

## THE MORPHOLOGICAL VITALITY PARAMETERS OF *TRIFOLIUM PRETENSE* L. UNDER URBANIZED ENVIRONMENT CONDITIONS

Glibovytska N.I.

Ivano-Frankivsk National Technical University of Oil and Gas  
Karpatska str., 15, 76019, Ivano-Frankivsk  
nataly.glibovytska@gmail.com

The morphological vitality parameters of *Trifolium pratense* under urbanized environment conditions are investigated. Species reproductive, assimilation, storage and habitual sphere are explored. The species population vitality index of generative organs, photosynthetic, root, habitual index are calculated. The scale for *Trifolium pratense* vitality assessing in urban areas conditions is proposed. The species heavy metals extraction, oil-remediant, medicinal and agricultural properties are analyzed. The greatest anthropogenic pressure on the species growth and development processes in the transport functional area of Ivano-Frankivsk ecological system is found. *Trifolium pratense* population is characterized by above-average vitality in the area of complex landscaping (II class of vitality), below-average vitality in the housing area (IV class of vitality), low vitality in the transport area (V class of vitality). Reproductive system of *Trifolium pratense* is more stable and well adapted to environmental stressful influence than the vegetative one. It indicates that under unfavourable environmental conditions *Trifolium pratense* population can be supported by the flowers mass and seed development. The generative organs mass is not significantly different in functional areas of the urbanized environment in comparison with the background area. The most sensitive morphometric parameter to the technogenic influence is *Trifolium pratense* stem mass and the aboveground plant mass. The species directs energy resources mainly to the development of stem and root mass, that reveals the plants life style K-strategy. *Trifolium pratense* is recommended to the use as biological indicator of anthropogenic impact in different man-made territories. *Key words*: *Trifolium pratense* L., environmental condition, urbanized ecosystems, pollution, vitality, morphological parameters.

### Морфологічні параметри життєвості *Trifolium pratense* L. в умовах урбанізованого середовища. Глібовицька Н.І.

Досліджено морфологічні параметри життєвості *Trifolium pratense* в умовах урбанізованого середовища. Досліджено репродуктивну, асиміляційну, запасуючу та габітуальну сферу виду. Розраховано індекси життєвості популяції виду – генеративних органів, фотосинтетичний, кореневий, габітуальний індекс. Запропоновано шкалу оцінки життєвості *Trifolium pratense* в умовах міської місцевості. Проаналізовано здатність акумулювати важкі метали, фіторекультивацийні, лікувальні та сільськогосподарські властивості виду. Визначено найбільший антропогенний тиск на процеси росту та розвитку виду у транспортній функціональній зоні екологічної системи Івано-Франківська. Популяція *Trifolium pratense* характеризується життєздатністю вище середньої в зоні комплексного озеленення (II клас життєвості), нижчою за середню життєвістю в житловій зоні (IV клас життєвості), низькою життєвістю в транспортній зоні (V клас життєвості). Репродуктивна система *Trifolium pratense* більш стійка і добре пристосована до стресового впливу навколишнього середовища, ніж вегетативна. Це свідчить про те, що за несприятливих екологічних умов популяція *Trifolium pratense* може підтримуватися за рахунок квіткової маси та розвитку насіння. Маса генеративних органів у функціональних зонах урбанізованого середовища суттєво не відрізняється від фонові. Найбільш чутливим морфометричним параметром до техногенного впливу є маса стебла *Trifolium pratense* і маса надземної рослини. Вид спрямовує енергетичні ресурси переважно на розвиток стовбурової та кореневої маси, що розкриває К-стратегію способу життя рослин. *Trifolium pratense* рекомендовано використовувати як біологічний індикатор антропогенного впливу на техногенних територіях. *Ключові слова*: *Trifolium pratense* L., екологічний стан, урбанізовані екосистеми, забруднення, життєздатність, морфологічні параметри.

**Formulation of the problem.** The natural environment is constantly exposed to anthropogenic influences, which on its scale has reached the planetary level, and in strength and speed is ahead of the natural factors influence. The problems of preserving the ecosystem and the biosphere as a whole are constantly becoming more acute and urgent [1; 2]. At present, there are almost no biocenoses that would not directly or indirectly feel the impact of man. Anthropogenic components of the environment to a greater or lesser extent cause pollution of biological systems. And those, in turn, either adapt to new conditions, withstanding them, or disappear [3; 4; 5]. The herbaceous plants vitality condition is one

of the most promising ecological way of environmental state monitoring.

**Relevance of research.** Phytoindication is one of the most promising methods in biological monitoring of anthropogenically-transformed environment [6; 7; 8]. Plants are the most sensitive objects to environmental chemical and physical pollution [9; 10]. A lot of herbaceous species, including including *Trifolium pratense*, are not studied yet as a possible indicators of the environmental state of urban ecosystems.

**The connection of the author's work with important scientific and practical tasks.** *Trifolium pratense* is one of the most well-known herbaceous plants, famous for its unique treatment

and phytoremediant properties. The works concerning its indicative properties of environmental state are very few, so there is the request to explore the morphological reactions of the plant at the organism organization level.

#### Analysis of recent research and publications.

*Trifolium pratense* is a well-known perennial plant of the Fabaceae family. Its natural habitats are found in North-West Africa, Europe and West Asia. More than a hundred years ago, the culture came to Chile and Argentina, resulting in naturalization in South and North America, in temperate regions. The species is widely spread in urbanized territories of Ukraine and is used as an effective nitrogen-combining plant in agriculture, as a powerful remediant of aromatic hydrocarbons and with medical purpose [11; 12; 13]. With the onset of spring, young green leaves and clover shoots are added to green vitamin salads and first courses to cope with vitamin deficiency and boost immunity. Decoctions and infusions of clover are used as an effective diuretic, diaphoretic, antipyretic and antiseptic. They also have anti-inflammatory, antifungal and wound-healing effects, antitumor drugs are prepared from the roots of the plant [14; 15]. Recent investigations reveal the role of *Trifolium pratense* as the effective remediant of oil-polluted environment and accumulator of heavy metals [16; 17; 18]. Some *Trifolium pratense* biochemical reactions in response to anthropogenic pollution are explored. Morphological biomass parameters changes of the plant under urbanized environmental condition are not studied yet.

#### Highlighting previously unsolved parts of the general problem to which this article is devoted.

The most of modern scientific biological researches are devoted to the exploration of physiological and biochemical responses of plants to environmental pollution. Morphological parameters of plants are not very well studied, despite they reveal the general functional state of the organism in the certain living conditions. The purpose of this work is to study the vitality of *Trifolium pratense*, distributed in the natural environment in the urban system of Ivano-Frankivsk, and to analyze the suitability of its use as a bioindicator of environmental quality.

**Novelty.** *Trifolium pratense* is well-studied as medical, phytoremediant and useful agricultural plant, but it is poorly studied as biological indicator of the environmental condition. Simple morphological studies of the species vitality on the organism level of biological organization help to investigate the plants reactions to anthropogenic pressure.

**Methodological or general scientific significance.** The study of *Trifolium pratense* morphological parameters of biomass in different urban ecological conditions gives an opportunity to analyse the influence level of anthropogenic factors. The species biological mass parameters, that are the most sensitive to technogenic transformation, can be used in biological monitoring.

**Presentation of the main material.** The research is conducted in the urban ecosystem of Ivano-Frankivsk, the territory of which is divided according to the functional type of zoning into the following areas: housing area, complex landscaping area, transport area.

*Trifolium pratense* which grows in the above-mentioned functional zones of the city, was selected as phytomonitoring object. Plants from the relatively ecologically clean territory – Demyaniv Laz forest – were chosen as control one. In the conditions of each functional area 15 formed individuals of *Trifolium pratense* were selected and morphometric analysis was performed.

All studies were performed according to generally accepted methods [19]. The functional status of the plants was established using the recommended rating scale (Table 1).

Table 1

#### The scale for *Trifolium pratense* vitality assessing in urban areas conditions

Deviation from control, %	The class of vitality	Category of stability
1–10	1	high
11–20	2	above average
21–30	3	average
31–50	4	below average
>50	5	low

To determine the viability of the plant species in the functional areas of the city the following parameters that form the four spheres of the plant are analyzed:

– reproductive sphere: mass of generative organs of one plant, index of generative organs (the ratio of the mass of generative organs to the mass of the whole plant);

– assimilation sphere: mass of leaves, mass of stems of the one plant, photosynthetic index (the ratio of leaf mass to mass of the whole plant), stem index (the ratio of stem mass to mass of the whole plant);

– storage sphere: root mass, root index (the ratio of root mass to the mass of the whole plant);

– habitual sphere: the total mass of the plant, the mass of the aboveground part, the ratio of the mass of the underground to the mass of the aboveground part.

In the conditions of Ivano-Frankivsk functional areas there is a decrease in the vegetative and generative organs mass of *Trifolium pratense* individuals (Fig. 1).

The lowest species individuals biomass and their individual parts is recorded in the transport routes area of the city, where the stem and aboveground part mass of *Trifolium pratense* is reduced in 3.2 and 2.7 times relative to control, respectively. The mass of the reproductive organs of the species is stable in the conditions of functional areas and decreases slightly relative to control – in *Trifolium pratense* 1.2 times.

Biomass decrease of *Trifolium pratense* separate parts of relative to background values in the conditions

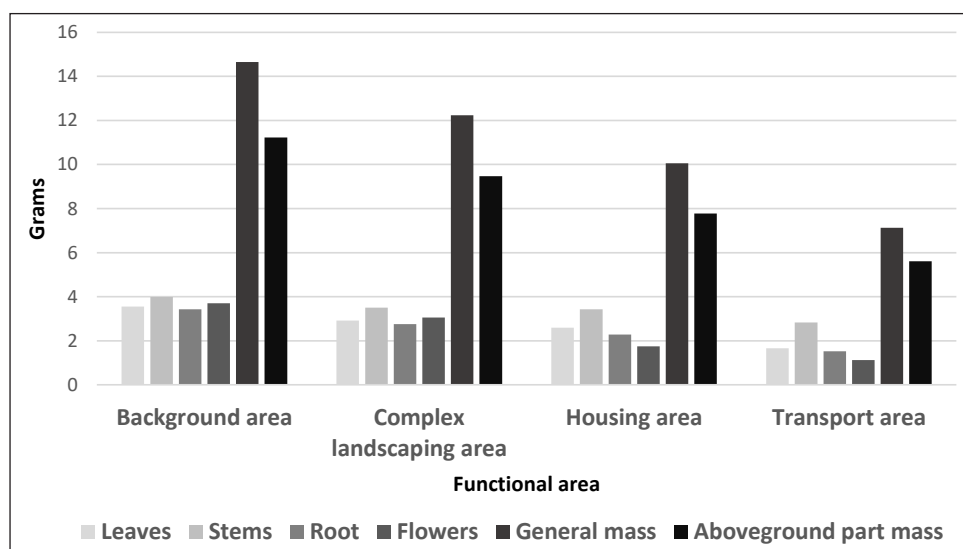


Figure 1. The structure of *Trifolium pratense* biomass in the functional areas of Ivano-Frankivsk

Table 2

*Trifolium pratense* biomass indexes in the functional areas of Ivano-Frankivsk

Functional area	Assimilation sphere		Storage area	Habitual sphere	Reproductive sphere
	Photosynthetic index	Stem index	Root index	Habitual index	Generative organs index
Background area	0,12	0,68	0,13	0,16	0,07
Complex landscaping area	0,14	0,65	0,13	0,15	0,08
Housing area	0,13	0,62	0,15	0,8	0,10
Transport area	0,15	0,53	0,18	0,23	0,14

of functional zones of the city takes place in the following order: flowers mass → root mass → leaves mass → total plant mass → aboveground part mass → stem mass.

In the conditions of the Ivano-Frankivsk urban system, there is an increase in the biomass indexes of *Trifolium pratense* in the following order: index of generative organs → photosynthetic index → root index → habitual index → stem index (Table 2).

Thus, the species directs energy resources mainly to the development of stem and root mass.

*Trifolium pratense* vitality deviation from the control in Ivano-Frankivsk indicates that the species population is characterized by above-average vitality in the area of complex landscaping (II class of vitality), below-average vitality in the housing area (IV class of vitality), low vitality in the transport area (V class of vitality) (Table 3).

**The main conclusions.** In the conditions of Ivano-Frankivsk urban system the *Trifolium pratense* directs energy resources mainly to the growth of stems and roots in comparison with the development of generative organs. This may lead to a reduction in the population and population density of the species in the future. In the conditions of functional areas of Ivano-Frankivsk there is a decrease in the vegetative and generative

organs mass of *Trifolium pratense* individuals, in comparison with the background area. The lowest biomass of individuals and their individual parts is recorded in the transport area of the city. *Trifolium pratense* individuals vitality deviation from the control in the conditions of Ivano-Frankivsk indicates that the species is characterized by above average, below average and low vitality according to the level of anthropogenic pressure in the functional areas.

Table 3

*Trifolium pratense* vitality deviation from the control in Ivano-Frankivsk ecosystem

Vitality parameter	Deviation from control, %		
	Complex landscaping area	Housing area	Transport area
Leaves mass	12	32	48
Stem mass	22	44	69
Root mass	10	17	27
Flowers mass	16	14	19
Total weight	19	38	59
The mass of the aboveground part	20	41	63
Average value	17	31	48
Vitality class	II	IV	V

**Prospects for the use of research results.** *Trifolium pratense* plants can be used as bioindicators of the environmental condition in relation to the influence

of anthropogenic factors. *Trifolium pratense* vegetative organs mass is more sensitive to anthropogenic pressure than the generative organs mass.

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