

NEW USES OF CLOVER-GRASS MIXTURES IN THE STRUCTURE OF FODDER CROPS ON ARABLE LAND

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Abstract

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The use of clover-grasses in the structure of fodder crops grown on arable soil, especially those with intergeneric hybrids as the main component part, could avert the negative current trend, i.e. further decreasing the area of perennial fodder plants or fodder crops as a whole on arable soil. They have an irreplaceable role in crop sequences and in preserving the cultural character of the countryside, above all due to the fact that they improve soil fertility and microbial life in the soil and that they have an excellent pre-produce value, and, at the same time, they are applied in various farming systems (both conventional and ecological) and in various climatic conditions, and agricultural businesses are well equipped for growing, harvesting and storing them. In the Czech Republic, the area of fodder crops grown on arable soil was decreased from 1,019.9 thousand hectares to mere 396.7 thousand hectares between 1980 and 2009, which is 15.6 % of the total area of arable soil whereas perennial fodder plants only take up 8.5 %. Fodder from clover crops and clover-grass growths on arable soil are one of the main resources of voluminous fodder for dairy cows. Most of this fodder is preserved through a fermentation process (silages, hay storage); a smaller part is fed as fresh fodder, or serves for production of hay. Silages made with perennial fodder plants are the most important source of both proteins and other nutrients for ruminants, especially for high-yielding milch cows. The basis of fodder production systems are the conservative elements of the landscape area (geomorphology) in combination with the progressive elements (weather conditions, plants and human labour) and relict ones, the representative of which is the soil. The fodder production systems in Europe are divided into five main fodder production zones. From this point of view, the areas where short-term clover-grass mixtures are grown on arable soil could be classed with Zone 4, i.e. intensive fodder production and cattle breeding. This characterisation corresponds with the Vysočina Region (the Czech Republic), which is the focus of our work even though extensive breeding can be found in this area on a smaller scale as well. Therefore, our aim was to verify the production and qualitative parameters of the fodder crops and mixtures included in the test in chosen agricultural businesses in the Vysočina Region and to recommend the most suitable variant for the given area. A statistically significant correlative relationship ($P < 0.05$) was proved between the net energy for lactation contents and the percentage of organic matter digestibility. The evaluation of the production parameters evidently shows the favourable influence of the grass component part or of intergeneric hybrids on the stability of dry matter yield per hectare as well as on the stability of individual nutrients.

legume-grass mixtures, forage quality, cutting frequency, crude protein, net energy for lactation, organic matter digestibility, intergeneric hybrids

Houdek (2009) refers about the advantages brought by growing clover-grass mixtures, such as a higher production of fodder, easier and quicker wilting of forage during conservation and the fact

that the mixture growths tend to be less infested with weeds. He also mentions produce stability in both colder and warmer (or drier) areas. As to the amount of carbohydrates in the fodder, he re-

commends various kinds of grasses with their suitable sowing rates. In the USA, SLEUGH *et al.* (2009) carried out an experiment with the Lucerne (*Medicago sativa*), the Common Bird's-foot Trefoil (*Lotus corniculatus*) and the Caucasian Clover (*Trifolium ambiguum*) in mixtures with the Cocksfoot (*Dactylis glomerata*), the Brome Grass (*Bromus intermis* Leysser) and the Middle Couch Grass (*Elytrigia intermedia*). They determined the production of dry matter, fibre and proteins in these mixtures. They discovered that the yield of dry matter, the contents of proteins and the digestibility of the fodder were always better in clover-grass mixtures than in clovers or grasses separately. The mixtures also had more stable yields during individual cuttings. The symbiotic fixation of nitrogen and its transport between the clover crop and the grass component was dealt with by RIESINGER, HERZON, 2008 a DAHLIN, STERNBERG, 2008. They found out that a growing growth of red clover fixates 38.6 kg.ha⁻¹ N after harvesting the cover crop plant; the average fixation for a two years' period determined in various stages of the yield year was 185.4 kg.ha⁻¹ N and was significantly influenced by the soil quality. In the mixture of red clover and ray grass, the determined transfer of nitrogen for nutrition of the ray grass was 32–34 kg.ha⁻¹ in the year with a normal rainfall, but it was only 15–18 kg.ha⁻¹ in the year with a poorer rainfall.

The clear merits of growing clover-grass mixtures were also proved during an experiment carried out in Turkey. In the course of five years, double-component mixtures of the Brome Grass and the Lucerne and of the Brome Grass and the Middle Couch Grass in various proportions of sowing were observed. The checking treatment was an individual growth of brome grass fertilised doses of 0, 50, 100 and 150 kg.ha⁻¹ N. The clover-grass mixtures were not fertilised apart from the initial dose of 40 kg.ha⁻¹ N. The production of dry matter in all the mixtures was higher than in the pure monocultures of clover or of the fertilised brome grass. In addition, the monoculture of grass was only sustainable with higher doses of nitrogen (150 kg.ha⁻¹ N). The highest recorded dry matter production was in the mixture of the Red Clover and the Brome Grass in the proportion 2:1, the second place was taken by the mixture of the Lucerne and the Brome Grass in the proportion 1:1. The highest production of nitrogen was recorded in the mixture of the Red Clover and the Brome Grass in the proportion 2:1, second placed the pure monocultures of the Red Clover and the Lucerne. The author mentions a good stability of dry matter production in the clover-grass mixtures during the whole experimental period. The grass components were more productive early in the spring while the fractions of the clover crops grew better in the summer. From the point of view of sustaining the stability of the growth without nitrogen fertilisation for a long time and keeping up the production of dry matter and CP it is recommended to grow a mixture of the Lucerne and the Brome Grass in the proportion

1:1. The mixtures of the Red Clover and the Brome Grass are recommended for a short-term utilisation of the growth. In the conclusion, the author states that the application of nitrogen can be eliminated in clover-grass mixtures without any yield reduction (GÖKKU, A., 1999). In the mixture of the Lucerne and the Reed Fescue (*Festuca arundinacea*), intergeneric reactions were observed by LAZARIDOU in 2008. The results showed that an intensive utilisation decrease the yearly and total production of shoot biomass and increased the competitiveness of the Fescue Grass towards the Lucerne, especially when sufficiently irrigated. The botanical composition changed during cuttings and also during the year. In Finland, NYKÄNEN *et al.* 2008, tested clover-grass mixtures with the Red Clover, the White Clover (*Trifolium repens*), the Alsike Clover (*Trifolium hybridum* L.) and the Hybrid Lucerne as clover components and the grass species of the Timothy Grass and the Fescue Grass and they compared their productivity with that of monocultures in various sowing rates, nutrition at 60 kg.ha⁻¹ N and triple-cutting utilisation. In the clover crop monocultures, the species of the clover had a greater influence on the dry matter production than the sowing rate. The clover-grass mixtures were always more productive than the monocultures. The highest competitiveness was detected in the Red Clover and the Alsike Clover, the competitiveness of the Lucerne was variable.

MATERIALS AND METHODS

The aim was to assess the test during the two harvest years 2006 and 2007, started as early as the year 2005 with unfertilised variants of clover crops and their mixtures with grasses. These semi operational experiments were started on arable soil in chosen businesses in the area of the Bohemian-Moravian Highlands at 450–550 above sea level, i.e. in the same weather and soil conditions. The average annual rainfall was about 580 mm in the first harvest year (out of this only about 370 mm in the vegetation season), the average yearly temperature was 14.1 °C in the vegetation season. The weather conditions in the second harvest year were different from the first one: the average temperature was only 0.12 °C lower in the vegetation season compared to the long-term standard, but the total of rainfall was 45.6 mm lower. Also, the distribution of rainfall during the vegetation was less even than in the first harvest year of the tests, especially during the onset of vegetation in the month of April the total rainfall was only 1.7 mm. The soils are classified as modal brown soils, in the term of granulation – loamy with a neutral to sub acid soil reaction (pH 6) (NEMEČEK, 2001). The average supply of Ca, 27,23 g.kg⁻¹, means a good supply, P, 88 mg.kg⁻¹, a good supply, K, 196 mg.kg⁻¹, a good supply, and Mg, 185 mg.kg⁻¹, is a good supply, too. The total content of N was average, the long-term content of humus was low – 1.2–1.7%, which means the soils are also moderately humic.

The basis of the experiments was that an area was sown with a determined proportion of mixtures (Tab. I), and the percentage of the components was established (Fig. 1), further the yield of dry matter and nutrients (CP, NEL, OMD) as a qualitative parameter in a sample of the mixtures were established. In chosen experimental treatment, samples were taken in four repetitions in each treatment in both the first harvest year 2006 and the second harvest year 2007. Seven treatment of clover-grass mixtures were included in the experiment, 200 samples altogether. In six of these treatment, a grass component or intergeneric hybrids were used (cv. Perun, Achilles and Perseus) (3,4,5,6) and brome grass (cv. Tabrom) (7), and, as a check variant (1), a mixture with main clover crops was used (Lucerne cv. Magda and a diploid treatment of the Red Clover cv. Vltavín). The dried and ground material was analysed using an NIRS 6500 instrumentation at the working site of VSTE Jevíčko. The digestibility of the organic matter (OMD) was established using the TILLEY a TERRY (1968) in vitro method modified according to RESCH (1991). The results concerning the quality of the fodder were statistically tested through a variation analysis (ANOVA). Tuckey's HSD test ($P < 0.05$) was used for a more detailed evaluation of the differences between the averages of the treatment in the years 2006–2007 (used software: Statistica 8.0 CZ).

RESULTS AND DISCUSSION

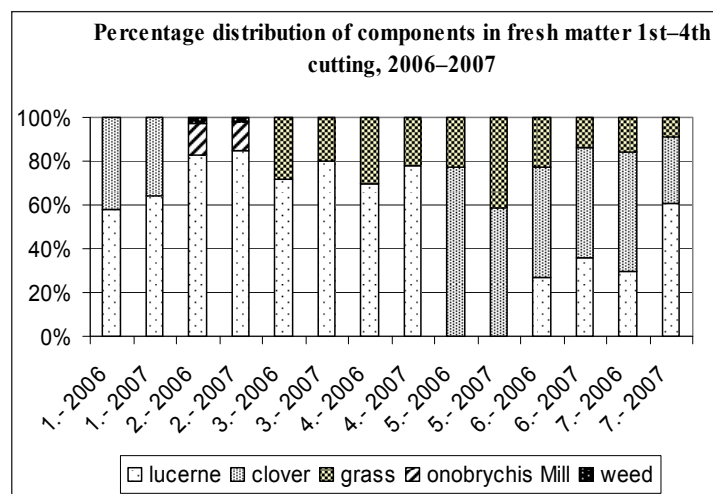
The results of intergeneric interaction expressed by the percentage distribution of the components of the mixtures (Fig. 1) show that the percentage of the Lucerne in the mixtures increased within the years. The percentage of clover in the growth rather tended to decrease. Of the grass hybrids, it was Perseus (Var. 5) that increased its distribution in the growth. This is in concordance with the findings of HRABĚ *et al.* (2007) showing the need of establishing a cultivation strategy for short-term clover-grasses (grown for 1–3 years) on a higher proportion of red clover (60–80%) and on one or two of his varieties supplemented by one or two intensive productive grass species, especially the Ryegrass (*Lolium multiflorum*) – annual and Italian (*Lolium multiflorum* subsp. *italicum* A. Br.), or the Hybrid Ryegrass (*Lolium* × *Hybridum* Heausskn.). The mixtures also proved a marked deweeding capacity as stated by HOUDEK (2009), with the exception of the mixture of the Lucerne and Onobrychis Mill. (Var. 2).

The values of the qualitative parameters of the mixtures included in the experiment prove the earlier knowledge of the good quality of clover-grass mixtures. As to the nitrogen content (Tab. II), the highest ones are shown by the mixture of the Lucerne with the Red Clover (Var. 1 – 231.7 & 228.3 g.kg⁻¹DM), further by the mixture of the Lu-

I: Clover-grass mixture treatment

Treatment	Seeding amount kg.ha ⁻¹
1. Lucerne (<i>Medicago sativa</i>) "Magda" + Red Clover (<i>Trifolium pratense</i>) "Vltavín"	10 + 8*
2. Lucerne (<i>Medicago sativa</i>) + Onobrychis Mill. "Višňovský"	10 + 15
3. Lucerne (<i>Medicago sativa</i>) + cross variety "Perun"	16 + 2
4. Lucerne (<i>Medicago sativa</i>) + cross variety "Achilles"	16 + 2
5. Red Clover + cross variety "Perseus"	16 + 2
6. Lucerne (<i>Medicago sativa</i>) + Red Clover + cross variety "Perseus"	10 + 6 + 2
7. Lucerne (<i>Medicago sativa</i>) + Red Clover + Brome Grass (<i>Bromus intermis</i> Leysser) "Tabrom"	8 + 6 + 4

(*, Treat. 1 as a check treatment for comparing the influence MRH)



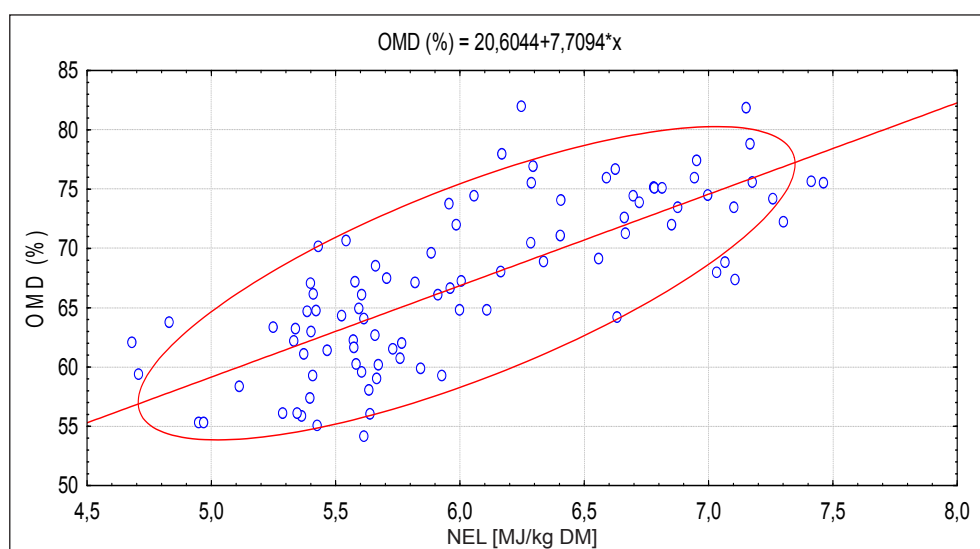
1: Distribution of the components of the individual treatment within both harvest years

II: Qualitative parameters of the utility in 2006 and 2007 Mean values in the same column with different superscripts are significant at the $P < 0.05$ level

Treatment	Harvest year					
	2006			2007		
	qualitative parameter (mean)					
	CP (g.kg ⁻¹ DM)	NEL (MJ.kg ⁻¹ DM)	OMD (%)	CP (g.kg ⁻¹ DM)	NEL (MJ.kg ⁻¹ DM)	OMD (%)
1	231.7	5.9 ^a	65.1 ^b	228.3	6.6 ^c	70.2
2	221.8	5.8 ^a	64.1 ^b	209.6	6.1 ^{abc}	65.7
3	213.8	6.0 ^{ab}	72.2 ^a	222.0	5.9 ^{ab}	68.7
4	207.9	6.2 ^b	72.5 ^a	211.2	5.7 ^a	63.8
5	222.5	6.0 ^{ab}	70.7 ^a	205.0	5.9 ^{ab}	65.2
6	217.9	5.9 ^a	71.5 ^a	203.8	5.8 ^a	68.4
7	236.0	6.1 ^{ab}	67.8 ^{ab}	226.4	6.4 ^{bc}	68.9

cerne with the Red Clover and the Brome Grass (Var. 7 – 236.0 & 226.4 g.kg⁻¹DM) while, compared to the other mixtures, they did not show any differences on the level of importance ($P < 0.05$). Demonstrable differences are shown in the average NEL contents in the first productive year (Tab. II) on the level of importance ($P < 0.05$) with a demonstrably higher contents in Treat. 3, 4, 5 & 7 (6.0, 6.2, 6.0 & 6.1 MJ.kg⁻¹ DM), in the second year (Tab. II) on the same level in Var. 2, 3 & 7 (6.1, 5.9, & 5.9 MJ.kg⁻¹ DM); the highest contents were shown in Treat. 1, 2 & 7 (6.6, 6.1 & 6.4 MJ.kg⁻¹ DM) all of them on the level of importance ($P < 0.01$). Organic matter digestibility was demonstrably higher in the mixtures with intergeneric hybrids in the climatically balanced year 2006 (Tab. II), when a difference was shown by Treat. 1, 2 & 7 on the level of importance ($P < 0.05$); in the second productive year 2007 (Tab. II), there were no demonstrable differences between the treatment included in the experiment, which is an evidence of their plasticity. Further, a statistically relevant ($P < 0.05$) correlative dependence between the NEL content and the percentage

of organic matter digestibility – OMD: the results of the whole experiment speak of 76%, i.e. strong, dependence between these two qualitative indicators (Fig. 2). The evaluation of the production parameters (Tab. III, IV & V) shows a demonstrably favourable influence of the grass component or MRH on the yield stability despite the climatically unbalanced second productive year, when the highest average yield of dry matter 21.09 t.ha⁻¹ in the course of all the experiment was shown in the mixture of the Lucerne + generic cv. Achilles (Treat. 4) and, with slight differences only, the variants of the Lucerne with the loloid hybrid Perun and of clover + generic cv. Perseus (Treat. 3 & 5), which is in concordance with the findings of not only NYKÄNEN *et al.* (2008), but also SLEUGH *et al.* (2009) and other authors.



2: Dependence of OMD on NEL during the whole experiment

III: Total production – pilot plant 2006

Treatment	Dry matter yield (t.ha ⁻¹)	Rank according to dry matter yield	CP yield (t.ha ⁻¹)	Rank according to CP yield	NEL yield (MJ.ha ⁻¹)	Rank according to dry NEL yield
1	17.93	6	4.16	6	115338.5	6
2	19.45	5	4.20	5	113588.6	5
3	23.12	2	4.95	2	148890.5	2
4	24.61	1	5.12	1	153074.2	1
5	21.23	3	4.71	3	129078.4	3
6	20.14	4	4.39	4	119833.0	4
7	17.61	7	4.05	7	105483.9	7

IV: Total production – pilot plant 2007

Treatment	Dry matter yield (t.ha ⁻¹)	Rank according to dry matter yield	CP yield (t.ha ⁻¹)	Rank according to CP yield	NEL yield (MJ.ha ⁻¹)	Rank according to dry NEL yield
1	13.92	6	3.18	6	91315.2	6
2	18.87	1	3.95	3	114163.5	1
3	18.68	2	4.15	2	110585.6	2
4	17.56	4	3.71	4	99916.4	5
5	18.39	3	4.57	1	108868.8	3
6	17.55	5	3.58	5	100912.5	4
7	13.01	7	2.94	7	83394.1	7

V: Total production of pilot plant

Treatment	Dry matter yield (t.ha ⁻¹)	Rank according to dry matter yield	CP yield (t.ha ⁻¹)	Rank according to CP yield	NEL yield (MJ.ha ⁻¹)	Rank according to dry NEL yield
1	15.93	6	3.67	6	103326.85	6
2	19.16	4	4.08	4	113875.75	4
3	20.90	2	4.55	2	129738.05	1
4	21.09	1	4.42	3	126495.30	2
5	19.81	3	4.64	1	118973.60	3
6	18.85	5	3.99	5	110372.75	5
7	15.31	7	3.49	7	94439.0	7

SUMMARY

The aim was to assess the test during the two harvest years 2006 and 2007, started as early as the year 2005 with unfertilised treatment of clover crops and their mixtures with grasses. These semi operational experiments were started on arable soil in chosen businesses in the area of the Bohemian-Moravian Highlands at 450–550 above sea level. The basis of the experiments was that an area was sown with a determined proportion of mixtures. In six of these treatment, a grass component or intergeneric hybrids were used (cv. Perun, Achilles and Perseus) (3, 4, 5, 6) and brome grass (cv. Tabrom) (7), and, as a check treatment (1), a mixture with main clover crops was used (Lucerne cv. Magda and a diploid variant of the Red Clover cv. Vltavín). The yield of dry matter and nutrients (CP, NEL, OMD) as a qualitative parameter in a sample of the mixtures were established. In chosen experimental treatment, samples were taken in four repetitions in each treatment in both the first harvest year 2006 and the second harvest year 2007. The dried and ground material was analysed using an NIRS 6500 instrumentation at the working site of VSTE Jevíčko. The digestibility of the organic matter (OMD) was established using the TILLEY a TERRY (1968) *in vitro* method modified according to RESCH (1991). Based on the verification of the qualitative and quantitative parameters it can be said that even a low proportion of grass component or intergeneric hybrid in grass-clover mixtures has a significant positive effect on yield stability and nutrient concentration. Affect the composition of the mixture ($P < 0.05$) content of NEL and in 2006 the OMD. These results can also be reached in the generally worse and climatically less balanced conditions of piedmont regions with no need of adding energy

in the form of nitrate fertilisers. (Of the chosen experimental treatment. On the base of comprehensive assessment the best results were found at the most suitable variant for the Region of Vysočina appears to be the mixture of the Lucerne with the loloid hybrid Perun. Another possible treatment is the Lucerne with the hybrid Achilles, and in damp conditions, it is also possible to use the mixture of the Red Clover with the hybrid Perseus.

SOUHRN

Nová uplatnění jetelovinotravních směsek ve struktuře pícnin na orné půdě

Cílem řešení bylo vyhodnotit pokus ze dvou užitkových let 2006 a 2007, založený již v roce 2005, a to s nehnojenými variantami jetelovin a jejich směsek s travami. Tyto poloprovozní pokusy byly založeny na orné půdě ve vytipovaných podnicích oblasti Českomoravské vysočiny již v roce 2005, v nadmořské výšce 450–550 m n. m. Základem experimentů bylo, že se osela plocha známým podílem směsek (Tab. I) a bylo provedeno procentuální zjištění podílu komponentů (Graf. 1), dále výnos sušiny a živin (NL, NEL, OMD) jako kvalitativního parametru ve vzorku směsek. U vybraných pokusných variant v prvním užitkovém roce ze sklizně 2006 a druhém ze sklizně 2007. Ze sedmi variant bylo v šesti použito travní složky, resp. mezirodových hybridů (odrůda Perun, Achilles a Perseus) (3, 4, 5, 6) a svehp bezbranný (odrůda Tabrom) (7) a jako kontrolní varianta (1) byla v pokusu použita směs s hlavními jetelovinami (vojtěškou setou odrůda Magda a diploidním jetelem lučním odrůda Vltavín). Usušený a pomletý materiál byl analyzován s využitím přístrojové techniky NIRS 6500 na pracovišti VSTE Jevíčko. Stravitelnost organické hmoty (OMD) byla stanovena pomocí *in vitro* metody TILLEY a TERRY (1968) v modifikaci podle RESCH (1991). Na základě ověření kvalitativních i kvantitativních ukazatelů lze konstatovat, že použití i nízkého podílu travní složky, respektive mezirodových hybridů v jetelovinotravních směskách se významně pozitivně projeví ve výnosové stabilitě i koncentraci živin.

Složení směsi ovlivnilo ($P < 0,05$) obsah NEL a v roce 2006 také OMD. Těchto výsledků lze dosáhnout i v celkově horších a méně klimaticky vyrovnaných podmínkách podhorských oblastí a to bez potřeby dodatečné energie ve formě dusíkatých hnojiv. Na základě komplexního posouzení zkoumané problematiky se jeví pro výše zmiňované oblasti Vysočiny jako nejvhodnější varianta směska vojtěšky s loloidním hybridem Perun. Další možnou variantou je vojtěška s hybridem Achilles a do vlhčích podmínek je možno využít též směsku jetele s hybridem Perseus.

jetelovinotravní směsky, kvalita píce, četnost sečí, dusíkaté látky, netto energie laktace, stravitelná organická hmota, mezirodové hybridy

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