and the transparency of their crowns, the time of shading of herbage during daylight hours.
Table 1. Average indicators of illumination of shaded ground coverings of urban landscaping objects for June–August 2019; RAS %

| Landscaping object                              | Ground vegetation          | Projective cover, % | Measurement time, RAS, % |
|------------------------------------------------|----------------------------|---------------------|--------------------------|
|                                                 |                            |                     | 8 h | 13 h | 17 h |
| Central Park                                    | forest grass               | 30–80               | 2.8–4.9 | 2.6–5.8 | 2.1–3.5 |
|                                                 | dead soil cover            | 0.0                 | 0.9–1.3 | 0.8–1.1 | 1.1–1.6 |
| Aleksandrovskii Park                           | forest species             | 60–100              | 2.9–3.6 | 2.6–8.5 | 1.8–5.5 |
|                                                 | sedge                      | 60–90               | 2.8–4.2 | 1.8–3.9 | 1.0–1.4 |
| Ermolov Boulevard                               | dead soil cover            | 0.0                 | 0.7–1.2 | 1.1–1.4 | 1.0–1.1 |
|                                                 | decorative lawns           | 40–60               | 2.7–6.8 | 3.2–4.6 | 3.6–9.2 |
| Teatralnyi Square                               | decorative lawns           | 0–20                | 0.9–2.5 | 0.8–1.3 | 1.2–1.6 |
|                                                 |                            | 40–60               | 3.5–8.2 | 3.6–5.9 | 4.1–7.9 |
| Square “In Memory of Fellow Countrymen Who Died in Battles During the Performance of Military Duty” | decorative lawns           | 0–20                | 1.0–1.3 | 0.9–1.4 | 0.9–1.1 |
|                                                 |                            | 40–70               | 2.1–4.3 | 58.6–81.4 | 2.3–6.5 |
| Square next to Lyceum No. 8                    | decorative lawns           | 0–20                | 1.1–1.5 | 1.4–1.9 | 1.1–1.2 |
|                                                 |                            | 60–80               | 6.5–11.9 | 8.9–17.5 | 4.2–9.6 |
| Mira St.                                        | decorative lawns           | 0–20                | 1.9–2.3 | 1.9–2.4 | 2.0–2.8 |
|                                                 |                            | 40–60               | 3.8–6.9 | 4.2–7.7 | 4.2–9.1 |
| Lenina St.                                      | decorative lawns           | 0–20                | 1.1–1.7 | 1.8–2.4 | 1.2–2.0 |
|                                                 |                            | 40–60               | 4.3–7.2 | 5.1–8.3 | 3.8–7.0 |

The investigated lawns on Mira Street, one of the longest in the city, are in different conditions of shading by single-row and double-row plantations of mixed species of tree species: small-leaved linden (*Tilia cordata* Mill.), common ash (*Fraxinus excelsior* L.), sycamor maple (*Acer pseudoplatanus* L.), Norway maple (*A. platanoides* L.), silver birch (*Betula pendula* Roth), Scots pine (*Pinus sylvestris* L.), horse chestnut (*Aesculus hippocastanum* L.). In open, not occupied by tree plantations and weakly shaded areas, lawns have 80-100 % coverage, their condition corresponds to the assessment – lawns of good and satisfactory quality. Lawns located in single-row tree plantations of broad-leaved species with a closed crown, in some places, have a projective cover (40–60 %) – lawns of mediocre quality. Congested crowns of multi-row tree plantations of broad-leaved species (horse chestnut, maple species, dense plantings of lindens) in some areas form highly thinned lawns and dead covers. A number of areas on the south side of the street receive additional shading in the daytime from adjacent multi-storey buildings.

On the parallel Lenina Street, single-row and multi-row mixed stands of English oak (*Quercus robur* L.), *Aesculus hippocastanum*, eastern cottonwood (*Populus deltoides* Marsh.), *Tilia cordata*, *Betula pendula*, *Fraxinus excelsior*, *Acer pseudoplatanus*, *A. platanoides*, *Pinus sylvestris*, European spruce (*Picea abies* (L.) Karst.). Most of the unshaded and lightly shaded lawns meet the rating – “lawn of satisfactory quality”. Moderate shading was noted under the crowns of single-row plantations of honey locust (*Gleditsia triacanthos* L.). There are a lot of low-quality lawns outside with permanent moderate and intense shading by crowns of *Tilia cordata*, *Quercus robur*, *Aesculus hippocastanum*, *Acer pseudoplatanus*, *A. platanoides*; in some places dead soil cover areas are formed here. The herbage of the lawns of the central streets of the city is regularly repaired and sown.

Thinned lawns and dead soil cover areas were marked under the crowns of mixed tree plantations over 35 years old, in the park “In Memory of Fellow Countrymen Who Died in Combat While Performing Military Duty”. A closed canopy is formed by crowns of *Tilia cordata*, *Acer platanoides*, *A. pseudoplatanus*, *Aesculus hippocastanum*, *Betula pendula*, *Quercus robur*, which are arranged in groups or rows. In spring, in the period before foliation of crowns (until mid-May), on sparse, shaded lawns, an ephemeral synusia of bulbous bluegrass (*Poa bulbosa* L.) with a projective cover of 20–60 % was noted, ending the growing season by the end of May. In lawns with a projective cover of 40–60 % (lawn of poor quality), invasive intrusions of medicinal dandelion (*Taraxacum officinale* Wigg.) occur.
In “Teatralnyi Square”, founded in 1960–1965, tree plantations of 32 species and garden forms are placed in mixed groups and alleys – robinia pseudoacacia L., red oak (Quercus rubra), Q. robur, yellow catalpa (Catalpa ovata G. Don), sycamore maple ‘Purpurascens’ (Acer pseudoplatanus ‘Purpurascens’), silver maple (A. saccharinum L.), A. platanoides, Betula pendula, Aesculus hippocastanum, Picea abies, blue spruce (P. pungens Engelm.), Douglas fir (Pseudotsuga menziesii (Mirb.) Franco), European larch (Larix decidula Mill.), Caucasian fir (Abies nordmanniana (Stev.) Sprach). Lawns located in conditions of moderate or temporary shading have a projective cover of 40–70 %. Under the crowns with constant shading conditions (RAS – 0.9–2.5 %), there are dead-cover areas. The lawns are carefully looked after, with regular additional sowing.

In the square near the Lyceum No. 8, tree plantations are arranged in the form of alley and group plantings, their age is more than 40 years. Under the closed canopy of the avenue plantings of Aesculus hippocastanum, under conditions of constant shading (RAS 1.1–1.9 %), lawn plants practically dropped out (projective cover 0–10 %). In the group Betula pendula, Acer saccharinum (RAS 8.9–17.5 %), herbage of Poa pratensis + Festuca arundinacea, has a coverage of 60–80 % (lawn of satisfactory quality). In the group Salix alba L., Tilia cordata, Pinus sylvestris, the projective lawn coverage is 40–60 % (lawn of mediocre quality).

Boulevard named after Ermolov is the oldest artificial green area, which first appeared on the city plan in 1854. Its length is 1700 m. The main tree-forming plantations of the boulevard are the chestnut Aesculus hippocastanum (793), Robinia pseudoacacia (125), Fraxinus excelsior (102). Acer species (93), Tilia species (92) and Quercus robur (63) (age 40–60 and more). The prevalence of broad-leaved species practically throughout the entire length of the boulevard determines the light regime of its lawn covers. The overwhelming majority of lawn areas adjacent to the central sidewalk are in shade conditions and have a projective coverage of 40–60 % (lawns of mediocre quality), closed herbage of lawns is preserved mainly on the outer, illuminated sides of the boulevard, facing the highway on both sides. In the upper central extended part of the boulevard, there are vast areas with permanent shading during daylight hours and throughout the summer period by closed crowns of Aesculus hippocastanum with an extremely low relative amount of sunlight – 0.7–1.4 %. Dead soil cover territories have formed here. Additional seeding of lawn grasses gradually die out during the period of complete foliation of crowns.

The territory of the Central Park of Stavropol (12.5 hectares), founded more than 150 years ago, in the past was a part of a natural forest. Until now, old-growth specimens of Quercus robur, sessile oak (Q. petrea L. ex Liebl.), Fraxinus excelsior, field maple (Acer campestre L.) have been preserved here. Later, the plantings were replenished with regular alleys and group plantings of Aesculus hippocastanum, Tilia caucasica, Acer platanoides, A. pseudoplatanus, Betula pendula, Populus deltoides, Picea abies (L.) Karsten, Abies nordmanniana (Stev.) Sprach, L., Pinus sylvestris L. The studies carried out have shown that parterre and ordinary lawns of good and satisfactory quality are arranged in unshaded areas. A significant part of the park's territory is shaded, and closed ground covers are formed here only in the spring, during the period before the complete foliation of tree crowns, when ephemeral, forest and forest fringe species form multi-species herbages. Ephemeraloid species are photophilous perennial herbaceous plants with a short growing season and long dormancy. By the time the foliage on the trees fully develops, they complete the growing season and lose the aboveground part, and they experience the period of summer dormancy in the form of underground organs – bulbs, tubers, rhizomes. Ephemeraloids are part of the temporary spring grass stand as independent thickets of certain species – hollow root (Corydalis marshalliana (Pall. ex Willd.), fumewort (C. caucasica DC.), lesser celandine (Ficaria calthifolia Reichenb.), Poa bulbosa, Black Sea toothwort (Dentaria quinquefolia Bieb.), so they can be included in the herbage of forest grasses. When examining natural herbage on 04. 26 2019, thickets of Corydalis caucasica with an area of more than 100 m² and smaller herbage of Ficaria calthifolia and Dentaria quinquefolia with a projective cover of 100 % (RAS 4.3–6.8 % at 13 o'clock) were noted. In areas with variable illumination conditions (RAS 5.1–8.9 %), multi-species herbages with the participation of ephemeral, forest, weed species with 70–100 % coverage grow. The number of species per 100m² is 8–17. Later, until
the end of the growing season, thinned herbages of forest grasses *Dactylis polygama* Horvat (*Dactylis glomerat ssp.polygama* (Horvat.) Domin) and *Brachypodium sylvaticum* (Huds.) P. Beauv., *Festuca gigantea* (L.) Vill. *Poa nemoralis* L remain in shaded areas of the park, from which the herbages *Dactylis polygama + Viola odorata* L. + *Festuca gigantea* are formed, with a projective cover of 30–60%; *Dactylis polygama + Brachipodium sylvaticum* – 40–60%; *Brachipodium sylvaticum + Lamium album* – 60–80% (RAS 2.8–6.4). The territories of the park which are permanently shaded have dead soil cover.

Table 2. Species composition of the soil cover of Central Park, April 2019

| Виды                | Abundance of species | Species                        | Abundance of species |
|---------------------|----------------------|--------------------------------|----------------------|
| *Dactylis polygama*| 3                    | *Stellaria media* (L.) Vill.   | 2                    |
| *Poa bulbosa*      | 2–3                  | *Festuca gigantea*             | r-2                  |
| *Brachypodium sylvaticum* | 2–3               | *Carex*, *аош*                | r-2                  |
| *Ficaria calthifolia* | 2–3               | *Veronica hederifolia* L.      | r-2                  |
| *Taraxacum officinale* | 2–3             | *V. filiformis* Smith          | r-2                  |
| *Trifolium repens* L.* | 2–(3)          | *Alliaria petiolata* (Bieb.)   | r-2                  |
| *Scilla sibirica* Haw. | 2–3            | *Plantago major* L.            | r-2                  |
| *Geum urbanum* L.  | 2                    | *Trifolium pratense* L.        | r-2                  |
| *Glechoma hederacea* L.* | 2              | *Poa nemoralis*                | r-2                  |
| *Prunella vulgaris* L.* | 2               | *Anemone ranunculoides* L.     | -                    |
| *Viola*, *аош*     | 2                    | *Lamium album* L.              | r-1                  |
| *Dentaria quinquefolia* | 2               | *Ranunculus repens* L.        | r-1                  |

The Aleksandrovskii Park was created on the site of the artificial plantings of *Quercus robur* more than 60 years old, in which a small amount of *Fraxinus excelsior* penetrated. The ground cover of the park receives more light and therefore a closed herbage of forest species has formed here. In more shaded places (RAS 1.2–4.2%), continuous thickets are formed by gray sedge (*Carex divulsa* Stokes, with a projective cover of 60–95%) and common violet (*Viola odorata* L.), in more clarified ones (RAS 1, 8–8.5%) *Brachypodium sylvaticum* dominates in the herbage of which *Dactylis polygama*, *Festuca gigantea* (L.) Vill., *Poa nemoralis* L., *Rubus caesius* L., *Anthriscus cerefolium* (L.) Hoffm., *Chaerophyllum bulbosum* L. *Lamium album*, *Stellaria media*, *Geum urbanum*, *Calystegia silvatica* (Kit.) Griseb. occur, (per 100 m² – 10–16 species, projective cover – 50–95%).

There is no special range for the shaded areas of our region, except for grass mixtures for lawns with the participation of *Festuca rubra* varieties up to 70%. Introduced forbs groundcover species can be used as sources for creating ground cover in highly shaded areas. In the Stavropol Botanical Garden, under the closed canopy of trees of an artificial decorative group of mixed species – *Acer platanoides*, *A. pseudoplatanus*, *A. campestre*, *Pinus sylvestris*, *Betula pendula*, etc. and an artificial oak-ash-hornbeam formation (*Quercus robur*, *Fraxinus excelsior*, *Carpinus betulus* L.), a number of species are cultivated that are promising for the creation of ground covers under shading conditions. For more than 20 years, thickets of lesser periwinkle (*Vinca minor* L.), common ivy (*Hedera helix* L.) and herbaceous perennial of the Caucasian hellebore (*Helleborus caucasicus* A. Braun) have been preserved, self-sustaining and growing, forming low uniform ground covers. These species are sciophytes that thrive in conditions of constant shading throughout the day and the growing season – RAS 1.2–6.4%.

Lesser periwinkle is an evergreen perennial herb (or shrub) with recumbent branchy stems rooting at the nodes with erect flowering stems 15–20 cm and a thin horizontal rhizome. Leaves are opposite, leathery, evergreen 3–5 cm long, 1.5–2 cm wide. Flowering is from 16.04. to 05.05 before foliation of the tree canopy. Flowers are blue, solitary, axillary; self-seeding was not found. The plant actively grows independently as a continuous carpet with an area of more than 2.7 thousand m², thickets with a height of 10–15 cm, with a projective cover of 70–100%.
Common ivy is a perennial shrub with a woody, branched trunk crawling along the ground and climbing trees with sucker-like roots. Leaves are winter green leathery 3–5 angular-lobed. The generative phase is not marked. The projective cover is 70–100 %. 

Caucasian hellebore is a summer-winter-green rhizome herbaceous perennial 40–60 cm high with wintering, leathery basal palmate-dissected leaves 28.7 cm long and 27.4 cm wide. Blooms in March. The flowers are large, up to 8 cm in diameter, collected in groups of 1–3 (5) on a long peduncle, the perianth is simple, yellow-green. Blooms at the age of 4–5 years. The fruits are numerous, the seeds ripen in June and quickly fall off, forming self-seeding. The plant grows until late autumn. The plant can exist for 40–50 years without transplanting. Under conditions of introduction, it forms continuous thickets on an area of more than 800 m$^2$. The projective cover of the herbage is 60–90 %, the number of plants per 1 m$^2$ – 15.2 ± 2.7 (juvenile – 6.1 ± 1.0, young and medium generative – 7.5 ± 1.4, old generative –2. 4 ± 0.4). A large number of seedlings – 67.6 ± 9.8 per 1 m$^2$ indicates that the population is actively supported by self-seeding.

All three species are well adapted to our conditions, drought-resistant, are not affected by diseases and pests, and can be used to create living ground coverings in heavily shaded landscaping objects.

4. Discussion
In landscaping objects with the participation of tree plantations, problems often arise with the creation of optimal amount of sunlight for lawn cover plants, which reduce their decorative effect and quality indicators. Traditionally used lawn grasses Poa pratensis, Lolium perenne, Festuca rubra, F. ovina, F. arundinacea are heliophytes, and under conditions of shading with tree crowns they can thin out and fall out. The tree canopy creates a variety of light shading options for lawn plants – from temporary to permanent ones. Its intensity depends on the species composition, age of trees, planting density; the degree of development, the height of the location and the transparency of their crowns; time of shading the herbage during daylight hours, additional shading by high-rise buildings. On the streets we surveyed, mixed plantations of mainly broad-leaved trees (Tilia cordata, Acer pseudoplatanus, A. platanoides, Aesculus hippocastanum, Betula pendula, Fraxinus excelsior, Quercus robur, Pinus sylvestris) were used. With sparse and single-row plantings, lawn herbage is in conditions of temporary shading and do not suffer significantly (lawns of good and satisfactory quality). In places with multi-row plantings of Aesculus hippocastanum, Acer pseudoplatanus, A. platanoides, Tilia cordata, Quercus robur, coniferous species, herbage can be severely thinned up to 40–60 %, (RAS 2.1–9.2 %, mediocre or poor lawns), the formation of a dead soil cover was noted (RAS 0.6–2.6 %). On areas which are not turf-covered, surface washing off of the soil occurs, deflationary processes increase, leading to dusting of the air, and erosion processes develop. Large dead soil cover areas arose under conditions of constant shading (RAS 1.1–1.6 %) under the closed canopy of Aesculus hippocastanum on Ermolov Boulevard and Central Park (Acer pseudoplatanus, A. platanoides, Aesculus hippocastanum, Tilia cordata, Quercus robur). Lawn grasses additionally sown here usually perish during one growing season. As an option for creating a ground cover in parks with a large shaded area, one can consider natural forest vegetation, which is adapted to grow in shaded conditions. E.g., in the Aleksandrovskii Park, with RAS of 1.8–8.5 %, multi-species forest vegetation grows, up to 10–18 species per 100 m$^2$ with the dominance of grasses Brachypodium sylvaticum, Dactylis polygama, Festuca gigantea, and Carex divulsa sedge (projective cover 60–100 %). Continuous herbage of Carex divulsa are preserved even with RAS 1.0–4.2 %. In the more shaded Central Park in spring, in the period before foliation of tree crowns (RAS 4.3–6.8 %), temporary communities of ephemeroid species Corydalis marschalliana, C. caucasica, Ficaria calthifolia, Poa bulbosa, Dentaria quinquefolia and forest grasses are formed (8–14 species per 100 m$^2$). After foliation of the crowns in less shaded places (RAS 4.3–8.9 %), only Brachypodium sylvaticum, Dactylis polygama, Festuca gigantea remain, with a projective cover of 40–80 %, which are periodically mown.

In the practice of planting greenery, forbs covers are used, consisting of ground cover plants, among which there are many sciophytes. As a result of introduction studies in the Stavropol Botanical Garden, Vincetoxicum minor, Hedera helix, Helleborus caucasicus were studied and evaluated as promising.
These species are sciophytes, they feel great in conditions of constant shading throughout the whole daylight time and the growing season – RAS 1.2–6.8 %, are well adapted to our climate, drought-resistant, are not affected by diseases and pests. They are capable of self-reproduction. They can be used to create living ground covers in highly shaded landscaping objects (parks).

5. Conclusion
In the objects of urban forestry we examined (streets, squares, boulevards, parks), the lawns are in different conditions of shading by the crowns of tree plantations of mixed species with a predominance of broad-leaved species. The tree canopy creates a variety of light shading options for lawn plants – from temporary to permanent ones. In conditions of temporary shading, lawns retain their decorative effect (lawn of good quality), with moderate variable shading lawns have a projective coverage of 40–60 %, RAS 2.1–9.2 % (mediocre or poor lawn). With strong permanent shading (RAS 0.6–2.6 %) lawn grasses almost completely fall out, a dead soil cover forms. The intensity of shading depends on the age, species composition, planting density of tree plantations. To preserve the long-term decorative state of landscaping objects, the species composition of trees should be taken into account when creating them. It is important to consider the conditions for optimal light regime for lawn plants. For broad-leaved and conifers with dense needles, thinned or single-row plantings should be practiced. It is necessary to avoid conditions of permanent shading of lawns during daylight hours. Special grass mixtures for shaded areas with a high proportion of up to 60–70 % of Festuca rubra varieties should be used. In places with a small area of shaded lawns thinning, annual additional sowing of fast-growing grasses is practiced. For turfing the soil cover of shady parks, forest species of grasses, sedges, motley grass, capable of creating low grassy cover can be used. Natural forest and ephemeral communities should be preserved. Sciophytic ground cover introduced plants adapted to local conditions are to be used. Ground cover sciophytes Vinca minor, Hedera helix studied in the Stavropol Botanical Garden, as well as a herbaceous perennial that forms perennial, low, continuous herbagues – Helleborus caucasicus, can be used under conditions of constant shading throughout the day and the growing season (RAS 1.6–6.4 %). They are well adapted to our climate, drought-resistant, are not affected by diseases and pests. They are capable of self-reproduction. They were assessed as promising and can be used to create living ground covers in heavily shaded landscaping objects (parks).

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