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# OCCURRENCE OF COUCH GRASS [*ELYTRIGIA REPENS* (L.) DESV. EX NEVSKI] UNDER DIFFERENT GRASSLAND MANAGEMENT

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## Abstract

ŠTÝBNAROVÁ MARIE, MIČOVÁ PAVLÍNA, KARABCOVÁ HANA, SVOZILOVÁ MARIE: *Occurrence of couch grass [Elytrigia repens (L.) Desv. ex Nevski] under different grassland management.* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 5, pp. 1399–1404

The objective of this research was to investigate occurrence of common couch grass (*Elytrigia repens* (L.) Desv. ex Nevski) under different grassland management by means of a small-plot trial. The trial was managed during 2003–2011 with four levels of utilisation: intensive (4 cuts per year, 1st cut on 15 May), medium intensive (3 cuts per year, 1st cut on 30 May), low intensive (2 cuts per year, 1st cut on 15 June), and extensive (2 cuts per year, 1st cut on 30 June). Four rates of fertilisation were applied for each utilisation treatment: nil-fertilisation, $P_{30}K_{60}$, $N_{90}P_{30}K_{60}$, and $N_{180}P_{30}K_{60}$ (pure nutrients). The intensively utilised treatments without N fertilisation showed the lowest mean percentage cover of couch (3.0 %, and 2.8 %, respectively). Further, we found a significant increase in couch grass cover (up to about 30 %) as a response to nitrogen fertilisation and it was most significant in grasslands utilised with two cuts per year. It can be concluded that grassland utilisation in three cuts per year and the dose 90 kg.ha$^{-1}$ of nitrogen led to the maintenance of the occurrence of couch at the reasonable level up to 10–15 %.

permanent grasslands, couch grass, N fertilisation, cutting frequency

Common couch grass (also called quackgrass: *Elytrigia repens* (L.) Desv. ex Nevski) is considered a primary noxious highly invasive weed (Westra and Wyse, 1981). As Sheaffer *et al.* (2004) mentioned couch grass is noted for aggressive spreading by rhizomes and persistence. It is frequently concentrated in the hedge bottoms and field margins and it rapidly spreads out from the field margins into cultivated fields. As couch grass is adaptable to a range of environments and management regimes, it often becomes the predominant grass in hay fields, pastures, and set-aside fields.

Knowledge about the response of couch grass to the different management practices is necessary to improve animal production. The occurrence of couch grass is one of the main factors reducing both grass yield and quality in cultivated meadows and pastures (Carrere *et al.*, 2010). Subsequently, the animal performance could be negatively affected. A percentage cover of over 15% is not generally desirable with respect to the poorer forage value of this species. Beside its negative impact on the forage quality in natural grasslands, couch grass is able to outcompete and exclude native vegetation, resulting in an overall loss of biodiversity.

Considering the negative effects of the weeds occurred in farmland areas they are often commonly controlled by herbicides (Hasan, 1994; Davis and Ballingal, 2009). Chemical methods of couch grass control are, however, expensive and may have negative effects on the environment (Bergkvist *et al.*, 2010). The chemicals usage is entirely prohibited in organic farming.

Little information is available on how occurrence of couch changes in response to different grassland management treatments. Đileika (2001) reported the advised management of new grassland by its renovation. As author mentions if some weeds still remain a problem chemical weed control may be necessary. Gaisler *et al.* (2008) recommended mulching performed at least twice a year as suitable way for non-chemical restriction of undesirable weeds such as *Cirsium arvense, Urtica dioica* or *Elytrigia repens*. The percentage cover of *Elytrigia repens* was especially promoted by no management. Dostálek and Frantík (2008) came to the similar conclusion that the cover of *Elytrigia repens* increased after grassland abandonment.

The biology and non-chemical control of common couch was further documented by Bond *et al.* (2007). Brandsaeter *et al.* (2010) mentioned that the success of weed management aimed at depleting the regenerative structures of perennial weeds depends largely on the sprouting activity of rhizome and root buds. Authors results implied that *E. repens* are more likely to be controlled by mechanical measures in autumn. Growth characteristics of *Elytrigia repens* in autumn were described also by Torrensen *et al.* (2010).

It is still an open question whether good grassland management can improve botanical composition without radical restoration or herbicides usage. This paper contains information about changes of couch grass dominance in permanent grasslands by different management practices obtained on the basis of the long-term small-plot trial investigation. The objective of this study was to determine the effects of different doses of N fertilizer (ammonium salt with limestone) and different intensities of grassland utilisation (cutting regime) on the occurrence of couch in permanent grasslands under the conditions of the Czech Republic. Recommendations regarding the ways of the couch grass regulation are in compliance with the organic farming principles. They could be applied in wide range of conditions without the risk of the soil or ground water contamination with undesirable chemicals.

## MATERIALS AND METHODS

Permanent grassland vegetation relating to the alliance *Arrhenatherion* has been studied in terms of a long-term small-plot trial. The experiment was established in 2003 in the locality of Rapotín (altitude 400 m a.s.l.; 49°58'N, 17°0'E; annual rainfall 693 mm; mean annual temperature 7.2 °C). The locality is situated in an upland region with mild climate conditions. Meteorological data during the monitored period are given in Fig. 1. The whole area belongs to the geomorphological unit called the Hrubý Jeseník. The soil is sandy-loam, type modal cambisol (horizons Ao–Bv-B/Cc–Cc). Before the experiment setup, the grassland had been used as cattle pasture.

The experimental design was a randomised complete block with four replicates and a plot size of 12.5 m$^2$. Four levels of intensity of utilisation were used:

treatment 1 = intensive (1$^{st}$ cut on 15 May, 4 cuts per year – cuts at 45-day intervals);
treatment 2 = medium intensive (1$^{st}$ cut on 31 May, 3 cuts per year at 60-day intervals);
treatment 3 = low intensive (1$^{st}$ cut on 15 June, 2 cuts per year at 90-day intervals) and
treatment 4 = extensive (1$^{st}$ cut on 30 June, 1 or 2 cuts per year, 2$^{nd}$ cut after 90 days).

Each utilisation treatment was divided into four levels of fertilisation:

treatment A = nil-fertilisation,
treatment B = $P_{30}K_{60}$,
treatment C = $N_{90}P_{30}K_{60}$,
treatment D = $N_{180}P_{30}K_{60}$ (pure nutrients).

Phosphorus was applied as superphosphate and potassium as potassium salt once in the spring. Calcium ammonium nitrate was used as a nitrogen fertilizer. Dosing of nitrogen (total dose 90 kg.ha$^{-1}$ or 180 kg.ha$^{-1}$) for particular treatments was:

- intensive utilisation – 30 kg.ha$^{-1}$ or 60 kg.ha$^{-1}$ at spring; 30 kg.ha$^{-1}$ or 60 kg.ha$^{-1}$ after the first cut; 30 kg.ha$^{-1}$ or 60 kg.ha$^{-1}$ after the second cut;
- medium intensive utilisation – 30 kg.ha$^{-1}$ or 60 kg.ha$^{-1}$ at spring; 30 kg.ha$^{-1}$ or 60 kg.ha$^{-1}$ after the first cut; 30 kg.ha$^{-1}$ or 60 kg.ha$^{-1}$ after the second cut;
- low intensive utilisation – 45 kg.ha$^{-1}$ or 90 kg.ha$^{-1}$ at spring; 45 kg.ha$^{-1}$ or 90 kg.ha$^{-1}$ after the first cut;
- extensive utilisation – 45 kg.ha$^{-1}$ or 90 kg.ha$^{-1}$ at spring; 45 kg.ha$^{-1}$ or 90 kg.ha$^{-1}$ after the first cut.

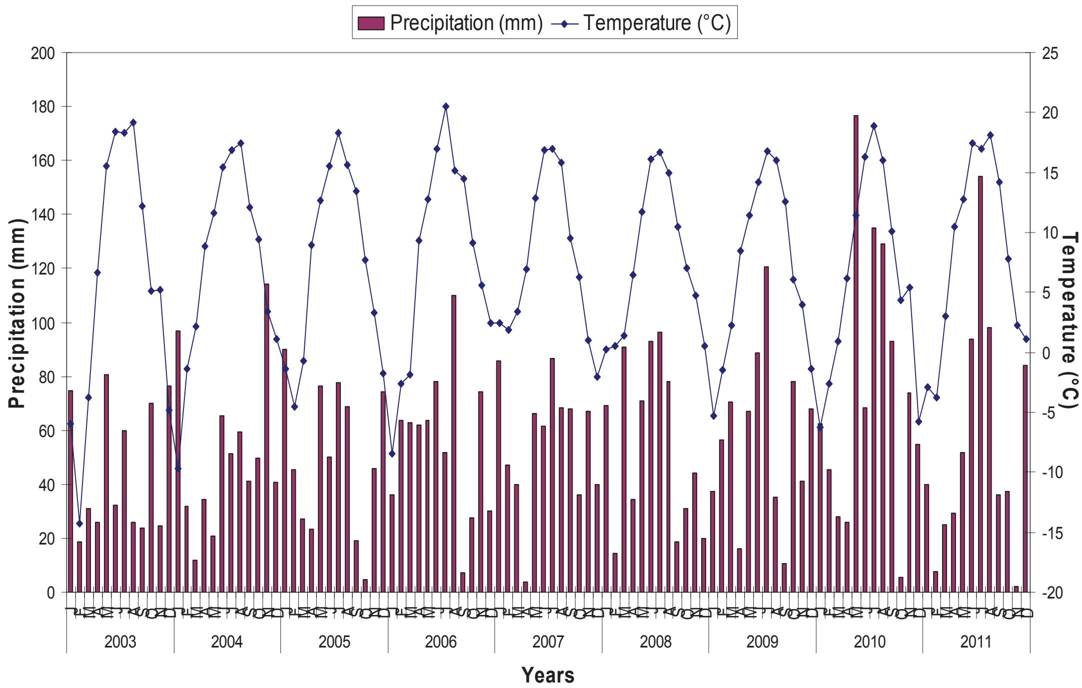
The botanical composition of swards was estimated during 2003–2011 by means of the projective dominance method (in %). To avoid the subjectivity of personal estimation, sequent classification of total dominance into morphologically different floristic groups and particular species was used.

A two-way ANOVA (effects of intensity of utilisation, fertilisation and their interactions) followed by post hoc comparison using Tukey's HSD test at the 0.05 level of significance was used to evaluate the data using the software Statistica v. 10.

## RESULTS

The results of changes in couch grass % cover caused by different cutting and fertilisation regimes during the investigation period 2003–2011 are given in Tab. I. After eight years of targeted management we found a maximum % cover of couch grass (40.8 %; in 2011) in treatment 3C, which is low intensively utilised grassland fertilised with $N_{90}P_{30}K_{60}$ (pure nutrients). In contrast, the intensively utilised grassland without fertilisation showed the lowest % cover of couch (1.5 %). From the viewpoint of statistical significance, effect of fertilisation as well as intensity of utilisation was found as significant ($P < 0.05$) throughout the years of our investigation.

As it is clear from Fig. 2 in mean number of years we found a significantly higher ($P < 0.05$) % cover of couch in grasslands with nitrogen fertilisation (C and D treatments) in contrast to grasslands without fertilisation or fertilised with $P_{30}K_{60}$ (A and B treatments, respectively). From the viewpoint of fertilisation, in particular the higher dose of

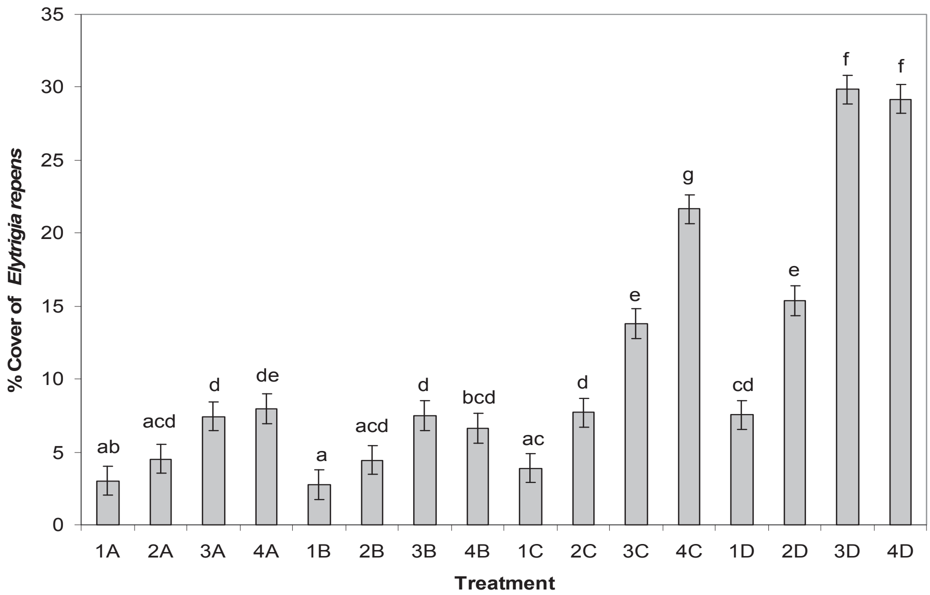



1: *Meteorological data of the experimental site*

I: *Cover [%] of Elytrigia repens depending on different cutting frequency and fertilisation. Intensity of utilisation: 1 = intensive, 2 = medium intensive, 3 = low intensive, 4 = extensive; Fertilisation: A = nil-fertilisation, B = $P_{30}K_{60}$, C = $N_{90}P_{30}K_{60}$, D = $N_{180}P_{30}K_{60}$ (pure nutrients)*

| Treatment | Year | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| 1A | 1.8 | 6.3 | 4.0 | 3.8 | 2.0 | 2.3 | 2.3 | 3.5 | 1.5 |
| 2A | 2.8 | 7.0 | 3.3 | 3.8 | 5.0 | 8.8 | 2.3 | 3.3 | 4.8 |
| 3A | 7.0 | 8.8 | 8.0 | 13.3 | 6.8 | 10.0 | 5.3 | 4.8 | 3.3 |
| 4A | 7.0 | 10.3 | 9.0 | 12.0 | 9.8 | 8.8 | 6.5 | 4.5 | 4.0 |
| 1B | 0.6 | 3.5 | 2.5 | 4.3 | 1.6 | 3.3 | 2.0 | 4.8 | 2.3 |
| 2B | 5.6 | 8.0 | 2.5 | 5.0 | 4.0 | 3.8 | 3.5 | 3.3 | 4.3 |
| 3B | 4.8 | 14.5 | 11.5 | 10.0 | 7.0 | 6.3 | 6.0 | 5.3 | 2.3 |
| 4B | 10.5 | 10.0 | 8.3 | 8.3 | 4.5 | 5.5 | 5.3 | 2.8 | 4.5 |
| 1C | 0.6 | 7.0 | 3.1 | 5.0 | 2.5 | 5.3 | 3.3 | 5.3 | 3.0 |
| 2C | 4.8 | 8.3 | 9.0 | 13.0 | 5.3 | 5.0 | 7.0 | 7.8 | 9.3 |
| 3C | 4.5 | 17.3 | 18.3 | 18.5 | 14.5 | 15.0 | 14.3 | 10.3 | 11.8 |
| 4C | 8.5 | 20.8 | 26.8 | 36.0 | 30.5 | 27.3 | 18.3 | 15.0 | 11.8 |
| 1D | 1.6 | 7.5 | 3.8 | 9.3 | 11.0 | 16.3 | 9.8 | 4.8 | 4.0 |
| 2D | 2.0 | 8.3 | 10.3 | 21.0 | 22.8 | 22.5 | 22.5 | 13.0 | 16.0 |
| 3D | 6.0 | 13.8 | 22.0 | 31.3 | 43.3 | 29.3 | 49.0 | 33.5 | 40.8 |
| 4D | 12.0 | 25.0 | 29.5 | 32.0 | 41.0 | 28.0 | 39.0 | 28.8 | 27.5 |
| *P*-values of effects | | | | | | | | | |
| cutting frequency | 0.00001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 |
| fertilisation | 0.90509 | 0.00400 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 |
| cuting fr.*fert. | 0.74349 | 0.05475 | 0.00736 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 | < 0.0001 |

nitrogen ($N_{180}$PK) increased the mean rate of couch in the swards up to 30%. Further, we found a statistically significant positive effect ($P < 0.05$) of low intensive and extensive grassland utilisation on couch grass % cover. Treatments with intensive and medium intensive grassland utilisation (four and three cuts per year) showed a significantly lower ($P < 0.05$) mean % cover of couch grass (maximum of 15%) compared to grasslands utilised with two cuts per year.




2: *Elytrigia repens mean % cover in grasslands under different fertilisation level and intensity of utilisation during 2003–2011 (vertical bars denote standard error of mean, different letters document statistical differences between treatments for Tukey's HSD test, α = 0.05). Intensity of utilisation: 1 = intensive, 2 = medium intensive, 3 = low intensive, 4 = extensive; Fertilisation: A = nil-fertilisation, B =* $P_{30}K_{60}$, *C =* $N_{90}P_{30}K_{60}$, *D =* $N_{180}P_{30}K_{60}$ *(pure nutrients)*

## DISCUSSION

The development of couch was significantly affected by the N-fertilisation, confirming results of Oerlemans *et al.* (2005) or Vařeková *et al.* (2008). The nitrogen content in the soil appears to be a fundamental factor, as it was also confirmed by Wilson *et al.* (2010). Authors found out that the nitrogen fertilizers' application caused a shift in pasture grasses resulting in a predominance of couch grass.

Also the intensity of grassland utilisation plays a key role. According to the results of Pavlů (1994) the proportion of couch grass decreased in intensively utilised grasslands, which is in line with our results. Jorgensen and Pestalozzi (2002) confirmed that both level of fertilizer and harvesting regime had significant effects.

If we speculate on the reasons for our findings, the investigations of other authors could be relevant. Bandeen and Buchholz (1967) pointed out that couch has the ability to reproduce vegetatively (by means of rhizomes) and sexually, and luxury uptake of nutrients and possible allelochemic toxins may also make it a strong competitor. Considering these facts, one of other reasons why couch extended its dominance mainly in extensively utilised grasslands could be that this type of management enabled the generative reproduction of couch. By extensive grassland utilisation the swards were mowed in later dates (flowering stage of grasses) and it might to strengthen competitiveness of couch. Turner (1969) further investigated effects of shoot removal on rhizome carbohydrate reserves of couch grass. High levels of soil nitrogen increased the rate of carbohydrate loss. He found a connection between the rhizome carbohydrate content at the time of burial, the ability of the plants to regenerate, and the rate at which new carbohydrate reserves built up during the following two months.

McIntyre and Cessna (1998) studied the growth and development of the rhizome and lateral rhizome buds in couch. These authors provided evidence that the C:N ratio may be an important morphogenetic factor in the mechanism controlling the path of bud and rhizome development. The effect of the N supply on growth of couch and its ability to compete by means of rhizome and lateral rhizome bud development may also be fundamental to our findings of couch dominance in permanent grasslands using different management strategies.

Esmaeili *et al.* (2009) investigated the effects of ramet defoliation frequency on clonal propagation and the patterns of biomass production and allocation on five rhizomatous species. Defoliation had a strong influence in biomass production of *E. repens* with a decrease in its rhizome mass.

As mentioned in introduction, producers consider utilizing couch for hay or pasture if the production and quality could be maintained at a reasonable level. There is generally recommend that couch be tolerated in meadow stands for hay production at amounts of 12–15 %. From this viewpoint and on the basis of our results attained in the trial conditions, we can conclude that this requirement could be met for the intensive and medium intensive grassland management by the fertilisation with the dose up to 90 kg.ha$^{-1}$ of nitrogen.

## CONCLUSION

Our results showed that regular dosing with nitrogen, particularly under conditions of extensive grassland utilisation had a significant influence on increasing couch dominance in the swards. Intensive and medium intensive grassland utilisation and the dose up to 90 kg.ha$^{-1}$ of nitrogen led to the maintenance of the occurrence of couch at the reasonable level (maximum of 15 %). These findings are important for the appropriate grassland management and maintenance of the optimal botanical composition of permanent grasslands.

## SUMMARY

The influence of cutting frequency (different number of cuts and cutting dates) and fertilisation on the occurrence of common couch grass (*Elytrigia repens* (L.) Desv. ex Nevski) in permanent grasslands were assessed in years 2003–2011. The small plot trial was established in 2003 in Rapotín, the Czech Republic. The locality was situated at 400 m a.s.l. (49°58'N, 17°0'E) in an upland region with mild climate conditions. Permanent grassland vegetation related to the alliance *Arrhenatherion*. Four treatments of nutrition level and four treatments of exploitation intensity were combined. Exploitation intensity: intensive (4 cuts per year, 1st cut on 15 May); (3 cuts per year, 1st cut on 30 May), low intensive (2 cuts per year, 1st cut on 15 June), and extensive (2 cuts per year, 1st cut on 30 June). Nutrition levels: nil-fertilisation, $P_{30}K_{60}$, $N_{90}P_{30}K_{60}$, and $N_{180}P_{30}K_{60}$ (pure nutrients). It was found out, that intensively utilised treatments without N fertilisation showed the lowest mean percentage cover of couch (3.0%, and 2.8%, respectively). Further, we found a significant increase in couch grass cover (up to about 30%) as a response to nitrogen fertilisation and it was most significant in grasslands utilised with two cuts per year. On the basis of our results we can conclude grassland utilisation in three cuts per year and the dose 90 kg.ha$^{-1}$ of nitrogen led to the maintenance of the occurrence of couch at the reasonable level up to 10–15%. Recommendation for farmers could be applied in a wide range of conditions without the risk of the soil or ground water contamination with undesirable chemicals.

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## REFERENCES

BANDEEN, J. D. and BUCHHOLTZ, K. P., 1967: Competitive effects of quackgrass upon corn as modified by fertilisation. *Weeds*, 15, 3: 220–224. ISSN 00967 19X.

BERGKVIST, G., ADLER, A., HANSSON, M. and WEIH, M., 2010: Red fescue undersown in winter wheat suppresses Elytrigia repens. *Weed Research*, 50, 5: 447–455. ISSN 0043-1737.

BOND, W., DAVIES, G. and TURNER, R. J., 2007: *The biology and non-chemical control of common couch*. [on line] 2007-11-26 [cit. 2012-10-13] Available at: http://www.gardenorganic.org.uk/organicweeds.

BRANDSAETER, L. O., FOGELFORS, H., FYKSE, H., GRAGLIA, E., JENSEN, R. K., MELANDER, B., SALONEN, J. and VANHALA, P., 2010: Seasonal restrictions of bud growth on roots of Cirsium arvense and Sonchus arvensis and rhizomes of Elymus repens. *Weed Research*, 50, 2: 102–109. ISSN 0043-1737.

CARRERE, P., PONTES, L. D., ANDUEZA, D., LOUAULT, F., ROSSEEL, D., TAINI, E., PONS, B., TOILLON, S. and SOUSSANA, J. F., 2010: Changes in the nutritive value of pasture grasses during their cycle of development. *Fourrages,* 201, 1: 27–35. ISSN 0429-2766.

DAVIS, K. and BALLINGAL, M., 2009: *Weed management in grassland*. Edinburgh: The Scottish Agricultural College, 16 p. ISBN 1-85482-887-8.

ĐILEIKA, A. S., 2001: *Grassland renovation*. [on line] 2001-02-03 [cit. 2013-01-21] Available at: http://www.baap.lt/education/grass_ren/grass_ren.pdf.

DOSTÁLEK, J. and FRANTÍK, T., 2008: Dry grassland plant diversity conservation using low-intensity sheep and goat grazing management: case study in Prague (Czech Republic). *Biodiversity and conservation*, 17, 6: 1439–1454. ISSN 0960-3115.

ESMAEILI, M. M., BONIS, A., BOUZILLE, J. B., MONY, C. and BENOT, M. L., 2009: Consequence of ramet defoliation on plant clonal propagation and biomass allocation: Example of five rhizomatous grassland species. *Flora*, 204, 1: 25–33. ISSN 0367-2530.

GAISLER, J., PAVLŮ, V. and HEJCMAN, M., 2008: Effect of different defoliation practices on weeds in an upland meadow. *Journal of Plant Diseases and Protection*, 115, Special Issue 21: 541–545. ISSN 1861-4051.

HASAN, H., 1994: Effect of glyphosate herbicide on aflatoxin production on wheat-straw and couch-grass. *Plant Production*, 40, 2: 189–192. ISSN 0370-663X.

JORGENSEN, M. and PESTALOZZI, M., 2002: *Long-term botanical changes in cut and grazed grasslands in the continental subarctic region of Norway*. REU Technical Series No. 64: FAO/CIHEAM Lowland Grasslands of Europe: Utilisation and Developement, Rome: FAO, 87–91. ISSN 1020-3737.

MC INTYRE, G. I. and CESSNA, A. J., 1998: Studies on the growth and development of the rhizome and lateral rhizome buds in *Elytrigia repens*: some effects of parent shoot excision. *Canadian Journal of Botany,* 76, 5: 769–776. ISSN 0008-4026.

OERLEMANS, J. F and OPITZ VON BOBERFELD, W., 2005: Long-term effect of levels of N-, P-, K-supply on the Shannon-Index for two pastures located in Central Germany. In: O'MARA et al. (Eds) *Proceedings of the XX International Grassland Congress*: offered papers, Wageningen: Wageningen Academic Publishers, p. 617. ISBN 9076998817.

PAVLŮ, V., 1994: Content of mineral substances in pasture herbage in relation to requirements of cattle. *Plant Production*, 40, 3: 209–217. ISSN 0370-663X.

SHEAFFER, C. C., EHLKE, N. J., WYSE, D. L., VELLEKSON, D. J., SWANSON, D. R., HALGERSON, J. L. and MATHISON, R. D., 2004: *Forage yield and nutritive value of selected quackgrass*. [on line] 2004-03-18 [cit. 2013-01-21] Available at: http://www.plantmanagementnetwork.org/pub/fg/research/2004/quackgrass/.

TORRESEN, K. S., FYKSE, H. and RAFOSS, T., 2010: Autumn growth of *Elytrigia repens, Cirsium arvense* and *Sonchus arvensis* at high latitudes in an outdoor pot experiment, *Weed Research,* 50, 4: 353–363. ISSN 0043-1737.

TURNER, D. J., 1969: Effects of shoot removal on rhizome carbohydrate reserves of couch grass. *Weed Research,* 9: 27–36. ISSN 0043-1737.

VAŘEKOVÁ, P., SVOZILOVÁ, M., MIČOVÁ, P. and RŽONCA, J., 2008: Effect of N fertilisation on the development of couch-grass (*Elytrigia repens*) in a grass sward. In: HOPKINS A. et al. (Eds) *Proceedings of the 22nd General Meeting of the EGF*, Uppsala: SLU Repro, pp. 347–349. ISBN 978-91-85911-47-9.

WILSON, C., UNDI, M., TENUTA, M., WITTENBERG, K. M., FLATEN, D., KRAUSE, D. O., ENTZ, M. H., HOLLEY, R. and OMINSKI, K. H., 2010: Pasture productivity, cattle productivity and metabolic status following fertilisation of a grassland with liquid hog manure: A three-year study. *Can. J. Anim. Sci.,* 90, 2: 233–243. ISSN 0008-3984.

WESTRA, P. H. and WYSE, D. L., 1981: Growth and development of quackgrass biotypes. *Weed Science,* 29, 1: 44–52. ISSN 0043-1745.

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