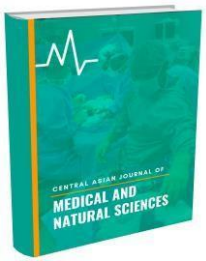

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Article

The Bioecology Of Some Beneficial Plants And The Influence Of Soil Moisture Factors (Case Study Of The Namangan Foothills)

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Abstract: This article presents information on the bioecology of plant species such as Zygophyllum atriplicoides (Fisch. et C.A. Mey.) Boiss., Alcea nudiflora (Lindl.) Boiss., Acanthophyllum albidium Schischk., Onobrychis chorosanica Bunge ex Boiss., Agropyron cristatum (L.) Gaertn., Hordeum bulbosum L., and Poa bulbosa L., which are distributed in the conditions of the Namangan steppe. The article also provides the phenospectrum of these species. In addition, based on measurements of soil moisture fluctuations in accordance with the climatic conditions of the steppes, the effects of soil moisture on the vegetation of these selected species are discussed.

Keywords: Steppe Areas, Vegetation, Bioecology, Phenospectrum, Biological Characteristics, Flowering, Bud Development, Dormancy Period.

1. Introduction

Given the climate change, it is necessary to carry out comprehensive measures to prevent soil degradation and desertification processes in steppe regions, as well as to optimize plant resources. From this perspective, studying the ecological and biological adaptation traits of forage and other useful plant species that are resistant to soil degradation and drought, and selecting the most promising species, is of great importance [1].

2. Materials and Methods

We observed the growth and development of plants in the Namangan steppe. Plant phenology was studied using widely recognized methods (Beydeman, 1974) [2]. The developmental stages of the plants were monitored regularly throughout the growing season. During the phenological observations, the following stages were recorded: bud formation, active growth, branching, flowering, fruit development, fruit ripening, and the end of the growing season. Soil moisture was measured using the Rode method [3].

3. Results and Discussion

In order to study the bioecological characteristics of certain useful plants distributed in xerothermic conditions, seven species from the following families were selected:

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Zygophyllaceae R.Br. (Zygophyllum family), *Fabaceae* Lindl. (Legumes), *Caryophyllaceae* Juss. (Pink family), *Malvaceae* Juss. (Mallow family), and *Poaceae* Barnhart. (Grass family).

There is insufficient information in the literature regarding the biology and ecology of *Zygophyllum atriplicoides*. From this perspective, phenological observations were conducted in the Namangan steppe (2023). In the third decade of March, buds ranging from 2–5 mm appeared from the axillary shoots. From these buds, relatively small, somewhat rough leaves developed.

Figure 1. *Zygophyllum atriplicoides* (Fisch. et C.A.Mey) Boiss.

During the first ten days of April, before the leaves were fully formed, bright yellow, double-flowered inflorescences began to form in the leaf axils. A significant aspect of the plant is the rapid opening of the inflorescences and the appearance of long stamens and pollen grains. The peak (mass) flowering period lasted from March 30 to April 3 (Figure 2).

By this time, the leaves had noticeably increased in size, taking on an inverted ovate shape, and due to thinning, they turned a dark green color. The fruits, initially dark green, ranged in size from 2–3 cm to 4.5–5 cm. As they grew, the color shifted to yellow, and by mid-June, they had ripened. It should be noted that when fully ripened, the fruits turn a dark yellow color. In the absence of wind, rain, or other mechanical influences, the fruits remain hanging on the *Zygophyllum* bush. Due to their slightly unpleasant odor, livestock do not consume them, and as a result, they accumulate beneath the bushes.

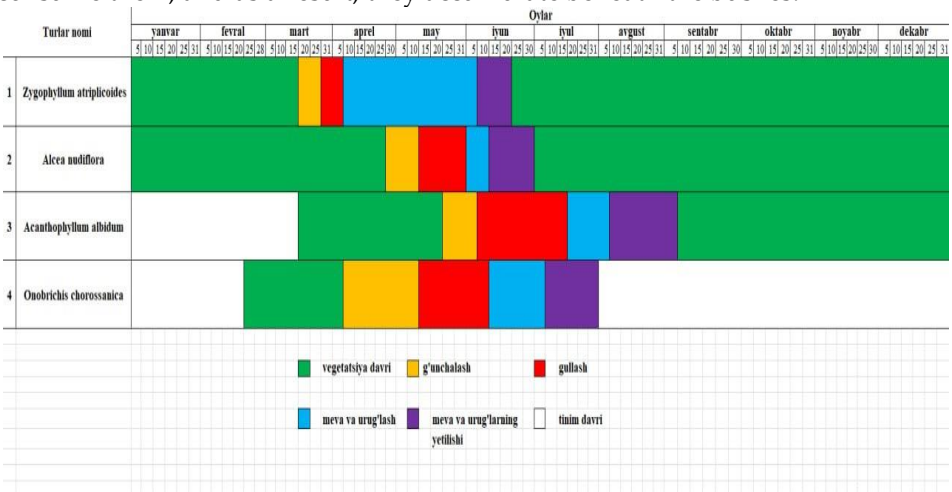

Figure 2. The phenospectrum of certain useful species

In summer, initially, shortened stems emerge from the axillary buds, followed by two pairs of oval-shaped, grayish young leaves. Relatively large spring leaves, if not consumed by herbivores, begin to shed in August. It should be noted that the appearance of spring and summer leaves, as well as their cyclic development, defines the specific biological characteristics of *Z. atripicoides*.

The summer gray leaves remain unchanged until spring, i.e., until the beginning of March. In early spring, around the beginning of March, ovate leaves with a pointed tip begin to form opposite the lateral growth buds on the overwintering shoots. New buds continue to form in the axils of these leaves, producing narrow, elongated, oval, bluish leaves in the second pair, which appear by the end of May and the beginning of June. In summer, the large spring leaves fall off, while the small "summer" leaves remain throughout the winter. The appearance and shedding of leaves follow a cyclic pattern. *Z. atripicoides* is a perennial plant that remains vegetative throughout the year. In steppe areas, it does not dry out even when the soil moisture reaches 2% during the summer. It is considered well-adapted to xerothermic conditions.

Alcea nudiflora (Lindl.) Boiss, also known as white mallow, is a perennial herb from the Malvaceae family, growing to a height of 1.5–2 meters. Its stem is erect, unbranched, and covered with coarse hairs. The leaves are petiolate, round, and divided into 5-7 lobes. The white, bright-colored petals have a yellow base, and the calyx is composed of 5 petals, with 6-7 triangular sepals, and the base is fused.

In the conditions of the Namangan steppe, the vegetation of *Alcea nudiflora* begins in the first half of March, with the appearance of primary buds at the base of the stem, which begin to grow. In the second half of March, several shoots emerge from the base of the stem, resulting in the formation of a plant clump with multiple stems. During this period, the growth of the stems coincides with the formation of the leaves. As a result, the stems are covered with broad, ovate leaves.

Figure 3. *Alcea nudiflora (*Lindl.*)* Boiss.

A.nudiflora Intensive growth of A. nudiflora was observed at the end of April and the beginning of May. Over a period of three days, growth reached 12–12.5 cm, and by the second half of May, it increased to 16–17 cm. At this time, the plants entered the generative phase, and flowering was recorded (Figure 2). Subsequently, the growth rate decreased, with growth not exceeding 4–4.5 cm over the next three days. By the end of May, mass flowering began in the lower parts of the plants, followed by fruit formation. At the beginning of July, the first mature fruits were recorded in the lower parts of the plants. In August, the average height of the *A. nudiflora* stems reached 175.3 cm.

As soil moisture began to decrease (in July), leaf shedding was observed, which was associated with rising air temperatures and decreasing soil moisture reserves. The shedding of leaves from the stems was particularly intense in early August and September. *A. nudiflora* began to dry out its leaves when soil moisture reached 5%.

Acantophyllum albidium Schischk. (also known as the "bigizsimon oqtikan") belongs to the *Acanthophyllum* genus in the *Caryophyllaceae* family, specifically the Oligosperma section. It is listed in the "Red Book of the Republic of Uzbekistan" (2002, 2006, 2019). This plant forms a semi-woody cushion-like appearance, growing to a height of 20–30 cm.

In research by E.Yu. Ro‘zmatov (2012), the morpho-anatomical structure of the vegetative and generative organs of *A. albidium* distributed in the Fergana Valley was studied. Its variability characteristics were examined, and the most ecologically rich form of saponin was identified [4].

In the Namangan region, near the village of Khonobod in the Pop district, A. albidium occurs in sparse populations on rocky and fine-grained soils in steppe areas. In our field studies, we recorded 1–2 individual plants in a 10 m² area where A. albidium populations were spread.

As a cushion-like, semi-woody plant, *A. albidium* primarily has a winter dormancy period and exhibits spring-summer vegetative growth. In 2023, phenological observations were conducted on *A. albidium* plants that were approximately 1–2 years old.

Like other species of *Acanthophyllum*, the buds of *A. albidium* are located in spiny leaf axils and the plant begins its vegetative growth in the warm days of early spring. In the second half of March and early April, bud break was recorded, with a sharp rise in air temperature triggering the mass awakening of the buds (+14–16°C). Shiny, colorless, smooth primary shoots emerged from the buds, which occurred in April–May. Throughout May, the intensive growth of shoots (branches) was observed, and the overall shape of the plant began to assume a cushion-like appearance. Starting from May 15, the plant began transitioning to its generative phase (Figure 2).

It should be noted that *A. albidium* does not produce distinct flowering shoots. Instead, "capitate" inflorescences, 25–30 cm long, form in the upper parts of the branches. Flowering occurred in the second half of May (25–28.05.2023), lasting 18–20 days. The flowering phase was observed for 14 days (20–25.06.2023). On July 20, seed development began, and by August, seed ripening was recorded.

By the end of the flowering period, the shortened stems (stems) and young leaves transformed into thorns. The plant’s spiny leaf axils produced growth buds that would remain dormant until the following spring. Under favorable weather conditions, bud break may also occur during a warm autumn or mild winter.

Figure 4. *Acanthophyllum albidium* Schischk.

At the end of the vegetation period of the *Acantophyllum albidium* plant, the stems and branches undergo lignification. Lignified, branched stems retain all their buds in a living state, and after the winter dormancy period, new shoots develop from them. Under

favorable weather conditions, the vegetation period of A. albidium lasts 10 months. However, as the plant ascends to higher parts of the steppe, where soil moisture decreases and drops to 3%, we observed that the plant dries out without flowering or seed formation.

Acantophyllum albidium, a saponin-rich plant, is one of the species whose natural reserves are declining under the influence of anthropogenic factors. Research has identified small areas in the Namangan steppes where this species grows. Due to anthropogenic impacts, such as the development of steppe areas for horticulture, industry, and other purposes, it is necessary to protect the once widespread *A. albidium* in the Fergana Valley, a plant known for its saponin content and high ornamental value.

Onobrichis chorossanica (Khorasan alfalfa) belongs to the *Fabaceae* family, *Onobrichis* genus, and *Hymenobrichis* section. It is a perennial herb with numerous, erect, rarely branching stems that grow densely.

This plant is a component of the green pasture, wheat, and other plant communities [5]. According to L. Shamsuliyeva (1983), it has strongly pubescent, bifoliate or sometimes unifoliate, short, three-pointed, and serrated large legumes. Its root system reaches a depth of 100 cm by the first year of growth [6]. According to Rahimova, alfalfa grown in the Fergana Valley steppe is characterized by a short vegetation period [7]. *Onobrichis chorossanica* has a spring-summer growing season, with a dormancy period in late summer-autumn and winter.

In the Namangan steppe, the vegetation period of *Onobrichis chorossanica* begins in March. In the second half of March, new shoots and small compound leaves emerge. From April onward, generative buds begin to develop beneath these leaves. Active growth is observed from April 5 to April 15, when both heat and moisture conditions are favorable. By May, the plant grows to a height of 60–70 cm, and buds begin to form. Flowering starts in mid-May, depending on climatic conditions, and lasts until the second half of June. Flowering begins at the bottom of the plant and progresses upward. The inflorescences are dense, with many small yellow flowers, which are veined. During the branching phase and before mass fruiting, the plant's stem undergoes intensive growth (Figure 2).

Fruiting occurs from June to July. By the end of July, the stems begin to dry out. In the fruiting stage, the legume develops. The seeds, which initially are green, turn brown when mature. The seeds ripen by July 20. In some cases, with warm autumn conditions (August-September), the plant exhibits secondary growth of up to 30 cm in height after the drying phase in June, as recorded in the literature.

In late July, the plant enters dormancy. The duration of the summer dormancy period lasts from early August until the end of February the following year. The active growth period lasts for 5 months or approximately 150 days. This plant completes its vegetation when the soil moisture drops to 5%.

Agropyron cristatum (L.) Gaertn. – Crested wheatgrass, belongs to the Poaceae family, the true grasses, and the Triticeae tribe. It is a perennial cereal plant.

In the Namangan steppe, A. cristatum is a plant with a summer dormancy period and a fall-winter-spring growing cycle. This plant typically begins its vegetative growth in the fall. After the first rains, the plant begins *tillering*. *Dormancy* starts when *tillering* ceases in winter and resumes in early spring. In spring, the activity of tillering increases.

In the field studies conducted, the appearance of tiller-producing shoots (tillering) was recorded in the second half of April, starting from May 14 and continuing until the end of May. Flowering began on May 28 and lasted for 30-35 days. Seed formation occurred in June, and the seeds began to shed in July. The plant entered dormancy in the second half of July. The summer dormancy period lasted from the end of July until the beginning of September. The vegetation period of *A. cristatum* lasted for 11 months or 320 days. We observed that the plant ceased its vegetation when soil moisture dropped to 2%.

Hordeum bulbosum – Bulbous barley, is a perennial grass belonging to the Poaceae family, the true grasses, and the *Hordeum* genus. It grows to a height of up to 150 cm. The lower part of the stem becomes bulbous.

The leaves are 3–7 cm wide, with ligules up to 1 mm in length, and the inflorescences measure 1.5 cm in length.

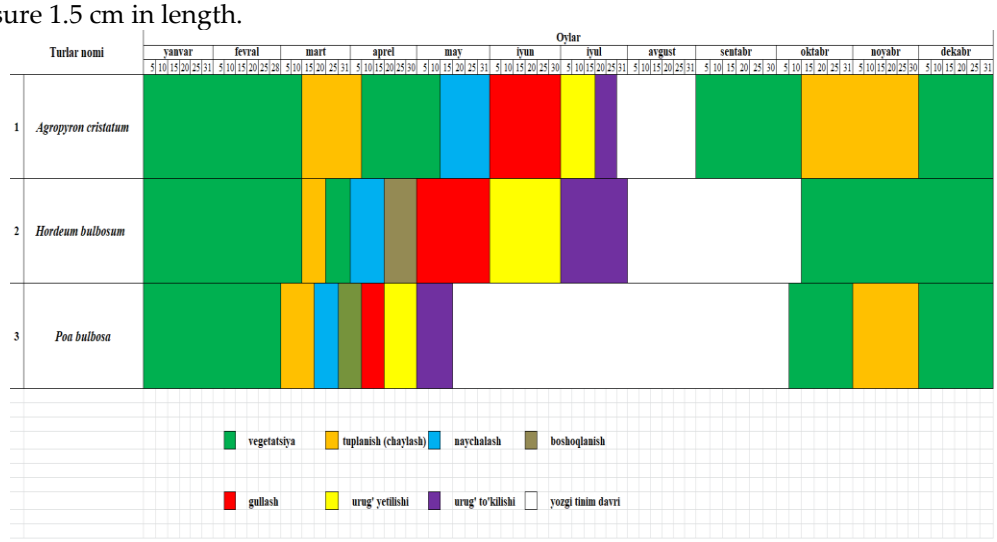

Figure 5. Phenospetry of the representatives of the Poaceae family.

Hordeum bulbosum is primarily considered a winter-vegetating (or winter-green) plant that undergoes a dormant period during the summer (Fig. 4). According to I.V. Borisova (1972), this plant has a long vegetative period, characterized by its summer dormancy and autumn-winter-spring greening. After the summer dormancy, when the air temperature rises to +15°C, the development of the stems begins due to the onset of autumn rains. Starting from October, *H. bulbosum* begins the intensive growth of winter, leafless stems. After 2-8 days, it enters the dormancy phase (autumn dormancy, senescence) which lasts until the winter frost (until December 6). Winter observations in December 2023 showed that, although the plants in the dormancy phase remained green, their development had slowed down. However, during the cold winter days when the air temperature dropped to -10°C, no damage from the cold was observed on the leaves.

In early spring of 2023 (March 10-12), when the air temperature rose above +10°C, the dormancy process began to reverse. By the third decade of March, the spring dormancy process ended. From the beginning of April, the plants entered the generative phase, and the "tillering" (stem elongation) started on April 6 and continued for 12 days. Observations showed that the flowering phase lasted from April 18 to May 1. On April 20, several spikelets began to form from the arrangement of flowers in the spikelets. Full flowering was recorded on April 28, and the flowering lasted for 30-33 days (Fig. 5). The Tak-tak seeds ripened in the spikes by June, began shedding at the beginning of July, and then entered the dormancy period. The summer dormancy period lasted from early August to early October. Phenological observations showed that the vegetation period of H. bulbosum lasts from autumn to summer, constituting 9 months or 265 days. The plant completed its vegetative cycle when soil moisture dropped to 5%.

Poa bulbosa L. – Brownhead Poa is a perennial grass belonging to the *Poaceae* family. In the conditions of the Namangan foothills, *P. bulbosa* is highly adaptable to the environment, developing generative buds depending on conditions. The plant grows from 10-15 cm to 50 cm and forms 2-3 or even several stems. With a small taproot system, *P. bulbosa* begins its vegetation in the fall. In late February and early March, significant leaf enlargement and a dark green color were observed. Similar to other grasses, the initiation of the dormancy process in *P. bulbosa* is related to the warm days. When the air temperature rises above +13°C (in March 2023), the plant transitions from dormancy to tillering. Within 5-6 days, the plant began to spike, and flowering continued for 8-10 days (Fig. 5). The flowering period lasted 10-12 days. The average air temperature during the spiking and flowering phases was +15.5°C.

During the second decade of April, the formation of seeds was observed. In April-May, instead of seeds, vegetative "bulbous cloves" appeared in the spikes. These "bulbous

cloves" ripened by the first decade of May and began to fall to the ground. At the same time (April 20), leaf senescence was observed at the lower part of the stem. On warm autumn days, after the first rain, the "bulbous cloves" started growing. Phenological observations showed that the overall vegetative period of P. bulbosa lasted 105 days. The plant completed its vegetative cycle in the northern and northeastern parts of the foothills when the climatic conditions showed a moisture content of 6% and 5%, respectively.

4. Conclusion

In the northern-northeastern to northwestern parts of the Namangan foothills, soil moisture changes in accordance with climatic variations. For example, in our studies, we have demonstrated that the moisture content decreases progressively from the Uychi-Birlashgan foothills towards the Chust-Pop foothills.

The vegetation periods of the seven selected plant species varied based on their adaptation to the environment. In some species, due to higher moisture content in the northern-western parts of the region, we observed that Alcea nudiflora began leaf drop in the Uychi Birlashgan-Chortoq foothills in July. This process intensified during August and the early part of September. In the Chust-Pop foothills, however, with the decrease in soil moisture, Alcea nudiflora leaves started to fall in July. For Acanthophyllum albidum, as we moved up the Chust-Pop foothills and the moisture content decreased, we observed that the plant's leaves and upper portions began to dry out.

In the lower parts of the foothills, in areas near flood channels and those exposed to the sun’s radiation, where soil moisture was about 5%, the plants began to dry out in August. In areas with lower moisture content, where the soil moisture dropped to 3%, Acanthophyllum albidum dried out without flowering in June. The vegetation period of Zygophyllum atriplicoides extends throughout the year. Even when the soil moisture content drops to a minimum of 2%, the plant does not cease its vegetative cycle.

In the Kososon foothills, Onobrychis chorassanica began shedding leaves at the top of the foothills in early June when soil moisture reached 5%. In the lower parts of the foothills, leaf drop occurred by mid-August. Especially in the phases of tillering and flowering of grasses, if soil moisture is insufficient, it may cause a significant reduction in the populations of plants within this group in the following season. Soil moisture is of critical importance for all plants in xerothermic conditions.

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