Structure of weed species on railway

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Abstract: The aim of this thesis is to evaluate species structure of weeds on chosen part of railway between Brno-main station and Řečkovice station. Observation was made on twenty localities also on railway embankment and between rails. Vegetation was evaluated by phytocenological relevé during two months (July-August) in the year 2011. Observation was statistically evaluated by DCA and CCA analysis. 41 species of plants was found on the railway. The most cover had species like *Solidago canadensis*, *Urtica dioica*, *Lolium perenne*. *Lolium perenne*, *Aegopodium podagraria*, *Artemisia vulgaris*, *Stellaria media, Achillea millefolium* were the most common species between rails. Species *Urtica dioica*, *Solidago Canadensis, Helianthus tuberosus*, *Fragaria vesca*, *Hypericum perforatum* or *Plantago lanceolata* were the most occurred species on the railway embankment.

Key-Words: weeds, coverage, railway

Introduction

Development of human society requires a significant exchange of material which tend to leave a negative traces in the regions. One of the media which mediates these traces is a transportation. The need of transportation and subsequent road expansion in todays global environment has resulted some changes in landscape and quality of cultural and natural environment [1].

Czech Republic is a landlocked country, that is why the import of raw agricultural materials is high. This goes hand by hand with import foreign expansive weed species mainly via rail transport. The rails in most railways, especially freight railways stations have the largest presence of foreign expansive weed species. These foreign expansive and aggressive weeds species could in the future significantly reduce the fertility of agricultural soils in some areas [2].

Roads and rivers can similarly as railways serve as corridors for spreading of weed species. The concept of corridor then implies that the organisms and plants can move and/or be moved along the longitudinal elements in the landscape [3].

There are three main ways how are these foreign plants brought to the Czech Republic. The most of the plants are brought from North America.

From the south-east are brought plants via road and lastly the eastern route brings weed species commonly known in Mediterranean region. Such weeds are mainly brought with the transportation of cereal [4].

One of the most important reasons for removing the weeds from railway embankments is to preserve the quality and safety of the railways, to ensure a safe movement of staff, who are responsible for track maintenance. The risk of tripping or slipping on weedy track is high, therefore the prevention is very important [5].

If we decide to use herbicides on the railway embankments, it is important to fully understand their behavior and possible impact on the station. Well executed use of herbicides implies the limitation of the weed species as well as the absence of the side effects (e.g. injuries of employees, damage of equipment or environmental damage) [5].

It should be noted that weed species can be found not only in an arable land but also on non-agricultural lands like paths along the roads or railway lines. This paper will therefore address the issue of generic representation of weed species along the railways.

Material and Methods

Characteristic of Experimental Location

The phytocoenological evaluation took place in the area situated between the railways stops Brno, Česká and Řečkovice and follows the same path as previous old monorail connecting Brno and Tišnov called "Old Tišnovka". The train track was officially opened on July 2, 1885 and extended from Tišnov to Zdar and later to Česká twenty years later. The new railway track was launched in the years 1953 to 1957 and became fully electrified in the years 1964 to 1966.

Řečkovice (GPS 49.250730, 16.589991) is located on north from the Brno city. The altitude varies between 226 to 398 meters a.s.l. While the southern part of the district has more urban character, the eastern part is covered by an extensive forest. Village Česká (GPS 49.284692, 16.566626) is situated in the district Brno-countryside with the altitude of 295 m above the sea level. This area has the highest proportion of black soils, mainly on loess, and than brown soils. The subsoil consists of granodiorite, slope sediments (clay, stones) green shales, arkoses, aplite and pegmatite. Deep magnatiti, unpaved and paved sediments and metamorphites occur here. Meteorological data were used from the Czech Hydrometeorological station Brno - Tuřany. The average temperature and rainfall in the years 1961 to 1990 (per month) are listed in Table 1. The average temperature and precipitation for the months of the year 2011 are presented in Table 2.

Methodology of weed infestation evaluation and statistical processing

The composition of the weeds species on the railways has been observed in the abovementioned rail route Brno - Česká towards to Řečkovice. The route is 5 km long and for the most part is surrounded by forest. 20 habitats differently spaced along the track were selected to evaluate the weed species. Habitats were chosen randomly (eg. in the railway track, on the railway embankment or a few meters from the railway embankment). The weed species were evaluated on the basis of phytosociological relevé in the area of 20 square meters. Each relevé was evaluated separately based on the composition of the weed species as well as its cover which is shown in percentage. The evaluation was out in two periods of the year 2011 (June and August).

Czech and Latin terms of each weed species are used according to Kubat [6].

The obtained data were processed by multivariate analysis of ecological data. Selection of the optimal analysis followed the length of the gradient (*Lengths of Gradient*), which was detected by segment analysis DCA (*Detrended Correspondence Analysis*). A total number of 499 permutations were calculated in Monte-Carlo test. Collected data were processed by a computer program called Canoco 4.0 [7].

Table 1 Data of weather conditions from the meteorological station Brno – Tuřany, in period 1961-1990

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	average
The average temperature (°C)	-2.5	-0.3	3.8	9.0	13.9	17.0	18.5	18.1	14.3	9.1	3.5	-0.6	8.7
Precipitation (mm)	24.6	23.8	24.1	31.5	61.0	72.2	63.7	56.2	37.6	30.7	37.4	27.1	490.1

Table 2 Data of weather conditions from the meteorological station Brno – Tuřany, based on data from 2011

	I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.	average
The average temperature (°C)	-0.5	-0.8	5.7	12.5	15.1	19.2	18.9	20.5	17.2	9.5	2.9	2.1	10.2
Precipitation (mm)	17.6	3.0	46.4	24.5	44.2	61.6	92.6	35.6	30.6	18.6	0.0	18.0	392.7

Results and Discussion

41 plant species were observed in total, the highest cover had species as *Solidago canadensis, Urtica dioica* and *Lolium perenne.* For more details reffer tto Table 3.

Statistical evaluation

The obtained data with respect to the frequency and the cover of individual plant species were firstly processed by DCA analysis which calculated the Lengths of Gradient at 4.106, followed by a Canonical Correspondence Analysis (CCA). CCA analysis defines the spatial arrangement of an individual species and selected monitoring sites. This is then expressed graphically using the ordination diagram. Weed species and different habitats are demonstrated by different shapes and colors. The results of CCA analysis indicate that the influence of the plant frequency and species cover is quiet compelling and significant at the significant level $\alpha = 0.050$ for all canonical axes. According to the ordination diagram (Fig. 1) plant species can be divided into several groups:

Table 3 The sum of weed species vegetation cover found in the selected section of the railway

Weed species	Stands	
	"Násep"	"Koleje"
Aegopodium podagraria	135	133
Achillea millefolium	67	85
Arctium tomentosum	20	35
Armoratia rusticana	50	26
Artemisia vulgaris	83	124
Atriplex sagittata	0	5
Carduus acanthoides	47	12
Cichorium intybus	40	13
Cirsium arvense	77	0
Convolvulus arvensis	0	3
Crepis biennis	28	13
Erigeron annuus	7	0
Euphorbia cyparissias	48	20
Fragaria fesca	145	34
Galinsoga parviflora	3	0
Geranium robertianum	41	57
Helianthus tuberosus	160	0
Hypericum perforatum	110	20
Chaerophyllum temulentum	30	5
Chelidonium majus	58	31
Chenopodium album	25	0
Knautia arvensis	0	2
Lamium album	50	25
Linaria vulgaris	0	4
Lolium perenne	245	256
Lotus corniculatus	8	0
Medicago sativa	5	7
Plantago lanceolata	89	13
Plantago major	78	10
Polygonum aviculare	5	0
Potentilla anserina	60	53
Securigera varia	0	5
Setaria viridis	10	0
Solidago canadensis	374	220
Stellaria media	6	96
Taraxacum officinale	54	27
Trifolium pratense	40	0
Trifolium repens	84	28
Urtica dioica	408	108
Urtica urens	55	31
Vicia sativa	42	16

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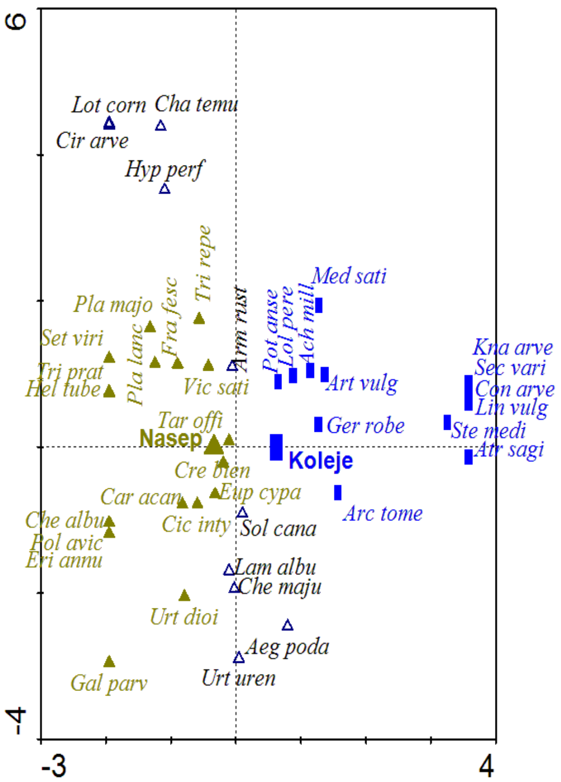
Fig. 1 Ordination diagram expressing the weed species composition in both monitoring terms



Legend: railway embankment - a group of phytosociological relevé in the area called "nasep"; train tracks - a group of phytosociological relevé in the area called "Koleje"

Species: *Aeg poda - Aegopodium podagraria, Ach mill - Achillea millefolium, Arct tome – Arctium tomentosum, Arm rusti – Armoratia rusticana, Art vulg - Artemisia vulgaris, Car Acan – Carduus acanthoides, , Cic inty – Cichorium intybus, Cir arve – Cirsium arvense, Con arve – Convolvulus arvensis, Cre bien – Crepis biennis, Eri annu – Erigeron annus, Eup cypa – Euphorbia cyparissias, Fra vesc – Fragaria vesca, Gal parv – Galinsoga parviflora, Ger robe – Geranium robertianum, Hel tube – Helianthus tuberosus, Hyp perf – Hypericum perforatum, Cha temu – Chaerophyllum temulentum, Che albu – Chenopodium album, Che maju – Chelidonium majus, Kna arve – Knautia arvensis, Lam albu – Lamium album, Lin vulg – Linaria vulgarit, Lol pere – Lolium perenne, Lot corn – Lotus corniculatus, Med sati – Medicago sativa, Pla majo – Plantago major, Pol avic – Polygonum aviculare, Pot anse – Potentilla anserina, Sec vari – Securigera varia, Set viri – Setaria viridis, Sol cana – Solidago canadensis, Ste medi – Stellaria media, Tar offi – Taraxacum officinale, Tri prat – Trifolium pretense, Tri repe – Triforium repens, Urt dioi – Urtica dioica, Urt uren – Urtica urens, Vic sati – Vicia sativa.*

The first group of weed species is more often on group-habitat "Násep" and includes: *Aegopodium podagraria, Achillea millefolium, Arctium tomentosum, Armoratia rusticana, Artemisia vulgaris, Carduus acanthoides, Cichorium intybus, Cirsium arvense, Crepis biennis, Erigeron annus, Euphorbia cyparissias, Fragaria vesca, Galinsoga parviflora, Geranium robertianum, Helianthus tuberosus, Hypericum perforatum, Chaerophyllum temulentum, Chelidonium majus, Chenopodium album, Lamium album, Lolium perenne, Lotus corniculatus, Medicago sativa, Plantago major, Polygonum aviculare, Potentilla anserina, Setaria viridis, Solidago canadensis, Stellaria media, Taraxacum officinale, Trifolium pretense, Triforium repens, Urtica dioica, Urtica urenc* and *Vicia sativa.*

On the second group-habitat "Koleje" occurred: *Aegopodium podagraria, Achillea millefolium, Arctium tomentosum, Armoratia rusticana, Artemisia vulgaris, Atriplex sagittata, Carduus acanthoides, Cichorium intybus, Convolvulus arvensis, Crepis biennis, Euphorbia cyparissias, Fragaria vesca, Geranium robertianum, Hypericum perforatum, Chaerophyllum temulentum, Chelidonium majus, Knautia arvensis, Lamium album, Linaria vulgaris, Lolium perenne, Medicago sativa, Plantago major, Potentilla anserina, Securigera varia, Solidago canadensis, Stellaria media, Taraxacum officinale, Triforium repens, Urtica dioica, Urtica urens* and *Vicia sativa.*

The third group consists of weed species occurring in both group-habitat: *Aegopodium podagraria, Armoratia rusticana, Cichorium intybus, Hypericum perforatum, Chaerophyllum temulentum, Chelidonium majus, Lamium album,* *Lotus corniculatus, Solidago canadensis* and *Urtica urens.*

According to Torstensson [5] a deep-rooted plants are one of the main reasons for removing the weeds from the railway embankments. Due to significant risk of the weed blocking the hollow spaces of the railway embankment and subsequent raise of water which could freeze in the winter and cause the damages. The risk of tripping or slipping on weedy track is high, therefore the prevention is very important. Additionally, the overgrown track can also be dangerous for the train itself and cause skidding or extend the distance in which the train is capable to stop. Risk of fire due to flying sparks from the trains' wheels surrounded by extremely dry vegetation increased during dry summer.

Conclusion

Number of different weed species were found during the observation of the monitored area on the railway tracks between stops Brno - Řečkovice and Česká.

Cover and occurrence of the weed species differs by localities. The most often weed species in terms of repetition and vegetation cover were: *Solidago canadensis, Urtica dioica, Lolium perenne, Aegopodium podagraria* or *Artemisia vulgaris.* The most occurring weed species on the railway embankment except the already mentioned were: *Helianthus tuberosus, Fragaria vesca, Hypericum perforatum, Plantago lanceolata* and *Cirsium arvense*. On the railway tracks then were for example: *Stelaria media, Achillea millefolium, Geranium robertianum* or *Arctium tmentosum*.

We can represent that the railway tracks have a diverse variety of the weed species which might have negative impact on the safety of the railway line. Weed species that can easily spread and have well-developed root system can be the most dangerous, namely: *Solidago canadensis, Urtica dioica, Artemisia vulgaris, Helianthus tuberosus* and *Cirsium arvense.*

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