Thaiszia - J. Bot., Košice, 15, Suppl. 1: 83-89, 2005
http://www.upjs.sk/bz/thaiszia/index.html

THAISZIA
JOURNAL OF
BOTANY

Management of synantropic weeds distribution by native steppe vegetation in the Forest-Steppe and Steppe zone of Ukraine

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DIDYK N. P. , PAVLOVA O. S. , MARYUSHKINA V. Y. , MASHKOVSKA S. P. (2005): Management of synantropic weeds distribution by native steppe vegetation in the Forest-Steppe and Steppe zone of Ukraine. – Thaiszia – J. Bot. 15, Suppl. 1: 83-89. – ISSN 1210-0420.

Abstract: Potentials of turf-grass steppe vegetation native to Ukraine to form tolerant to synatropic weeds communities were analyzed. Such communities could be sown on lawns, roadsides, waste grounds promoting native steppe vegetation and restraining spread of synantropic one. In the result of the conducted studies it was shown that the mixtures of fescues with 5-10 species of legumes and 10-20 other representatives of herbaceous steppe vegetation positively or indifferently associated with fescues are promising as stable, tolerant to weeds communities.

The allelopathic activity of water-soluble allelochemicals of fescues (*F. pseudodalmatica, F.rubra*) and steppe legumes (*Astragalus cicer*, *Medicago romanica*) was markedly higher than that of other tested species. These results confirmed our field observations about these species weeds suppressive ability and suggested participation of allelopathy in this phenomenon.

Keywords: steppe vegetation, synantropic weeds, cenotic interactions, allelopathy.

Introduction

Radical distinction of the modern antropogenic influences from natural ones, which has been acting for thousands of years, present a hazard for humanity and environment stability. Therefore the enhancement of urban environment, protection and restoration of zonal ecosystems and biodiversity are of high importance. The creation of "ecological framework" – a closed, integrated, self-regulating complex of ecosystems on urban territories could be a solution to many present environmental problems. The autotrophic link of such ecosystems could be formed by tolerant to synatropic weeds plant communities, imitating natural zonal vegetation, presenting suitable habitat for native fauna (FLINT et al. 2002). Evidently, traditional methods of green landscaping, such as mowing before flowering stage of native plants, usage of pesticides, burning and other factors leading to elimination of native flora and fauna should be avoided. Therefore, there is an urgent need in innovative, ecologically based conception of urban green landscaping, taking into account the above mentioned requirements.

The objective of our study was to analyze the potentials of turf-grass steppe vegetation native to Ukraine to form tolerant to synantropic weeds communities, which could be used in green landscaping practices.

Turf-grass steppe vegetation has wide ecological amplitude, tolerant to drought, cost effective and easy for cultivation. Communities of turf grasses are characterized by high species richness and compact niches differentiation, which makes them tolerant to synatropic weeds invasion (OSYCHNYUK 1973). Therefore, these vegetation present inexhaustible source of species perspective for utilizing in green landscaping of lawns, road sides, waste grounds, thus, promoting native steppe vegetation and restraining spread of synantropic weeds.

Materials and methods

Field observations on plant species cenotic interactions were conducted on three habitats of native turf-grass vegetation: landscape park "Lysa Gora", "Steppes of Ukrane" plot of the National botanical garden (Kyiv, Forest-Steppe zone of Ukraine, soil – grey podzol) and Kudashevka village (Dniepropetrovsk region, soil – slightly washed off chernozem).

In each habitat about 250 vegetation descriptions on plots with an area of 0,5x0,5 m^2 located along a transect crossing studied communities were made. Out of 192 plant species observed in these habitats 69 occurring on no less than 20% of plots were chosen for the analysis of their cenotic interactions. The effect of steppe species abundances on species richness and the abundances of other plant species were determined by the method of cenogradient analysis (GRODZINSKY et al. 1985).

The data of field observation were compared with the results of allelopathic study of steppe plants. The allelopathic activity of water-soluble allelochemicals of fresh plant material was studied immediately after collection at flowering stage of the donor-species (MARYUSHKINA 1990) using bioassay on *Lepidium sativum* root growth (GRODZINSKY 1991).

Results and discussion

Analysis of the cenotic effect of steppe species on species richness allowed distinguishing of four groups of plants. The first group constituted species of steppe *Gramineae* of *Festuca* L. genus (*F. ovina* L., F. *pratensis* HUDS., *F. rubra* L., *F. rupicola* HEUFF.), *Dactylis glomerata* L., *Phleum pratense* L., as well as herbaceous grasses (*Achillea millefolium* L., *Centaurea jacea* L., *Centaurea pseudoleucolepis* KLEOP., *Euphorbia stepposa* Zoz, *Galatella dracunculoides* (LAM.) NEES, *Galium boreale* L., *Plantago stepposa* KUPRIAN, *Potentilla argentea* L., *Rumex thyrsiflorus* FINGERH., *Thymus marschallianus* WILLD.), which abundances positively influenced species richness of the studied communities (P<0,05) (Fig. 1 (A)). Therefore these species could be used as more or less abundant components in grass mixtures to make the latter differentiated by ecological niches, floristicaly and cenoticaly complete and, thus, more tolerant to weed invasion.

The second group constituted such dominants as *Agrostis stolonifera* L., *Agrostis tenuis* SIBTH., *Centaurea diffusa* LAM., *Deschampsia caespitosa* (L.) BEAUV., *Equisetum arvense* L., *Euphorbia cyparissias* L., *Galium verum* L., *Lotus arvensis* PERS., *Medicago romanica* PROD., *Galium verum* L., *Pimpinella saxifraga* L., *Poa angustifolia* L., *Poa pratensis* L., *Salvia stepposa* SHOST., *Trifolium montanum* L., *Trifolium prantense* L., *Trifolium repens* L., *Veronica incana* L., *Vicia cracca* L., which at low values of their abundances positively influenced species richness with a maximum at 3-15 % of a factor species cover. Above these values dependence was negative (Fig. 1 (B)). Therefore these species could not be recommended as main components (dominants) of grassy mixtures. However, they need to be included in small quantities (no more than 10-15%) to make the mixtures more floristically complete and differentiated by ecological niches.

The third group constituted species of *Arrhenatherum elatius* (L.) J. ET C. PRESL, *Alopecurus pratensis* L., *Bromopsis inermis* (LEYSS.) HOLUB., *Elytrigia repens* (L.) NEVSKI, *E. intermedia* (HOST) NEVSKI. negatively influencing species richness even at low values of their abundances (Fig. 1 (C)). These species tend to form monodominant communities with very low representation of other species. Because of cenotic incompleteness and unidirectional transformation of ecotope such communities are not stable and would degrade after a certain period of time giving way to synantropic vegetation (DIDYK 2001). Therefore we recommend to avoid these species in green landscaping and to control their invasion by mowing of grass-stand at their critical stages.

The forth group constituted dominants, which showed no influence on species richness even at high values of their abundances: *Achillea setacea* WALDST. ET KIT., *Cichorium intybus* L., *Coronilla varia* L., *Knautia arvensis* (L.) Coult., *Plantago lanceolata* L., *Plantago media* L., *Taraxacum officinale* WEBB. EX WIGG. These species have complementary cenotic strategies with the representatives of the first and second group and could also be recommended for green landscaping to make grass mixture more stable.

Evidently, to create stable, tolerant to synatropic vegetation grass mixtures one need to combine species positively associated in the natural communities and negatively influencing weeds. As the main components of grass mixtures we choose fescues, because of their tolerance to many environment factors, weed suppressive ability due to both high competitiveness and allelopathic potential (WESTON & al. 2003). To reveal the most suitable components for the studied fescues (*F. ovina*, F. *pratensis*, *F. rubra*, *F. rupicola*) we conducted further analysis of their cenotic interactions with the other steppe species.

As a factor species the fescues positively affected a number of herbaceous grasses of genera *Astragalus* L., *Centaurea* L., *Dianthus* L., *Trifolium* L., *Cichorium intybus* L., *Gypsophila fastigiata* L., *Medicago romanica*, *Plantago stepposa*, *P. lanceolata*, *Tragopogon orientalis* L., *Vicia cracca* etc. and negatively affected *Arrhenatherum elatius*, *Poa angustifolia, Convolvulus arvensis* L., *Elytrigia repens, Erigeron canadensis* L. The three latter species are noxious weeds and rather undesirable for green landscaping.

As a dependent species fescues were positively associated with species of *Centaurea L., Achillea L., Cichorium intybus.* While the most of the mentioned above legumes positively affected fescues abundance at low values of their cover with a maximum positive effect at 15-25% (depending on a species) and replaced fescues at higher values of their abundance. Besides, the studied legumes negatively influenced some noxious weeds: *Amaranthus retroflexus* L., *Convolvulus arvensis*, *Elytrigia repens*, *Cirsium arvense* (L.) SCOP. Evidently, adding to the studied fescues 10-15% of the legumes would not only enhance the community stability due to mutual positive cenotic effect but also would restrict weed invasion.

The rest of the mentioned above species did not show reliable effect on fescues. Taking into account high species richness and patchiness of natural turf grasses communities we recommend to use mixtures of fescues with 5-10 species of legumes and 10-20 other representatives of herbaceous steppe vegetation positively or indifferently associated with fescues, depending on ecotope condition and esthetic requirements. The herbaceous component we suggest to sow as separate patches each with one of legumes as prevailing component.

To find out more about eco-physiological aspects of the studied steppe species cenotioc interactions we tested 16 species of native steppe flora and synatropic ones, growing in the collections of National botanical garden in Kyiv, for their allelopathic potential using bioassay on *Lepidium sativum* L. root growth (Fig. 2). As in conditions of moderate climate water soluble allelochemicals are thought to be the main source of allelopathic interactions (GRODZINSKI 1991) we tested 2% water extracts from fresh plants collected at flowering phase.

The allelopathic activity of water-soluble allelochemicals of fescues (*F. pseudodalmatica* KRAJINA, *F.rubra*) and steppe legumes (*Astragalus cicer*, *Medicago romanica*) was markedly higher than that of other tested species.

These results confirmed our field observations about these species ability to suppress synatropic weeds and suggested participation of allelopathy in this phenomenon. The studied synatropic species demonstrated relatively low allelopathic activity in bioassays.

Though, the preliminary results suggests that allelopathic factor could play a role in the observed tendencies of cenotic interactions further investigations of root exudations, decay products and rhizosphere soil of the prospective steppe species and their physiological effect on specific weeds are needed.

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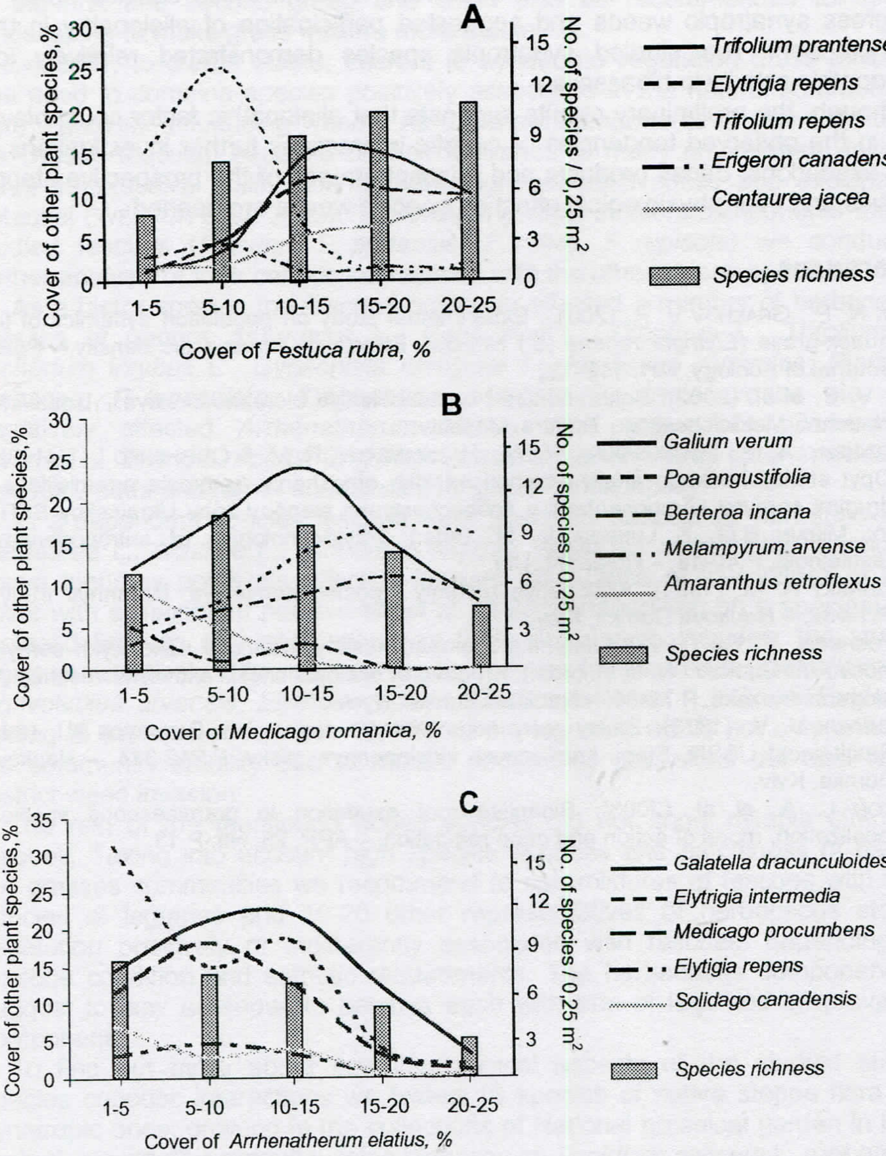

Fig. 1. Effect of the abundances of some steppe dominants on species richness and abundances of other species (empirical regression curves). The effect is significant at P < 0,05.

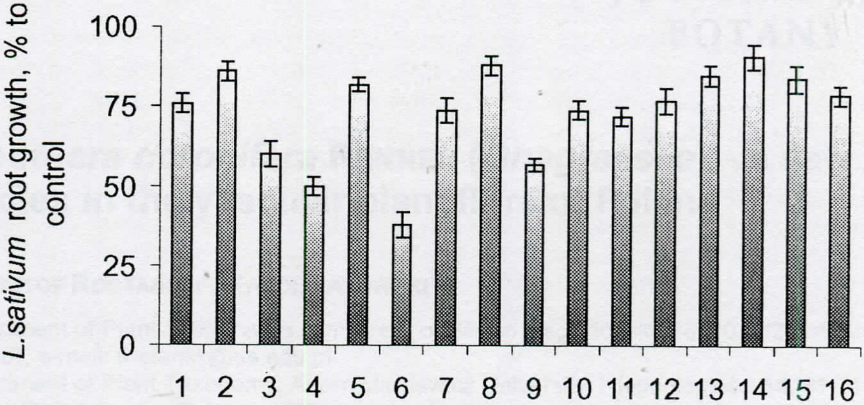

Fig. 2. Allelopathic activity of 2% water extracts of aerial parts of some steppe dominants and weeds collected at flowering stage (bioassay – *L. sativum* root growth): 1 - *Agropyron pectinatum*, 2- *Arrhenatherum elatius*, 3 – *Astragalus cicer*, 4 – *Festuca pseudodalmatica*, 5 – *Festuca heterophylla*, 6 – *Festuca rubra*, 7 - *Festuca tenuifolia*, 8 –*Festuca valesiaca*, 9 – *Medicago romanica*, 10 – *Phlomis pungens*, 11 – *Salvia stepposa*, 12 – *Stipa capillata*, 13 – *Amaranthus retroflexus*, 14 - *Chenopodium album*, 15 - *Setaria glauca*, 16 – *Stellaria media* (vertical bars – standard error).