The influence of poplar forest belts on agrocenoses in the forest-steppe zone of the Altai Territory

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Abstract. The article considers the influence of protective forest strips forest strips composition and structure of agrocenoses in the forest-steppe zone of the Altai Territory. The territory of the Altai Territory is intensively plowed. Soils are subject to destruction and degradation. The creation of forest belts helps to improve the water regime, increase soil fertility and increase crop productivity. They bind carbon, helping to reduce the greenhouse effect and offsetting industrial carbon dioxide emissions. The role of forest belts in improving the microclimate and reducing wind erosion has been well studied. The changes in the species diversity of weeds and the structure of agrocenoses depending on the structure and species composition of forest belts have not been sufficiently studied. The article presents the results of the study of the influence of poplar forest belts of different designs (2-, 3 - and 4-row) on agrocenoses. The regularities of changes in the height and projective cover of the weed and cultural layer, the composition of weed species, depending on the location of the agrocenosis in relation to the forest belt are revealed. Data on the influence of forest belts of agrophytocenoses located on the southern and northern sides of the forest belt are presented.

1. Introduction
Protective forest belts were created in our country in 1950-1960 to protect against soil erosion, preserve soil fertility and stabilize the productivity of agricultural land in steppe and forest-steppe zones. To optimize the use of agricultural land, the share of protected forest belts should be on average more than 8% of the area of plowed land, and in steppe zones-about 20% [1-3].

In the conditions of steppe and forest-steppe forest belts have a great agroforestry value. Many authors note the positive effect of protective forest belts on improving the microclimate of inter-band fields, increasing snow retention and soil moisture, and reducing the intensity of soil erosion [3-6]. In the conditions of a sharply continental arid climate, protective forest belts help to increase soil fertility, prevent degradation processes and provide an increase in crop yields [7-9]. At the same time, the protective actions of forest belts are better manifested at a distance of more than 50 m from the forest belt [10-11].

Forest belts are the habitat of various species of plants and animals. According to the Kyoto Protocol, they bind carbon, contributing to the reduction of the greenhouse effect and offsetting industrial carbon dioxide emissions [1-2; 10]. Forest belts have recreational and aesthetic functions, enrich the species composition of flora and fauna. Forest belts are the ecological framework of the territory and one of the main regulators of ecosystem stability.

Forest belts allow you to accumulate 1.5–2.5 times more snow compared to open areas, affect the depth of freezing and soil moisture. In the soils located between the forest belts, the density decreases,
the porosity and the humus content increases. The yield of agricultural crops and forage grasses grown in the zone of influence of forest belts is higher by 7–25%, and the highest productivity is characteristic of areas located 30–50 m from the forest belt [11].

The territory of the Altai Territory is intensively plowed. Soils are subject to destruction, such degradation processes as erosion, deflation, and salinization occur and develop on them. The most environmentally friendly and effective way to combat these negative processes is to create protective forest stands. Forest belts occupy a small area, but at the same time perform a number of important functions: regulate the flow from the catchment area, protect agricultural land and settlements from dry winds and dust storms, increase soil fertility [8-9].

In the steppe and forest-steppe conditions of the Altai Territory, increased requirements for their design are imposed on the protective forest strips, which is associated with the intensity of tree fall in them. Forest belts consisting of hanging birch and balsamic poplar with 2-3 rows of trees turned out to be the most effective for protecting the fields [12]. In the dry steppe-it is mainly birch forest belts, and in the arid steppe and forest-steppe-poplar forest belts. When creating forest belts, it is necessary to take into account the soil and hydrological conditions. Poplar forest belts develop better when the ground water is close to 3 m, and birch forest belts-when the ground water is deeper (Paramonov).

The design of protective forest stands is the most important aerodynamic indicator that affects wind permeability and wind speed in the landscape. The wind-protective effect of forest strips increases along with their height. At a distance of 2 planting heights on the windward side, the wind speed is 63.2% of the control wind speed, at a distance of 5 heights–50.0% [12].

According to the design features of the forest belts are divided into openwork, blown and windproof (Pavlovsky). The planting of the blown structure has the best windproof properties and has the most effective effect at a distance of up to 30 heights in the windward direction. The overall effectiveness of the influence of forest belts is about 40 heights. The blown structure is preserved almost throughout the entire period of life by birch and poplar 2-3-row forest belts. With an increase in the width of forest belts, wind permeability decreases, and this process is more intense in poplar forest belts due to the more intense growth of poplar in height and width [13-15].

2. Materials and methods
The aim of our work was to study the influence of poplar forest belts of different designs on the species composition and structure of agrocenoses in the forest-steppe zone of the Altai Territory. The assessment of the influence of poplar forest belts of various designs was carried out on the basis of detailed geobotanical descriptions in forest belts and adjacent agrocenoses.

In total, 10 poplar forest belts of various designs (two-row, three-row and four-row) were investigated. In each forest belt, 5 ecological profiles were laid, within the boundaries of each of which 12 geobotanical descriptions were made (2 – in the forest belt, 5 – from different sides of the forest belt). Sites for geobotanical descriptions were laid every 10 m, and in forest belts communities were described on an area of 400 sq. m, and in agrocenoses - on 100 sq.m. When conducting geobotanical descriptions, we used standard geobotanical methods for studying phytocenoses.

Poplar (Populus balsamifera L.) forest belts in the study area are represented by two-, three-and four-row variants of forest belts. The layering of the stand in all strips remains approximately the same. The degree of crown closure is 70–85%. The age of the poplar varies from 40 to 60 years. There is no shrub layer in poplar forest belts. The grass tier has a projective cover of about 90%. The herbage is dominated by such species as Bromopsis inermis (Leyss.) Holub., Thalictrum simplex L., Convolvulus arvensis L., Agrimonia pilosa Ledeb. et al.

3. Results and Discussion
The total projective cover of the grass stand in agrocenoses is 30–50%. The greatest projective cover is marked at a distance of 20-40 m from the forest belt. The projective cover of the weed layer is on average 5–15%, naturally decreasing at a distance of 30–50 m from the forest belt. The projective
The cover of the cultural layer is 80–95%, the largest projective cover is found at a distance of 30–40 m from the forest belts.

The number of tiers in the grass stands of agrocenoses from the northern and southern expositions of poplar forest belts is not the same and ranges from 2 to 3 tiers. The change in the number of tiers is related to the design features of the forest belts. Double-row poplar forest belts do not affect the tiering of the agrogenosis grass stand. Three-and four-row forest belts, depending on the characteristics of the accumulation of snow cover and, accordingly, changes in the soil moisture regime, contribute, as a rule, to a decrease in the number of tiers in the herbage of agrogenoses located both on the northern and southern sides of the forest belts.

The height of the cultural layer in agrogenoses located along poplar forest belts naturally increases first to a distance of 20–30 m, then decreases again; the highest height of the cultural layer is characteristic of agrogenoses located on the southern side of the forest belts. Design of shelterbelts affects the distance, which is characterized by the maximum height of the cultural layer of agrogenoses: the maximum height of the cultural layer of agricultural lands, located along a double-row poplar shelterbelts, is formed at a distance of 30 m from the shelterbelt; along three-row poplar shelterbelts at a distance of 20 m, along a four-row shelterbelts at a distance of 30–40 m. On the northern side of the forest belt, the highest height of the cultural layer of agrogenoses is marked at a shorter distance from the forest belts compared to the southern side (table 1).

| Indicators                      | Structure of forest belts | Distance from the forest belt on the south side | Distance from the forest belt on the north side |
|--------------------------------|--------------------------|-----------------------------------------------|-----------------------------------------------|
|                                |                          | 10 m  | 20 m  | 30 m  | 40 m  | 50 m  | 10 m  | 20 m  | 30 m  | 40 m  | 50 m  |
| Average height of the cultural tier, sm | 2 inline                | 54    | 58    | 60    | 56    | 52    | 52    | 56    | 55    | 52    | 50    |
|                                 | 3 inline                | 55    | 60    | 58    | 57    | 53    | 50    | 54    | 54    | 50    | 48    |
| Number of weed species, pieces  | 4 inline                | 58    | 60    | 62    | 66    | 62    | 51    | 55    | 60    | 58    | 55    |
|                                 | 2 inline                | 8     | 8     | 6     | 5     | 5     | 6     | 4     | 4     | 3     | 4     |
|                                 | 3 inline                | 7     | 6     | 5     | 3     | 3     | 6     | 5     | 5     | 3     | 3     |
|                                 | 4 inline                | 7     | 5     | 4     | 3     | 3     | 7     | 6     | 6     | 4     | 5     |
| Average height of the weed tier, sm | 2 inline                | 46    | 43    | 43    | 40    | 40    | 47    | 45    | 42    | 42    | 43    |
|                                 | 3 inline                | 44    | 43    | 43    | 43    | 42    | 43    | 43    | 42    | 42    | 42    |
|                                 | 4 inline                | 45    | 44    | 43    | 43    | 42    | 46    | 44    | 44    | 42    | 42    |
| Projective coverage of the cultural tier, % | 2 inline                | 90    | 90    | 95    | 90    | 85    | 95    | 95    | 98    | 98    | 95    |
|                                 | 3 inline                | 95    | 98    | 96    | 95    | 95    | 90    | 90    | 95    | 95    | 90    |
|                                 | 4 inline                | 94    | 96    | 98    | 98    | 95    | 90    | 95    | 95    | 90    | 90    |
| Projective coverage of the weed tier, % | 2 inline                | 18    | 10    | 9     | 5     | 5     | 10    | 8     | 5     | 5     | 4     |
|                                 | 3 inline                | 15    | 12    | 9     | 8     | 6     | 12    | 10    | 9     | 7     | 5     |
|                                 | 4 inline                | 15    | 13    | 14    | 10    | 6     | 15    | 12    | 10    | 6     | 5     |

The average height of the weed layer is not affected by the location of agrogenoses along double-row poplar forest belts. Three-row and four-row poplar forest belts lead to a change in the average height of the weed layer. In the case of a three-row poplar forest belt, the height of the weed layer decreases when moving away from the forest belt, and this process occurs more intensively in agrogenoses located on the northern side. In the case of four-row shelterbelts, weed height tier on the South side of windbreaks up to a distance of 20 m increases, and then decreases; and on the North side of the shelterbelt height Soren layer remains constant.

Among weeds, the most common types are: *Convolvulus arvensis*, *Vicia sepium*, *Cichorium intybus*, *Stachys annua*, *Taraxacum officinale*, *Setaria viridis*, *Panicum miliaceum*, *Convolvulus arvensis*, *Amaranthus albus*, *Fallopia convolvulus* et al.
The number of weed species in agrocenoses located both on the northern and southern sides of all poplar forest belts ranges from 8 to 3, and there is a clear tendency to reduce the species diversity of weeds to 3-4 species at a distance from the forest belt, regardless of the location and design of the forest belt (table 2).

The greatest species diversity of weeds is observed in the agrocenoses located on the southern side of the forest belts. Some weed species prefer agrocenoses located on the southern side of the forest belt (*Chenopodium album*), and some weed species are confined to agrocenoses located on the northern side of the forest belt (*Vicia sepium, Chenopodium album, Berteroa incana, Stachys annua, Fallopia convolvulus, Lactuca tatarica*).

**Table 2.** Occurrence of weed species in agrocenoses.

| Weed species | Location of the agrocenosis | Distance from the forest belt |
|--------------|----------------------------|-------------------------------|
| *Setaria viridis* (L.) Beauv. | south side north side | 10 m 20 m 30 m 40 m 50 m |
| *Convolvulus arvensis* L. | south side north side | + + + + + |
| *Vicia sepium* L. | north side south side | + + + + + |
| *Artemisia vulgaris* L. | south side north side | + + + + + |
| *Cichorium intybus* L. | north side south side | + + + + + |
| *Lactuca tatarica* (L.) C.A. May | south side north side | + |
| *Chenopodium album* L. | south side north side | + + + + + |
| *Taraxacum officinale* Wigg. | south side north side | + + + + + |
| *Berteroa incana* (L.) DC. | south side north side | + + |
| *Fallopia convolvulus* (L.) A. Löve | south side north side | + + + |
| *Stachys annua* (L.) L. | south side north side | + + + |

### 4. Conclusion

Poplar forest belts have a positive effect on the structure of agrocenoses at a distance of up to 30 m from both the southern and northern sides of all forest belts. At a distance of up to 30 m from the forest belt, the average height and the projective cover of the cultural layer increases. When moving away from the forest belt, the average height, the projective cover and the species composition of weeds decreases. The optimal effect on the structure of agrocenoses is exerted by 3-4-row poplar forest belts due to lower windage and greater moisture retention.

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