THE EFFECT OF SOIL WATER REGIME ON VIGOUR OF SPECIES OF PERMANENT GRASSLANDS

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Soil water regime is one of the most important factors affecting distribution and vigour of meadow species. Water regime (hygrosery) is influenced by many uninfluenceable ecological factors. based on medium indication values of the stand, grassland sites were divided into five ecological stages according to water regime: xerophytic, mesoxerophytic, mesophytic, mesohygrophytic and hygrophytic. Average dominance and presence was calculated on each stage of hygrosery in 102 species. As a standard for the level of vigour, index of occurrence (I_v = P.D/100) was used. 10 most vigour species were determined for each ecological stage according to the indices of occurrence. Xerophytic sites do not allow existence of quality cultural species. This stage suits the best to narrow-leaved tall fescue species. On mesoxerophytic stage two grass species are of greatest vigour and of fully distinct requirements for the content of available nutrients. *Arrhenatherum elatius* is dominant in good soils, whereas *Nardus stricta, Festuca ovina* prevail in oligotrophic soils. Of cultural species flexible *Festuca rubra* grows well here. Highest index of occurrence in mesophytic site in oligotrophic soils have: *Nardus stricta* and *Agrostis tenuis*, while *Alopecurus pratensis, Festuca pratensis* and *Dactylis glomerata* are dominant in mesotrophic to eutrophic sites. Good vigour is manifested here by cultural grass species. Mesohygrophic site with reduced soil aeration is dominated by low sedges and other unsuitable herbs. Air deficit in soil of hygrophytic sites is made impossible by existence of cultural grasses and clover crops. Dominant species are high sedges (*Magnocariceta*) and other indicators of strong waterlogging.

water regime; vigour of species; index of occurrence

INTRODUCTION

Vigour of meadow components is one of marginalized sociological factors which conditions significantly their competitive and production capacity.

Vigour of these species cannot be considered statically but always dynamically and under ecological aspect.

Literary data on dependence of vigour of meadow components on the level of various ecological factors are rare. It is implicated by ambiguity of criteria in studying of the level of vigour and time demandingness in long-term investigations. The definition of vigour alone is grasped by different authors in different way. Braun-Blanquet and Pavillard (1920) consider vigour an equivalent analytical and sociological character which designates the degree of development and prosperity of species in certain community. Moravec et al. (1994) suggest that the vigour is an important property of plants in community which is hard to be measured and therefore mostly estimated and by authors expressed by four-member scale by figures or graphic symbols. In majority of phytocoenological studies you cannot meet evaluation of vigour using the symbols. Reduced vigour only is usually presented. Krajčovič et al. (1968) indicates that quality traits of the stand should be supplemented by vigour of species. He states that one species can thrive well in lower area distribution and other one grows bad in greater numbers. Thus it is recommended to evaluate not only degree of coverage, but also vigour by three-degree scale. A detailed study on utilization of different plant species as biological indicators is presented by Clements (1920). Klečka and Fabian (1934) pointed out an importance and significance of many biological indicators for ecological characteristics of grasslands. Indication values of grassland plants were determined by Ellenberg, Zeller (1950) and Klapp (1957).

Indication properties of species were in the centre of attention of Ramenskij et al. (1956), who worked up distribution of different species growing in grasslands into individual ecological series. He gives that a full vigour of species may be developed only in its ecological optimum when individuals reached the full development.

De Vries (1957) calculated indication values of most distributed species as based on frequency. Regal and Krajčovič (1963) stated the range of site amplitude for major species growing in our conditions. He indicates that vigour and competitiveness of species are not stable qualities but they are modified by ecological conditions and age of individuals (Regal, 1967). Balátová-Tuláčková (1955, 1957, 1966) deals with induction of some ecological factors by means of species composition of communities as based on indication values of the species for assessment of meadow and grassland phytocoenoses. After Moravec et al. (1994) grassland vegetation may be used as complex indicator of water regime.

Vigour of species should be considered in wider conception as a complex property, including competitive and production capacities, adaptability to

ecological conditions, ability of intensive vegetative propagation, dissemination and regeneration as well.

MATERIAL AND METHODS

Vigour and interspecies competition is complexly affected by a set of ecological factors and their stages. Thus, presentation and particularly dominance of each species in different stages of water regime is a result of interspecies competitive relationships conditioned by vitality.

Projective dominance (D) and presence (P) of different meadow species were in the centre of authors' attention. In the years 1980–1995 920 natural grasslands in the territory of the CR were analyzed. Different species composition has been recorded in each floristic diagram directly in percentage of reduced projective what allows a synthetic data processing. The prevailing majority of stands was analyzed in spring aspect before the first cut.

On each ecological stage of hygrosery average dominance and presence for 102 meadow species have been calculated. As a standard of the degree of vigour index of occurrence (I_v), which represents a hundredth of product of average dominance and presence (I_v = P.D/100), was used. Index of occurrence expresses percentage of area taken by an investigated species of the total area of certain ecological degree of water regime. Within hygrosery five-degree ecological series. For each ecological stage 10 most vigour species according to the greatest indices of occurrence were determined.

RESULTS AND DISCUSSION

Water and air regime of soil are among most significant factors which condition distribution and vitality of meadow species. Its action is of direct primary character whereby a number of induced effects are applied simultaneously in despite of other factors, particularly in despite of chemical soil properties. Water content in soil is given above all by groundwater table. Its effect on stand composition may be as positive as negative in pratotechnical view. Water regime of meadow soils is affected by a lot of factors: precipitation, temperatures, soil texture, gradients of slope, exposure of terrain, nutrition, way and frequency of utilization. The level of water regime is changing throughout the year.

Based on mean indication value of the stand (Regal, 1967), the site has been divided into five ecological stages of water regime.

Xerophytic ecological stage (H_1), which in view of meadow aspect is fully inconvenient site, does not allow an existence of quality species (Tab. I). The only exception in this ecological stage is *Lotus corniculatus* (I_v = 2.18)

I. Indices of occurrence of ten most distributed grassland species in xerophytic site

Species	*Iv*
Festuca d. sp.	14.48
Poa pratensis ssp. *angustifolia*	5.75
Hieracium pilosella	3.42
Agrostis tenuis	2.31
Lotus corniculatus	2.18
Euphorbia cyperissias	2.16
Medicago falcata	1.71
Thymus d. sp.	1.58
Plantago lanceolata	1.51
Agrostis prorepens ssp. *gigantea*	1.42

which in these conditions is of a great vigour, however of minimum production capacity. An important species of xerophytic sites is *Poa pratensis* ssp. *angustifolia* with strongly incrustated leaves. This ecological stage suits best to narrow-leaved fescue species (*Festuca valesiaca*, *Festuca pseudoovina*, *Festuca ovina*, *Festuca duriuscula* and others) of low feed value. *Thymus d.* sp. (I_v = 1.58) and *Plantago lanceolata* (I_v = 1.51) exhibited greatest vigour among herbs.

Regal (1967) gives good indication values of species on xerophytic site for *Coronilla varia*, *Daucus carota*, *Hypericum perforatum*, and *Plantago media*. Greater dominance of these species indicates that a site is unsuitable for intensive grassland management. Rychnovská et al. (1985) suggest distribution of xerophytes mainly in warm regions of the CR. Dominant species in species combination are narrow-leaved fescue species (*Festuca valesiaca*, *Koeleria gracilis*, *Bromus erectus* as well as xerophilous sedges – *Carex humilis*).

In the second stage of hygrosery – **mesoxerophytic sites** (H_2) – two grass species are of greatest vigour with fully different demands for the content of available nutrients (Tab. II). Under good nutritive soil regime *Arrhenatherum elatius* is dominant, while *Nardus stricta* prevails in oligotrophic soils. Of cultural species flexible *Festuca rubra* thrives well, and in grazing utilization also *Trifolium repens* and *Poa pratensis* ssp. *angustifolia*. Though *Festuca pratensis* is of relatively great vigour, its production capacity is lower. Indices of occurrence of other quality components are as follows: *Dactylis glomerata* – 1.75; *Trisetum flavescens* – 1.34; *Trifolium pratense* – 1.85; *Lotus corniculatus* – 1.02.

II. Competition of ten most distributed species in mesoxerophytic site

Species	*Iv*
Arrhenatherum elatius	7.11
Nardus stricta	7.01
Festuca ovina	4.94
Agrostis tenuis	4.92
Festuca rubra	3.91
Poa pratensis ssp. *angustifolia*	3.67
Trifolium repens	2.45
Calluna vulgaris	2.26
Festuca rubra	2.13

Neither this stage of hygrosery is suitable for intensive grassland management. Xerophilous species prevail here, but in dependence on nutrient reserves some more quality grass species and legumes are present in this stage.

Mesophytic site allows an existence and full vigour of the greatest number of species and therefore increased competition occurs here (Tab. III). With respect to extraordinary and frequent predominance in oligotrophic soils the highest index of occurrence was recorded for *Nardus stricta* (I_v = 9.07). Rychnovská et al. (1985) call attention to the distribution of matgrass particularly in colder regions rich in precipitation and in soils where crude humus is accumulated. Greater distribution has been reported in soils poor in nutrients where other concomitant species are: *Deschampsia flexuosa*, *Sieglingia decumbens*, *Potentilla erecta* and other acidophilous species.

In mesotrophic to eutrophic mesophytes *Alopecurus pratensis*, *Festuca pratensis* and *Dactylis glomerata* are dominant, while *Agrostis tenuis* and *Festuca rubra* prevail in oligotrophic soils. All cultural grasses here manifest a good vigour. Relatively high indices of cultural legumes were recorded for *Trifolium repens* (2.54) and *Trifolium pratense* (2.27). Relatively high index of occurrence was determined also for more hydrophilic weed species *Deschampia caespitosa* what confirms that this species stays also in drained meadows.

Mesophytic site adequately supplied with underground or precipitation water creates the best conditions for permanent grasslands. In abundance of nutrients in this ecological stage, cultural grasses prevail and *Trifolium repens* and *Trifolium pratense* of legumes.

Mesohygrophytic sites are affected by fluctuating groundwater table early in spring, where is a strong abundance of water and soil is poaching. In

III. Indices of occurrence of ten most vigour grassland species in mesophytic site

Species	*Iv*
Nardus stricta	9.07
Agrostis tenuis	8.02
Alopecurus pratensis	5.60
Deschampsia caespitosa	4.33
Festuca rubra	4.29
Festuca pratensis	4.10
Alchemilla d. sp.	3.19
Dactylis glomerata	2.64
Trifolium repens	2.54
Trifolium pratense	2.27

summer groundwater table falls. Low sedges (*Parvocariceta*) and other invaluable species, particularly *Deschampsia caespitosa,* are dominant in mesohygrophytic sites with reduced soil aeration and in deficit of available nutrients also *Nardus strictus*, as a species with extraordinary flexibility in view of soil water regime (Tab. IV). Of quality grass species the greatest vigour is manifested by *Alopecurus pratensis* while other species have significantly lower indices (*Poa trivialis* – 2.08; *Lathyrus pratensis* – 2.07; *Festuca pratensis* – 1.89; *Festuca rubra* – 1.56).

Air deficit in soil of **hygrophytic sites** does not allow an existence of cultural grasses and legumes. This is a site poachy throughout the year (Tab. V). Of higher quality grass species, *Poa trivialis* exhibits satisfactory vigour (I_v = 1.42) and *Lotus uliginosus* (I_v = 1.74) of legumes. Maximum vigour has been confirmed by tall sedges (*Magnocariceta*) and other phytoindicators of strong waterlogging. It has been proved that a flexible species *Nardus stricta* shows greater adaptability on hygrophytic stage compared with typically hydrophilous species *Deschampsia caespitosa*. Rychnovská et al. (1985) report that in the site with surplus of stagnating water plant communities are altogether formed by species of low feeding value (small sedges, cotton grass or rushes). In lowlands on waterlogged and inundated sites tall sedges (*Carex gracilis*) or grasses (*Phalaris arundinaceae, Glyceria maxima* and *Phragmites communis*) grow more frequently.

Regal (1967) reports of 90 studied species as significant phytoindicators of hydrophytic sites: *Scirpus silvaticus* and *Caltha palustris*. The following species have a good indication value for water deficit in soil: *Angelica sil-*

IV. Indices of occurrence of most distributed species in mesohygrophytic site

Species	*Iv*
Carex d. sp.	15.75
Deschampsia caespitosa	7.02
Alopecurus pratensis	5.81
Nardus stricta	4.10
Molinia coerulea	4.06
Ranunculus repens	4.03
Juncus d. sp.	3.83
Phalaris arundinacea	3.55
Equisetum palustre	2.66
Scirpus silvaticus	2.65

V. Indices of occurrence of most distributed species in hygrophytic site

Species	*Iv*
Carex d. sp.	28.14
Nardus stricta	4.00
Juncus d. sp.	3.67
Agrostis canina	3.09
Phragmites communis	3.04
Agrostis prorepens ssp. *prorep.*	1.94
Lotus uliginosus	1.74
Deschampsia caespitosa	1.61
Ranunculus repens	1.59
Equisetum palustre	1.59

vestris, *Cirsium palustre* and *Filipendula ulmaria*. This indication of moisture conditions of different sites is of practical meaning particularly for assessment of purposefulness of drainage, many hygrophytes however can be easily adapted to fluctuation of groundwater table.

The change in vitality of different species in different years is probably reflected into variability of composition of grasslands. For this reason re-

versely from investigations of variability of grasslands and quantitative composition of components their vitality can be examined.

Grassland communities are marked by their significant fluctuation and great sensitiveness to main decisive ecological factors, i.e. to water and nutritive regime and to the method of management which affect species diversity of the species.

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Vliv vodního režimu půdy na vitalitu lučních druhů v trvalých travních porostech.

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Vodní režim půdy je vedle výživného režimu jedním z významných faktorů ovlivňujících rozšíření, vitalitu, kvalitu a konkurenční schopnost druhů v trvalých lučních porostech. Na pěti stupních vodního režimu jsme se zaměřili na zjišťování projektivní dominance a prezence jednotlivých druhů. V letech 1985–1995 bylo analyzováno 920 přírodních travních porostů. Zastoupení jednotlivých lučních druhů bylo v každém floristickém snímku zaznamenáno v procentech redukované projektivní dominance. Porosty byly analyzovány v jarním aspektu před první sečí. Na každém stupni hygroserie byla vypočítána průměrná dominance (D) a prezence (P) pro 102 lučních druhů. Pro vitalitu druhů byl použit index výskytu (I_v), který vyjadřuje procentuální podíl plochy, který sledovaný druh zaujímá z celkové plochy určitého ekologického stupně vodního režimu (I_v = P.D/100). Pro každý ekologický stupeň bylo stanoveno 10 nejvitálnějších druhů podle nejvyšších indexů výskytu.

Xerofytní ekologický stupeň představuje zcela nevhodné podmínky pro rozvoj kulturních druhů trav. Z leguminóz vykazuje dobrou vitalitu *Lotus corniculatus* (I_v = 2,18), ale s minimální produkční schopností. Tab. I dokumentuje indexy výskytu nejrozšířenějších deseti druhů na tomto ekologickém stupni vodního režimu, který vyhovuje úzkolistým druhům rodu *Festuca* (*Festuca valesiaca*, *Festuca ovina*, *Festuca pseudoovina*, *Festuca duriuscula* aj.). Významným druhem je i *Poa pratensis* subsp. *angustifolia* vykazující horší kvalitu listů, které jsou silně inkrustovány. Z bylin vykazovaly vysokou vitalitu *Euphorbia cyperissias*, *Thymus d.* sp. a *Plantago lanceolata*.

Na mezoxerofytních stanovištích (tab. II) je nejvyšší vitalita u dvou druhů trav se zcela rozdílnými požadavky na obsah přístupných živin. Při příznivém obsahu živin dominuje *Arrhenatherum elatius* (I_v = 7,11), kdežto na chudých oligotrofních půdách *Nardus stricta* (I_v = 7,01). I na tomto stupni převažují suchomilnější druhy a podle zásoby živin k nim přistupují i kvalitnější druhy trav a jetelovin (*Festuca rubra*, *Poa pratensis* ssp. *augustifolia*, *Festuca pratensis*) a při pastevním využití porostu i *Trifolium repens*.

V tab. III. jsou uvedeny indexy výskytu nejvitálnějších druhů na mezofytních stanovištích, které umožňují rozšíření a plnou vitalitu největšímu počtu druhů. Na tomto stupni vodního režimu při dostatku živin převládají kulturní trávy. Na oligotrofních půdách je predominantním druhem *Nardus stricta* s nejvyšším indexem výskytu (I_v = 9,07). V mezotrofních až eutrofních mezofytech dominuje *Alopecurus pratensis*, *Festuca pratensis* a *Dactylis glomerata*, kdežto na chudších půdách *Agrostis tenuis* (I_v = 8,02) a *Festuca rubra* (I_v = 4,29). Poměrně vysoký index výskytu má i vlhkomilnější plevelný druh *Deschampsia caespitosa* (I_v = 4,33).

Indexy výskytu nejrozšířenějších deseti druhů na mezohygrofytním stanovišti jsou uvedeny v tab. IV. Jedná se o půdy s omezenou aerací. Stanoviště zde ovládají převážně nízké ostřice a další nekulturní nekvalitní druhy, zejména *Deschampsia caespitosa* a při nízké zásobě přístupných živin *Nardus stricta* (I_v = 4,10) a *Molinia coerulea* (I_v = 4,06). Z kvalitních druhů trav zde má největší vitalitu *Alopecurus pratensis*, kdežto ostatní druhy vykazují snížené indexy výskytu. Rozšiřují se zde vlhkomilné druhy, např. *Ranunculus repens*, *Juncus*, *Scirpus*, *Equisetum palustre* aj.

Hygrofytní stanoviště znemožňuje pro nedostatek vzduchu v půdě existenci kulturních druhů trav a leguminóz. Maximální vitalitu mají vysoké ostřice (I_v = 28,14), dále *Juncus d.* sp., *Agrostis canina*, *Phragmites communis* a jiné druhy indikující silné zamokření půdy. Z hustě trsnatých trav měly vysokou vitalitu *Nardus stricta* (I_v = 4,00) a *Deschampsia caespitosa* (I_v = 1,61), z kvalitnějších druhů měly uspokojivou vitalitu *Poa trivialis* (I_v = 1,42) a *Lotus uliginosus* (I_v = 1,74).

Hodnoty indexu výskytu jednotlivých druhů na pěti stupních hygroserie dokumentují vitalitu těchto druhů a podle jejich rozšíření a konkurenční schopnosti můžeme usuzovat na další pratotechnická opatření v trvalých lučních porostech.

vodní režim; vitalita druhů; index výskytu

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