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Bachelor Thesis

Utilization of extraspecific and extragenus hybrids in grass breeding

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Affidavit:

“I hereby confirm that I wrote this thesis “Utilization of extraspecific and extragenus hybrids in grass breeding” on my own and without the use of any other than the cited sources and tools and all explanations that I copied directly or in their sense are marked as such, as well as that the thesis has not yet been handed in neither in this nor in equal form at any other official commission. Furthermore I agree to an anonymous test of plagiarism which electronically verifies the validity of my declarations. I am aware that my thesis will not be evaluated in case of not making this statement.”

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Content

Možnosti uplatnění mezidruhových a mezirodových hybridů při šlechtění trav

Souhrn: Tato práce se věnuje travinám a důležitosti jejich křížení. Tráva je celosvětově rozšířená, a jakožto kulturní plodina slouží jako zdroj potravy nejen pro hospodářská zvířata, je hospodářsky významná ve sportovním průmyslu a poskytuje cenný zdroj genetické diversity. Záměrem této práce je shrnutí informací o metodách křížení trav a popsat morfologii Kostřavy červené v ranných fázích růstu. Toto by mělo přispět k výběru vhodných fenotypů pro další křížení. Metodika je založena na skleníkovém pokusu s vybranými kultivary trsnaté a krátce výběžkaté Kostřavy červené. Morfologický vývoj podzemních a nadzemních orgánů bude studován postupným odebíráním rostlin.

Klíčová slova: křížení trav, trávníky, genetická diverzita, travní hybridi, morfologie Kostřavy červené, *Festuca rubra commutata*, *Festuca rubra trichophylla*, Aranka, Musica, Cezanne, Viktorka

Utilization of extraspecific and extragenus hybrids in grass breeding

Summary: This thesis is dedicated to grass and its importance of breeding. Grass is widespread throughout the world. This cultural plant serves as the source for livestock, plays economically important role in sport industry and provide valuable source of genetic diversity. The aim of this thesis is to summarize the information about methods of grass breeding and describe the morphology of Red fescue in the early stages of development. This may contribute to the selection of suitable phenotypes for further breeding. Methodology leans against a glasshouse cup experiment with selected varieties of bunch type and spreading type of Red fescue. The morphological development of underground and aboveground organs will be studied by the gradual sampling of plants.

Keywords: grass breeding, turfgrass, genetic diversity, grass hybrids, morphology of Red fescue, *Festuca rubra commutata*, *Festuca rubra trichophylla*, Aranka, Musica, Cezanne, Viktorka

1. Introduction

Grass belongs among worldwide plant species. Forage grasses sustains millions of livestock, turfgrasses are used in athletic fields, roadsides, golf course roughs and other areas where moderate levels of turfgrass quality are desirable. As A human needs change, so too will turfgrasses, resulting in future co evolution with humans.

Aims of extraspecies and extragenus hybridization is usually the accumulation of positive parental features in newly established genotype, introduction of some important economical features into cultural plants, for example disease and pests resistance, freeze resistance, persistence, protein content, sugar content and induction of cytoplasm sterility.

The progress in improvements of biotic and abiotic stress tolerance is being made. Molecular technologies, such as genetic transformation and marker-assisted breeding, have become effective and efficient, procedures for improving stress tolerance of some major crop species the conventional breeding through sexual hybridization is the principal route for the development of stress resistant forage and turf varieties. Hybrids of genus Festuca together with Lolium are, as the fine grasses with desirable characteristics, economically very important. I this work, I will try to enrich a little the knowledge about the Festuca rubra and its cultivars by observing their morphology and growth features.

2. Literature review

2.1 Turfgrass breeding

2.1.1 Evolutionary history of grasses

Grasses probably originated in the late Cretaceous in wet nutrient- poor sunny habitats. By the Paleogene the lineage had diversified into swamps, the forest understory, epiphytic habitats, and nutrient- poor heath lands (Linder and Rudall, 2005). The earliest grasses lived in shady tropical forests. The evolution and spread of grasses undoubtedly resulted from their ability to adapt to seasonally dry habitats created as tropical-deciduous forests developed 58 million years ago (Jacobs et al., 1999; Linder and Rudall, 2005;. Kellog (2011) supposed the origin of the grasses can be dated by the appearance of grass pollen in the fossil record. This is consistent with the claim of Van Devender (2012), the oldest reliable megafossil grass fossils were spikelets and inflorescences from the latest Paleocene (about 58 mya). First grasses were proto-bamboos with broad leaves. By the early Miocene (24 mya), however, grasses in all our modern subfamilies were present, indicating that our modern taxonomic and physiologic diversity had been well established by that time (Van Devender, 2012). During the evolution, the grass gain the features as wind pollination, presence of ferulic acid in cell walls, drought tolerance and the capacity to grow and thrive in dry open habitats to CO – concentrating mechanisms such as C4 photosynthesis and CAM (Linder and Rudall 2005; Kellogg 2011). These features had preserved in grasses and had originated multiple times during the phylogeny, as declares Kellog (2001). Extant families of Poales occur in virtually all nonmarine habitats, from equator to pole, from floating water plants to the most severe deserts, and on most (if not all) soil types. Furthermore, there are representatives of most major-forms – lianas, epiphytes, hydrophytes, emergent-rooted aquatics, tall and short plants, annuals and long lived perennials; only the tree form is absent. Grasses includes about one third of all monocot (Angiosperm) species, with cca 20 000 species dominating modern savannah and steppe vegetation (Linder and Rudall, 2005). From the end of the seventeenth century, when the stamens were appeared as the male plant organs and Linnaeus's first plant hybrid- *Tragopogon pratensis* and *T.porrifolius* in 1759, the grass breeding walked a long way. In nineteen century, the fertility or infertility of hybrids, whether due to the pollen or the female organs and the constancy of fertile hybrids through reproduction by seeds were known. The conception of the possibility of hybridizing plants arose as soon as the sexuality of the higher plants became known (Focke, 1913).

2.1.2 Grass breeding objectives

The turfgrass breeding importance originates from the basic functions of grass stand and its environmental aspects. These factors are becoming significantly important in large residential areas and cities with increased air pollution in the second half of last century. By the economical importance, where the turfgrass breeding plays a key role, the importance of breeding is also environmental.

From the scientific point of view, turfgrass entraps and holds rainfall better than most surfaces (Beard, 1991). Thereby conserve water and energy and may carry eroded soil and organic chemicals and reduce their leaching to sewers, streams, rivers or lakes. Turfgrass also reduce water loss caused by runoff and enhances the potential for ground water recharge (Beard, 1991) also demonstrated, that actively growing turfgrass has ability to reduce surface temperatures by 30 – 40 F (1-4 C) in comparison to synthetic turf surfaces. Turf similarly considerably contributes to our environment by adding beauty to our surroundings. The species diversity present in turfs is a functional diversity contributing to the previously mentioned agronomic and environmental benefits. The species belong to different functional groups and the adequate species composition may maximise the agronomic performance through symbiotic nitrogen fixation or sources of pollen and nectar to pollinators as suggests Huyghe (1991).

In a given turf, the genetic diversity available in each variety contributes to this economic and environmental performance, but also to the stability of these performances including the stability of the resistance against pathogens and pests. Natural grasslands share many species (grass and leguminous) with the sown swards. They are valuable sources of diversity for breeding. Resources available for turfgrass breeders become increasingly large, with more access to better characterised materials, rapid and accurate methods for phenotyping and genotyping, expanding molecular resources, bioinformatics and computational resources (Huyghe, 1991). Zhang et al. (2004) report the development of molecular and genomic resources grasses (especially turfgrass) has been limited in comparison to the new methods improving stress tolerance in major crop plants. It is logical, because crop plants so as forage grasses sustains millions of grazing animals and billions of people as a food source. Notwithstanding the turfgrass breeding is the prerequisite in sustaining the genetic diversity. The importance of genetic diversity for future breeding objectives as well as for long-term stability of ecosystems gave rise to two conservation strategies for genetic resources (CBD 2005).

Ex situ conservation includes the storage in gene banks of germplasm collections intended to best represent genetic diversity. In breeding station, superior genotypes are maintained with vegetative propagation. *Ex situ* conservation can be effective for protecting species or small number of threatened varieties or ecotypes. However, it is not very effective for maintaining the vast genetic diversity characteristic of the species and are very expensive, especially when live plants are maintained (Peeters, 2004). In contrast in-situ conservation includes the maintenance of plants at their specific habitats (e.g. permanent grassland), allowing continuing evolutionary adaptation (Frankel et al. 1995; Maxted et al. 1997). Ecological factors and agricultural practices have created a vast biodiversity that can only be conserved by protecting the habitats and using management methods close to those that created that diversity (Peeters 2004). Genetic diversity present in permanent grasslands is threatened by intensification of forage production. This is basically a consequence of an increasing use of external inputs of fertilizers and large-scale resowing with improved cultivars of only few species (Brown 1992);

2.1.3. Aims in turfgrass breeding

The improvement in stress tolerance is the major breeding goal in turfgrass breeding (Zhang and Bouton, 2004). For the development of sustainable and environmentally friendly production systems, the cultivars with improved stress tolerance are necessary. Specifically, the aim of breeding is focused nowadays to disease resistance. The stresses can be divided into biotic and abiotic. Grazing by herbivores, diseases caused by viruses, microbial and fungal pathogens so as allelopathy and interactions, those are all biotic stresses. Abiotic stresses could be from physical like UV light, extreme temperatures, drought, flooding to chemical like lack of oxygen, poor nutrient soil, abundance salt ions and hydrogen in soil, toxic metals and organic compounds in soil and also toxic gases in the air. To relieving of plant stress also contributes the proper maintenance like adjusting the amount of water or air in the soil, optimizing the availability of essential plant nutrients, increasing the mowing height to allow more light absorption by the leaves, and sometimes overlooked clean cutting. Most turfs are made up of a mixture of grasses, such as ryegrasses, bentgrasses, bluegrasses, fescues, Moser and Hoveland (1996) add buffalo grass. Growing in mixtures is preferred before growing the grass in monocultures for various reasons, higher disease resistance, better wear tolerance, higher plasticity, better reaction to stress factors, including better use of soil moisture during times of low rainfall (Skinner et al, 2004).

Due their adaptability, turf and grasses occupy twice the land area of grain crops worldwide (Jauhar, 1993). As stated Lancashire et al. (1977), one of the reasons could be that turfgrass have coevoluted with many disease causing pathogens resulting in alleles for resistance in many natural population. The natural selection created morphological and chemical barriers and resistance mechanisms to various insects (Fungal pathogens such as *Heltminthosporium* causes leaf spot and melting-out and reduces competitive ability, which is one of the factors which greatly reduces the desirability of the turfgrass species as fine fescue (Payne et al., 1974). Adaptation of many turfgrasses is influenced also by their mutualistic association with *Endophytes* (Zhang and Bouton, 2004) so as claims Christians (2011). Endophyte-enhanced cultivars have greatly increased the area of adaptation of this species (Brilman in Christians 2011). Similarly, with the aim to breed the resistant, stress tolerant grasses, the esthetical value plays an important role in grass breeding. Control over fertility, growth dynamics, leave fineness and plugging are also goals of breeders. Valuable source for extraspecies hybridization are wild species. These species provide a huge potential of genes controlling features, which are and may be the source of new combination and features. For this reason, it is necessary to protect, collect and store in gene banks and though keep this wild flora for the future breeding. A genus *Festuca L.*, comprising some 450 species that range from diploid (2n = 2x = 14) to dodecaploid (2n = 12x = 84) on chromosome number (Šmarda, 2006) provide a great breeding material.

2.1.4 Turfgrass Hybrids

Classical breeding approaches such as phenotypic and genotypic recurrent selection have been widely used in grasses that are cross-pollinated and are predominantly self-incompatible. Identification of superior genotypes and their subsequent interbreeding to produce new combinations of genotypes with improved expression of specific character is the basis of this process (Fojtík). Genetic modification of turfgrasses continues to be explored as an avenue to introduce genes or characteristics unavailable or difficult to achieve through traditional breeding (Brilman, 2005).

The hybrids are intragenus, interspecific and intraspecific. Intragenus (or extragenus as I state in my thesis) means hybrids within the genus. Interspecific (extraspecific) means occurring between species and intraspecific involves the members of one species.

For development of new hybrids it is expected to overcome the barriers to inter-and intraspecific incompatibility. The main cause of crossing impossibility lies in the pre-zygotic and post-zygotic incompatibility. Pre-zygotic incompatibility is mainly based on morphological differences of flowering (different length of pollen tubes and pistil, etc.), the disharmony of the parental flowering period, different climatic conditions (drought, moisture, heat, cold) in the physiology (pollen does not germinate on stigma), cytological and genetic barriers such as the presence of incompatibility genes (S-alleles), which inhibit the growth of pollen tubes on the stigma and control the pollination and fertilization stages of pollen. Post-zygotic incompatibility is characterized by defects emerged after fertilization, during the embryo and endosperm development. The normal ratio of extragenus hybridization in the same number of chromosomes is 2:3:2 (embryo - 2n - 3n and nucelus - 2n). Violation of these conditions has always a negative influence on the development and production of seeds.

The fertility of extraspecific and extragenus hybrids is usually decreased or they are completely sterile. Primarily, the sterility of F1 hybrids is a result of disorders of meiotic cell division cycle. In meiosis, chromosomes of different species conjugate badly or not conjugate. The consequence of this irreparable mechanism is the creation of univalents, trivalents or polyvalents instead of bivalent configuration which are generated during chromosome pairing. In anaphasis the gametes created thereby consist of irregular chromosome number and low viability. This leads to the pollen and anthers fertility disorders, decreased functional capacity of embryonic sacks herewith reduced seed production.

The solution for fertility disorders is polyploidisation F1 hybrids, creation of aloploids, which makes homologous chromosomes able to pair and produce viable gametes. Aloploidisation recovers not only fertility but also amplify the genetic variability. More recombinant possibilities allow more intensive selection of combinations. Another solution for sterility and hybrid genome stabilization is back-cross breeding with one of the parental genus or breeding with fertile form of the hybrids. Also induction of genetic and chromosomal mutations with mutagens like UV radiation of pollen or gamma radiation of F1 plants helps to break the barriers of sterility. The newest way to break the problem with breeding and sterility of F1 hybrids is somatic hybridization – the protoplast fusion. Product of this method is aloploid hybrids with less numerous meiosis disorders that the hybrids created through sexual reproduction. Through the hybridization, the newly originated cultivars are then placed in the List of eligible varieties.

2.2 Features of genus Festuca L.

The genus *Festuca L.* is one of the largest in *Gramineae* (Yamada, 2011) *Festuca L.* belongs to the kingdom *Plantae* (plants), division *Magnoliophyta* (flowering plants), class *Liliopsida* (monocotyledons), order *Poales*, family *Poaceae* (grasses). Recent evidence from molecular phylogenetic studies shows that the genus lacks monophyly. As a result, several species, including the forage grasses, tall fescue (*Festuca arundinacea)*, and meadow fescue (*Festuca pratensis*.) formerly belonging to the genus Festuca have been recently placed into the genus *Lolium* (Yamada, 2011). *Festuca L.* and its closely allied genus *Lolium L.* have long fascinated agronomists, evolutionists, and plant breeders, and these genera are among the most widely studied of the non-cereal grasses (Yamada, 2011).

A genus of *Festuca L*, is characterized with morphological features as follows; perennial tufted to something short-rhizomatous; leaf blades typically parallel-veined, mostly rolled, something flat; leaf sheaths open; ligules short, membranous; auricles present or absent; inflorescence a compressed or lax panicle; spikelets two - many-flowered, disarticulating above the glumes; glumes shorter than lemma; upper glume usually three-nerved; lemmas membranous to thinly coriaceous, usually glabrous, five nerved, acuate, awnless or awn-tipped; palea almost equal to lemma, scabrous, or ciliate; lodicules two; stamens three; ovary sometimes hairy on the top (Jahuar, 1993).

Classification of the almost cosmopolitan genus Festuca has varied through the last two centuries. Hackel (1882) subdivided Festuca into six sections: *Ovinae, Bovinae, Sub-bulbosae, Variae, Scariosae* and *Montanae* based on vegetative and floral characters. Within sect. *Ovinae* and *Variae*, subgroups were characterized by intravaginal versus extravaginal innovation.

Because of the diversification of the ploidy levels in various taxonomically intricate groups, ploidy level is an important species character in recent *Festuca* systematic treatment. The genus Festuca contains two agriculturally important forage crops, hexaploid tall fescue (*F.arundinacea*) (2n = 6x = 42) and diploid meadow fescue (*F.pratensis*) (2n =

2x = 14). Tall fescue is the most important forage species worldwide of the Festuca genus. (Jauhar, 1993). The molecular systematic studies provided new insights in the phylogeny of subtribe *Loliinae* of tribe *Poeae* (Catalán et al. 2004; Torrecilla et al.2004). The subtribe can be roughly classified into two major lineages; broad leaved fescues and fine leaved fescues containing the majority of *Festuca* species.

2.2.1. Systematic of *Festuca rubra L.*

For the closer view how, the *Festuca rubra* is subdivided as part of the *Poaceae* family, we observe from the tab.1. The grass family is so big and especially in the genus Festuca ssp., this intermediate ranks are sometimes confusing. In the tab.1, we can observe fine-leaved Festuca ssp. classification hierarchy. We can see one example, how the Festuca nomenclature is complicated. For the *F.rubra litoralis*, there is also equivalent *trichophylla*, and I will use this name *trichyophylla* throughout this work, to avoid misunderstood.

The fine-leaved *Festuca* spp. classification hierarchy includes:

Family: Poaceae
Subfamily: Festucoideae
Tribe: Festuceae
Genus: ***Festuca*** L.
Subgenus: ***Festuca***
Section: ***Festuca***

- ***Festuca rubra*** aggregate
  - ***F. heterophylla*** Lamarck
  - ***F. rubra*** L.
    - ssp. ***commutata*** (Thuill.) Nyman
    - ssp. ***litoralis*** (G.F.W. Meyer) Auquier
    - ssp. ***rubra*** Gaudin
- ***Festuca ovina*** aggregate
  - ***F. filiformis*** Pourret
  - ***F. idahoensis*** Elmer
  - ***F. ovina*** L. ssp. ***hirtula*** (Hackel *ex* Travis) M. Wilkinson
  - ***F. trachyphylla*** (Hackel) Krajina
  - ***F. valesiaca*** Schleicher *ex* Gaudin

Picture.1
Classification of turf-type fine-leaved *Festuca* species within the *Poaceae* family (from Turfgrass Biology, Genetics and beeding, p. 134 Fig.9.1)

Festuca rubra is relatively slow growing in the sowing year is notable for the shade tolerance, very fine leaves and high shoot density (STRI, 2008). Red fescue belongs among cool-season species which are best adapted to the cooler times of year. They thrive in temperatures from 18 to 24 °C (Beard, 1973). The cool-season species emerge from dormancy and grow very rapidly in the spring. They are somewhat intolerant of summer stress periods, and growth is slowed in midsummer. Their growth increases in the fall, but not the same extent as the rapid growth of spring. Cool-season grasses maintain their green colour well into the fall, and may remain green through the winter. Warm-season loses their chlorophyll as they go dormant, and they remain brown until spring. The cool-season species are known as C3 grasses, and the warm-season species as C4 grasses. The names are based on their photosynthetic system. Cool-season grasses begin the process of carbohydrate production with a three-carbon compound, whereas the warm-season grasses begin the process with a four-carbon compound (Jones, 1985). There are also differences in the cell structure of the leaves at a microscopic level. The distinction between warm- and cool-season grasses is therefore based on real physiological factors, rather than on simple temperature preferences.

2.2.2 Morphology of Red Fescue

The most striking characteristic of grasses today is their floral and inflorescence structure. Grass flowers are generally arranged in little spikes, or spikelets; each spikelet consists of one or more flowers plus associated bracts (Kellog, 2001)

Red fescues (2n = 6x = 42 or 8x = 56) (Thomas and Humpreys, 1991), are perennial herbs, densely or loosely caespitose (forming often large tussocks) or rhizomatous, commonly monoecious, exceptionally dioecious. Culms unbranched 0,1-2 m high, below panicle glabrous or finely scabrous, with 1 or more (2-6) glabrous nodes (Stančík and Peterson, 2011). Innovations extravaginal, intravaginal or mixed. Intravaginal innovations grow from the outer root shooting zone and extravaginal are located in basal of root shooting zone (Míka, 2002). Extravaginal shoots are typical for the grasses growing in sufficiently moist and plump soils. This type of tillering supports fast growth and spreading of the plant in space (Serebrjakova,1971 in Čámská, 1995).

Sheaths with free or partially united margins, non-auriculate (except in *Festuca* subg. *Schedonorous*); basal sheats occasionally thickened into a bulb; ligules membraneous; normally less than 1 mm, rarely to 10 mm long; leaf blades flat but often conduplicate or setaceous and then basal, without cross nerves, 0,2-15 mm wide, basal cataphylls rarely present. The most striking characteristic of grasses, the inflorescence structure, as referred Kellogg (2001) is for the red fescue open or contracted panicle (Stančík and Peterson). Spikelets usually with 2 or several bisexual or unisexual florets and an apical rudiment, chasmogamous, some species cleistogamous or viviparous i.e., vegetative proliferation of the spikelets, laterally compressed, disarticulating above the glumes and below the florets; glumes lanceolate to ovate, pointed, carinate or non-carinate, shorter than adjacent lemma; lower glume shorter, 1 (rarely 3)-nerved; upper glume 3 (rarely 5)-nerved; lemmas commonly membraneous (rarely coriaceous), rounded (exceptionally carinate), 5-nerved, entire (rarely budentate), acute, shortly mucronate or awned; awn continuous with midnerve, terminal, rarely subterminal, up to 15 mm long; paleas membraneous, two-carinate, two-dentate, as long as the lemma or a little shorter, scabrous at keels, awnless; lodicules two, small, about 1mm long, two-dentate, hyaline.; stamens 3, anthers 0,4-6 mm long; ovaries glabrous, rarely hairy at apex, styles terminal without an apical appendage; stigmas 2, white. Fruit a caryopsis, free or with lemma adherent, with a linear or sometimes oblong hilum (Stančík and Peterson, 2007). Main morphological features of *Festuca rubra* are in Picture 2.

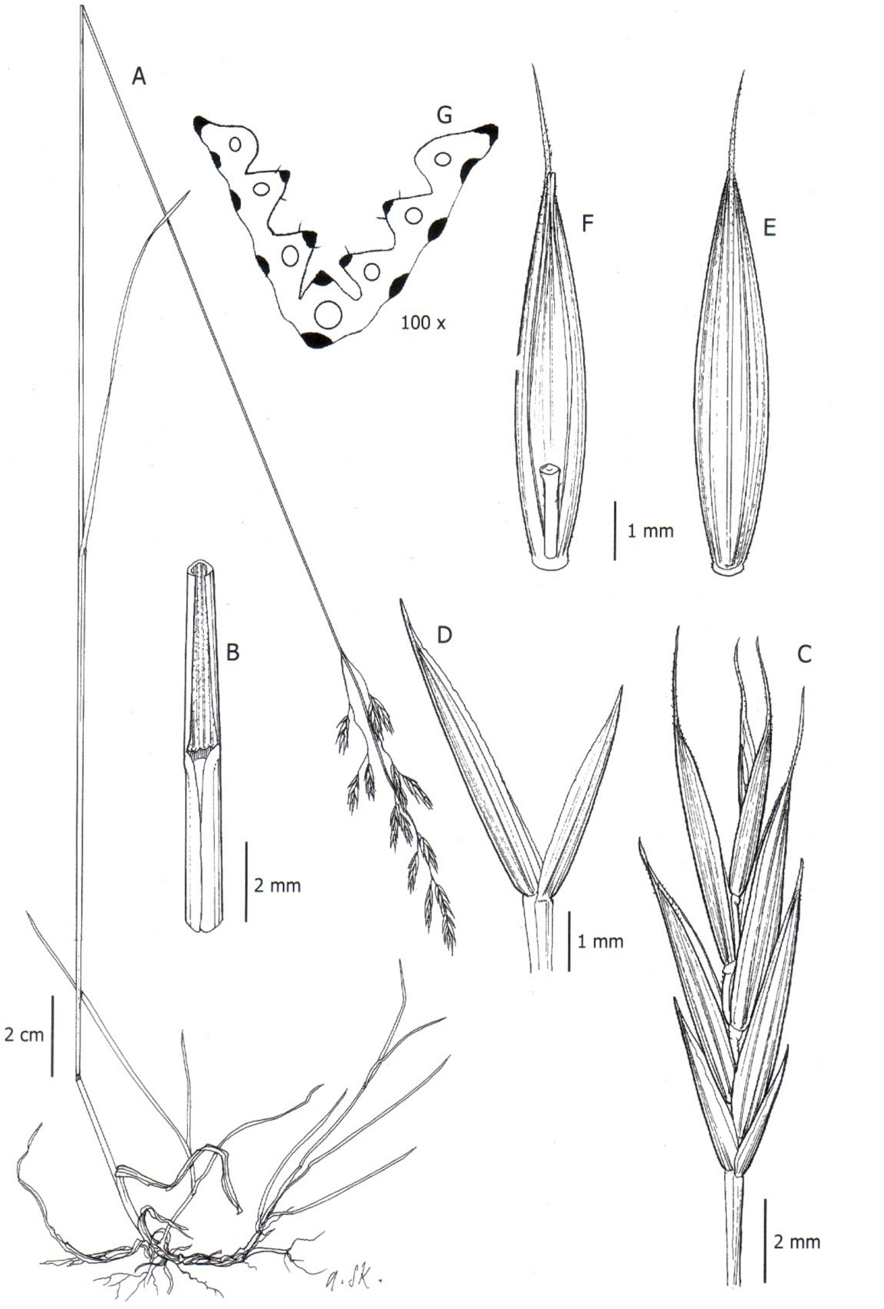

Figure 25. *Festuca rubra.* **A.** Habit. **B.** Ligule. **C.** Spikelet. **D.** Glumes. **E.** Lemma. **F.** Lemma with palea and rachilla. **G.** Leaf blade cross-section. A–G, *Stančík 3457* (PRC).

Picture 2. Morpology of *Festuca rubra* (Stančík, 2007, Festuca in South American Paramos p.58)

2.2.3 Slender creeping red fescue (*Festuca rubra var. trichophylla*)

Festuca rubra var. trichophylla has short rhizomes. The shoot density is very high, which allows it to withstand close mowing. High salt tolerance makes *Trichophylla* a good partner in mixtures for roadsides and parks where salt is used in the winter on roads and paths. The drought and shade tolerance of is higher than that of other red fescues, and it especially thrives in mild coastal climates (STRI Turfgrass, 2008).

2.2.4 Chewings fescue Type: *Rubra commutata* (*var.fallax* Hackel)

Festuca rubra commutata gets its unusual name from Mr. George Chewings, who first sold seed of this species in New Zealand (Hubbard, 1959). It is best adapted to shade, but will persist in full sun. It tends to tolerate summer stress a little better in the drier regions than does creeping red fescue. The Chewings fescues, and particularly the hard fescues, are better adapted to the drier regions (Christians 2001). A bunch type grass, *Festuca rubra commutata* has no rhizomes but the highest density of shoots of the three types. When using *Commutata* in mixtures, it is often necessary to add one of the other types of fescue with rhizomes (or *Poa pratensis*) in order to facilitate the infill and repair of gaps in the sward. In cold areas, *Commutata* is an important component as it has higher winter hardiness than other fescues. As shoot density is very high, *Commutata* is an integral component of mixtures that requires close mowing, especially for golf greens (STRI Turfgrass, 2008).

2.2.5 Strong creeping red fescue Type: *Rubra rubra* (*genuina* Hackel)

Rubra rubra is the most robust from these three varieties. *Rubra rubra* is adapted to more humid regions and is often used in the cooler, moister areas. By forming strong rhizomes, it is able to close gaps in the grass sward very quickly. *Rubra rubra* is faster to establish than *Trichophylla* or *Commutata* and can be used individually or in conjunction with the other types of fescue to ensure a good recuperation of the grass sward.

3. Goals

The aim of this thesis is to summarize the information about methods of grass breeding and describe the morphology of *Festuca rubra* cultivars in the early stages of development. This may contribute to the selection methodology of suitable phenotypes for further breeding.

4. Material and methods

4.1 Material

For the project were chosen 4 cultivars of red fescue. Slender creeping Cezanne and Viktorka and chewing fescues Musica and Aranka. Nowadays the utilization of these cultivars is, according to their visual merit and great shoot density, in luxurious ornamental turfgrass mixtures.

Cezanne is *Trichophylla* cultivar with the performance under very close cutting and rich density. Has medium to dark green colour. Cezanne is a adapted in hot/dry as well as temperate regions. Cezanne performs very well in golf greens (very close mowing) as well in cold/temperate regions as in hot and dry regions with irrigation. The good performance is again and again proven in STRI trials where it is top ranking, and from results of official trials in France and Germany. In 2007 Cezanne also joined the Danish list. The good adaptation to close cutting is certainly partly due to a very high density. (STRI Turfgrass, 2008).

Musica was the top *Commutata* cultivar in 2009 and the top rated cultivar in the UK for bowling greens. Musica is one of the most disease resistant *Festuca* cultivars. Very desirable is its mixture in the rate 50% Musica and 50% Cezanne. This luxurious mixture is known as county fescue.

Aranka is hexaploid *Commutata* cultivar was bred in Větrov and its keeper OSEVA UNI, a.s. Choceň; Aranka is hexaploid bunch type cultivar.

Viktorka is hexaploid *Trichophylla* cultivar. Viktorka belongs to the late cultivars. Among its benefits belong higher resistance against the leaf diseases, mainly powdery mildew. This cultivar is also ideal component for intensive ornamental lawns for its extraordinary density, fineness, low stature, dark green colour and high tolerance to very close mowing Viktorka found its utilization on golf greens and fairways. For its good wear tolerance it is used also in recreation lawns. Its low production of aboveground fytomass and drought tolerance makes from this cultivar also suitable component for extensive lawns. Its ripening is in the middle of July. Keeper: Oseva UNI, a.s., Choceň; Registrated in 2000.

4.2 Methods

The experiment was established on 4.8.2011 in experimental glasshouse in CULS. Plastic cups (volume 0.3 l) were filled (1cm below the edge) with the mixture of peat and sand in ratio 1:1 (the peat was sieved to reduce the amount of bigger particles such as bark, wood etc.). Each cultivar was sown in 20 cups, for each cultivar was sown 3 kernels per cup. Sowing depth was approximately 1 cm. Cups were randomly placed on the table in a glasshouse. Then the cups were irrigated. Irrigation was repeated weakly. After seedling emergence, the poorest seedling from each cup was selected and the only largest and most rigorous ones were kept to further growth. During 3rd and 4th week after sowing, we observed the first tillering. For six months, 6 samplings were performed, whereas, first three samplings were made for description of growth dynamics and the other three served for detailed plants description. First cutting to height of 4 cm (approx. 1/3 of leaf canopy length) and collecting of samples was performed after 13 days from sowing (17.8.2011). During each sampling, 4 samples of each cultivar were collected, washed in the laboratory to get rid of the remaining substrate from the roots. Then samples were scanned afterwards, the number of tiller was computed, the length of roots was measured (the longest root), the belowground and aboveground fytomass was dried (under 90 C for one day) and weighted. All samplings were performed when needed (after visual plant evaluation) – from one to three months. All received data were processed in Excel and mean data were analysed.

5. Results

From the procedures, as mentioned above, we proceed following valuable data. Observations provides us results as time of tillering, number of tillers, root aboveground fytomass weight, root weight and root length and number of root shoots.

Data (average values)	sampling	Aranka	Musica	Cezanne	Viktorka
number of tillers	Day 63.	6,25	13,25	7	6,25
	Day 111.	7,25	9,75	5,75	7,5
	Day 222.	8	9,5	4,5	7
aboveground weight (g)	Day 63.	0,013	0,034	0,017	0,014
	Day 111.	0,027	0,038	0,027	0,025
	Day 222.	0,087	0,095	0,035	0,061
root weight (g)	Day 63.	0,017	0,076	0,023	0,024
	Day 111.	0,030	0,043	0,023	0,012
	Day 222.	0,100	0,083	0,027	0,036
root length (cm)	Day 63.	15,825	19,5	20,125	16,5
	Day 111.	19,3	15,05	19,7	22,45
	Day 222.	14,93	15,58	17,9	16,23
From sowing to tailoring (days)		27	24	32	33

TAB. 1 Data sheet with average values of number of tillers, aboveground fytomass weight, root weight and root length in a given stage time

5.1 Time from sowing till tillering and tillering dynamics

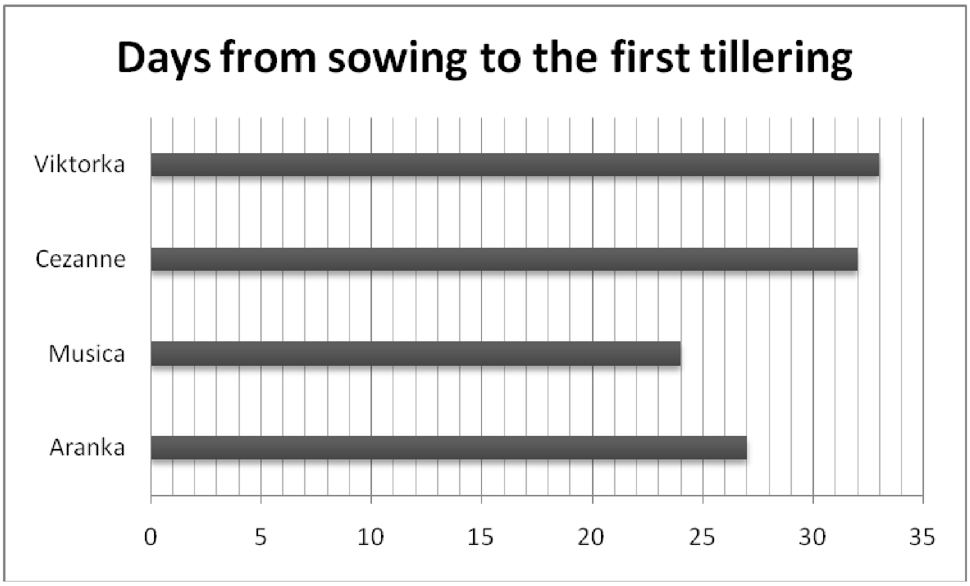

Figure 1. Days from sowing to the first tillering
The figure shows the average number of days after which each variety When started to produce the first tillers. Musica was the first tillering cultivar. The growth in the first 12 (Photo 1), 20 (Photo 2) and 26 days (Photo3).

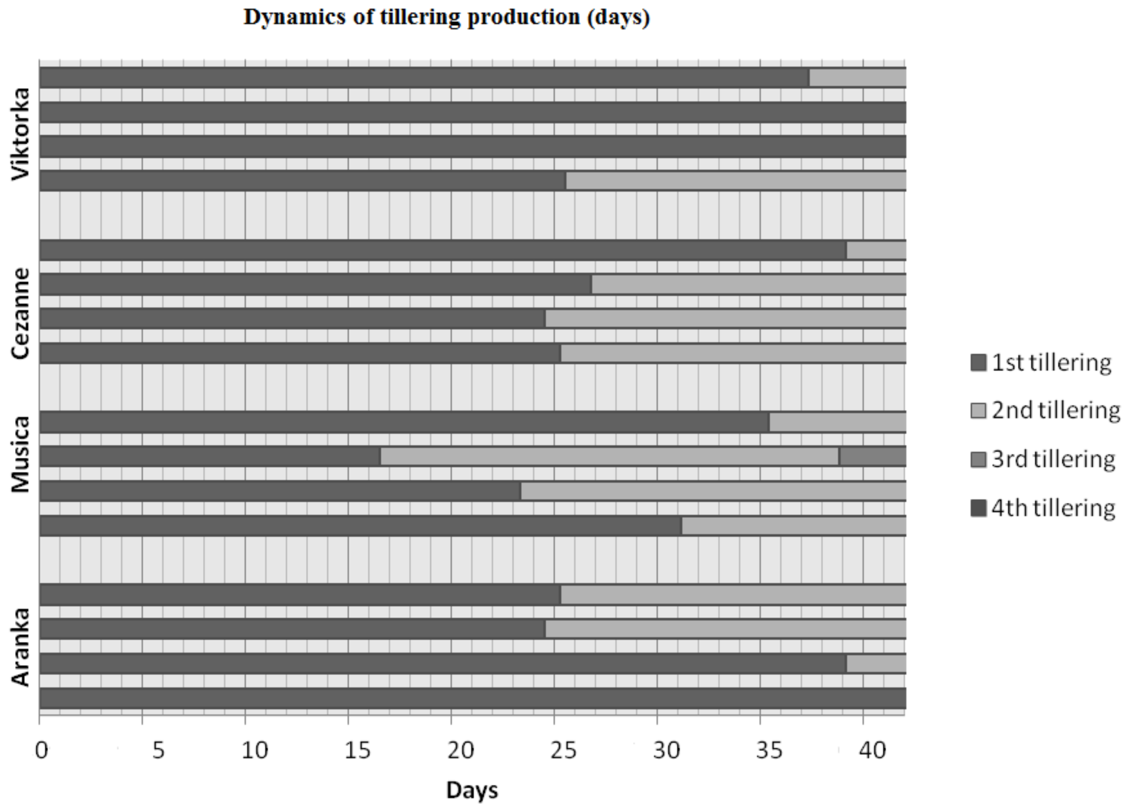

Figure 2. Dynamics of tillering production

Figure shows the time and frequency when the first tillers appeared. Tillering was the most dynamic in Musica. The least dynamic tillering production proved Viktorka. All of the cultivars already produced first tillers in 42. day.

5.2 Number of tillers

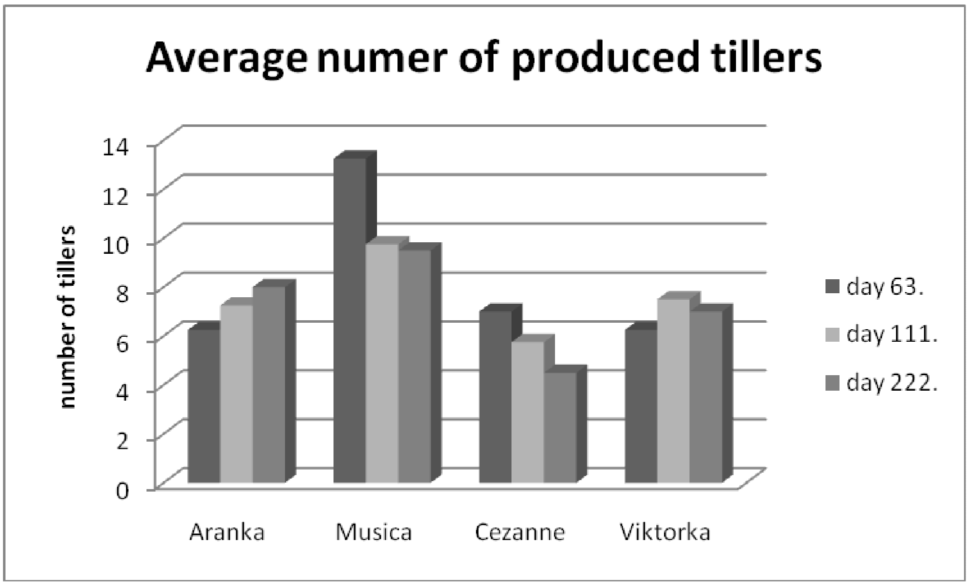

Figure 3. Average number of produced tillers
The average number of produced tillers after 63, 111. and 222. day. Musica Shows the greatest tillering ability; as the least tillering type showed Cezanne together with Viktorka, which is in compliance with the initial slower development characteristic for *Trichophylla* variety. The situation at the 63. day could be observed in Photo 4.

5.3 Aboveground fytomass weight

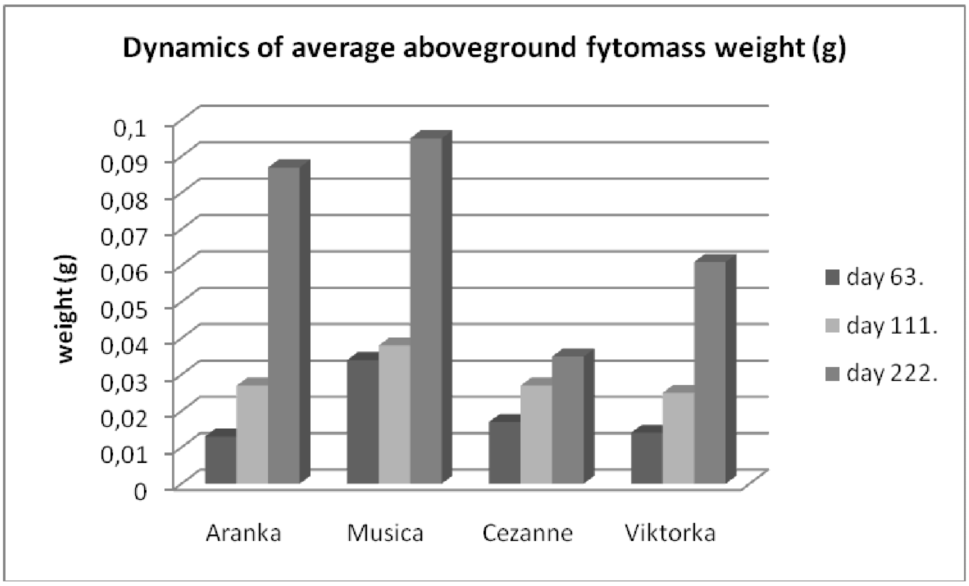

Figure 4. Dynamics of average aboveground fytomass weight (g)

The dynamics of average aboveground fytomass shows significant growth development in the third sampling. Musica and Aranka proved the faster reaction to enlarging photoperiod in early spring.

5.4 Root weight

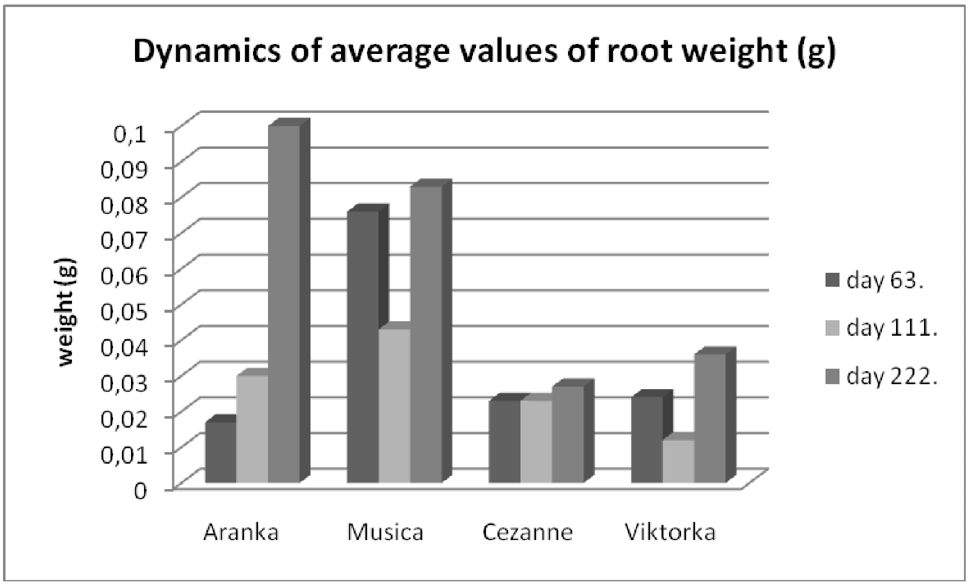

Figure 5. Dynamics of average values of root weight (g)
The weight of roots in early stages was very low except for Musica, which Proved the massive root development from the start. Aranka then became Also root productive culitvar. Viktorka and Cezanne kept its root mass At similar low rate in comparison to *Commutata* cultivars.

5.5 Root length in cm

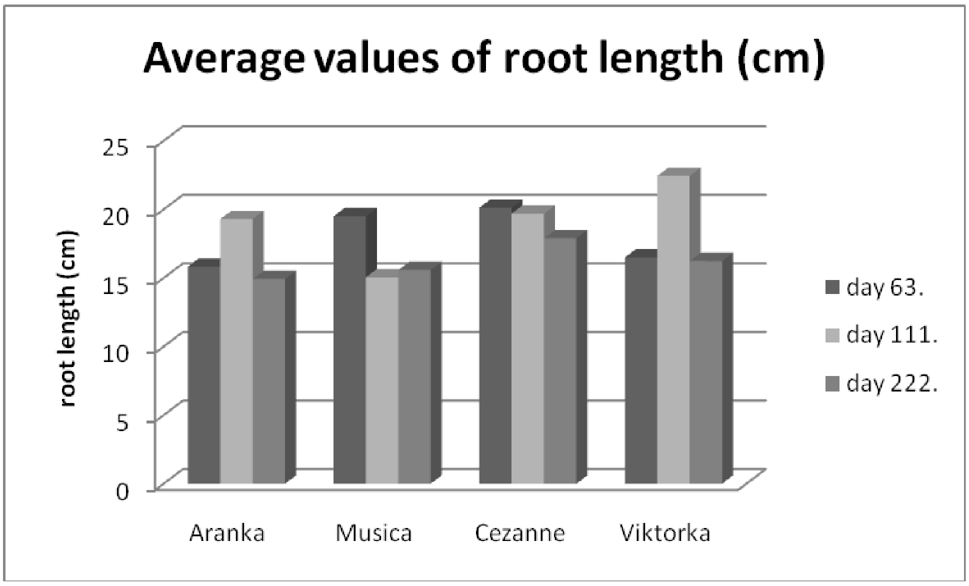

Figure 6. Average values of root length (cm)
The differences among all four cultivars were not so significant;
the longest roots were observed in Viktorka and Cezanne.

5.6 Number of root shoots

In our samplings there were only one single shoot in variety Viktorka in the second sampling. The root shoot is in the Photo 5. And then also in more detail in Photo 6.

6. Discussion

The dynamics of shooting concerning to shooting, in variety Musica, there were the most aboveground shoots. The growth development in the first month we can observe in the Photo 1, Photo 2 and Photo 3. The growth in this very early stage was very fast, in the autumn growth peak of the cold-season grasses.

Slender creeping varieties Viktorka and Cezanne, didn't show any root shooting, with one exception- one shoot in Viktorka (Photo 5 and Photo 6). The creeping fescues have a great root-shooting ability, but in our case this fact was not proved. Primarily it may be caused by the early stages of the plants, the poor light conditions - in the glasshouse; they were very poor as we didn't use any additional light like UV etc. Naturally, the photoperiod in our hemisphere is very short during the late autumn and winter. This could have impact to the time of producing new offshoots and overall growth dynamics of your samples. Production of rhizomes may be suppressed by the sustaining of regular level of soil moist in the cups, this in concordance with Čámská (1994), that refers, the extravaginal shoots are typical for the grasses growing in sufficiently moist and plump soils. First tillers appeared in cultivar Musica (Figure 1.) Aranka started to produce tillers as the second one but their production was less dynamic than in case of Cezanne. The average values showed, that the last and the least dynamic tillerng type (Figure 2.) was Viktorka. It contributes to the characteristic, that the initial development of this cultivar is slower.

The most tillers showed (Figure 3.) in Musica and Aranka. Cezanne together with Viktorka proved lower tillering production. This is also in compliance with the claim that of *Trichophylla* variety is characteristic slower initial development. Also the greater average aboveground fytomass was observed (Figure 4.) in *Commutata* cultivars. The big increase of aboveground fytomass was in all cultivars, but the Musica and Aranka proved the faster reaction to the photoperiod which became longer with the spring when the third sampling was done. With more daylight, the plants became more photosynthetically active which resulted in the fytomass growth. The weight of roots in early stages was very low except for Musica, which showed the massive root development from the start (Figure 5). Production of root mass in *Commutata* cultivars - Viktorka and Cezanne was significantly lower than that was in *Trichophylla* cultivars.

As shown in Figure 6. in the length of roots prevails Viktorka and Cezanne. Commutata species, growing under conditions where no need to produce the rhizomes and thereby spread among other plants, they produce thin, but very long roots. Roots of Musica (Photo 3) and Aranka (Photo 4) are massive and thicker than fine and very long roots of *Trichophylla* cultivars as shown in Cezanne (Photo 5), which has the finest root system from all four varieties. *Trichophylla* cultivars have smaller root weight but longer roots. *Commutata* cultivars had short and more massive root system than *Trichophylla* cultivars.

From the graphs, it is obvious, that bunch type grasses produce more tillers and creates more aboveground and underground fytomass than the spreading type. The spreading type feature is ability to produce rhizomes and can spread through the sward.

Similar results were obtained in experiments with bunch type festuca rubra *commutata* Barborka and *festuca rubra rubra* (Petruna) and *trichophylla* (Viktorka), where its ability to grow rapidly in first development stages was significantly higher then others ((Martinek et al., 2009, Martinek, 2011). According to author, this might be a reason of prevailing incidence of this species and, in some cases, which supports slower developing species in s turf during early stages of development, such as *Deschampsia caespitosa.*

7. Conclusion

The most tillers producing so as dynamic growing cultivar showed bunch type varieties which also consequently produced more above and underground fytomass than spreading type cultivars. Musica showed the fastest tillering ability in early stages of its development in comparison to *Trichophylla* cultivars Cezanne and Viktorka, which has slowed initial growth.

The dynamics of average aboveground fytomass shows significant growth development. Musica and Aranka proved the faster reaction to enlarging photoperiod in early spring.

The weight of roots in early stages was very low except for Musica, which proved the massive root development from the start. Aranka was the second most root productive cultivar. *Trichophylla* cultivars have smaller root weight but longer roots. *Commutata* cultivars had short and more massive root system than *Trichophylla* cultivars.

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9. List of Tables, Figures and Photos

10. Appendix

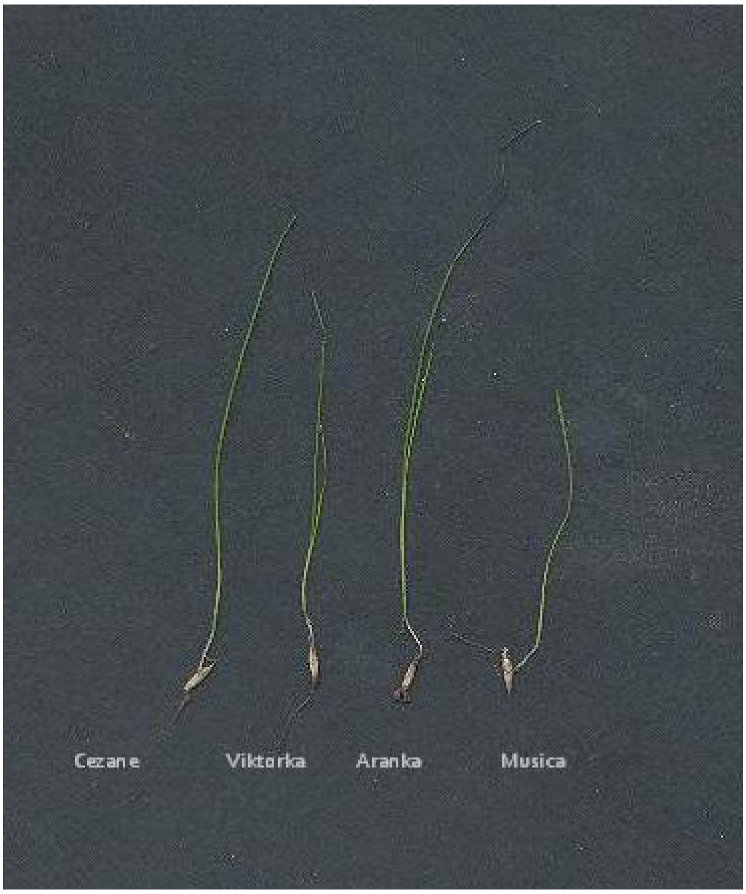

Photo 1. First sampling, 12 days after sowing

Photo 2. Second sampling **-** 20 days after sowing

Photo 3. Third sampling – 26 days after sowing

Photo 4. 63 days after sowing

Photo 5. Viktorka with one rhizome

Photo 6. Viktorka, with one rhizome, detail

Photo 7. Cezanne detail

Photo 8. Musica root system

Photo 9. Cezanne root system

Photo 10. Aranka root system

Photo 11. Musica detail

Photo 12. Cup glasshouse experiment