

7. Muchow R. C, Davis R. (1988) Effect of nitrogen supply on the comparative productivity of maize and sorghum in a semi-arid tropical environment. II. Radiation interception and biomass accumulation. *Field Crops Research* 18, 17–30.
8. Nichiporovich A.A. (1988) Fotosinteticheskaia deyatel'nost' rastenij kak osnova ikh produktivnosti v biosfere i zemledelii, *Fotosintez i Produktsionnyj Protsess*, (1988), Nauka, Moscow.
9. Nita Z. (1999) Stan aktualny i nowe kierunki hodowli owsa w Polsce. *PTTZ. Żywność – Nauka, Technologia, Jakość*. Kraków 1 (18), 186 – 192.
10. Reynolds M.P., van Ginkel M., Ribaut J. (2000) Avenues for genetic modification of radiation use efficiency in wheat *J. Exp. Bot.*; 51, 459 - 473.
11. Ross, J. (1981) *The Radiation Regime and Architecture of Plant Stands*. Dr Junk, The Hague.
12. Ruimy A., Jarvis P.G., Baldocchi D.D., Saugier B. (1995) CO₂ fluxes over plant canopies and solar radiation: a review. *Advances in Ecological Research* 26, 1–68.
13. Runyon J., Waring R.H., Goward S.N., Welles J.M. (1994) Environmental limits on net primary production and light use efficiency across the Oregon transect. *Ecological Applications* 4, 226–237.
14. Sinclair T. R, Horie T. (1989) Leaf nitrogen, photosynthesis, and crop radiation use efficiency: a review. *Crop Science* 29, 90–98.
15. Starck Z. (2003) *Transport i dystrybucja substancji pokarmowych w roślinach*. Wyd. SGGW, Warszawa.
16. Stockle C.O., Kiniry J.R. (1990) Variability in crop radiation-use efficiency associated with vapor-pressure deficit. *Field Crop Research*, 41, 633–644.
17. Varlet-Grancher C., Bonhomme R., Sinoquet H. (1993) *Crop structure and Light Microclimate: Characterization and Applications*. INRA, 518.
18. Zadocks J.C, Chang T.T, Konzak C. F (1974) A decimal code for the growth stage of cereals. *Weed Research* 14, 415-421.

THE INFLUENCE OF PERMANENT GRASSES ON WINTER WHEAT PRODUCTIVITY IN ORGANIC AND SUSTAINABLE FARMING SYSTEMS

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Abstract

The trial was conducted in light loamy *Dystric Albeluvisol* in Western Lithuania. The influence of mixture (80 % *Trifolium pratense* L. (Tp) cv. Liepsna + 20 % *Phleum pratense* L. (Pp) cv. Gintaras II) as green manure on the productivity of wheat was investigated in the organic farming system.

No pesticides and mineral fertilisers were used in Cattle manure 60 t ha⁻¹ was applied only. Red clover aftermath was used as green manure. Mineral fertilisers and pesticides according to plant needs and 60 t ha⁻¹ of cattle manure were applied in the sustainable farming system. Perennial grasses were grown for hay. Independently of the farming system red clover content in sward during the trial execution was 98.0-99.4 %. The dry mater (DM) yield of red clover regrowth was low (1.17-1.24 t ha⁻¹), because of the lack of precipitation. Higher winter wheat yield (6.72 t ha⁻¹) was obtained from the sustainable farming system. Maintenance with nutrients was better in sustainable than in the organic farming system, where the wheat yield was 1.8 times lower. Less nitrogen and phosphorus (2.8 and 2.6 times respectively) were applied to soil with green manure in the organic farming system when compared with the sustainable farming system.

Key words

Red clover, organic and sustainable farming systems, winter wheat

Introduction

The maintenance of potential soil fertility is related to soil humus conservation (Teit, 1990). Humus reduction is often observed in intensive farming systems (Abdallahi and Dayegamiye, 2000; Tate, 1991). In order to preserve soil fertility organic material, should be applied. Plants are attributed as being one of the major factors responsible for soil fertility.

As a result, soil fertility depends on the organic carbon content, left by preceding crops, and on its decomposition rate (Burke *et al.*, 1998; Tate, 1987). These processes are determined by the different biological properties of plants, their chemical composition, soil chemical and physical properties, climatic conditions and soil as well as crop cultivation management (Larsen *et al.*, 1994; Johnston, 1986). Many authors suggest that perennial legumes due to abundant root residues, rich in biologically fixed nitrogen, exert a positive effect lasting for several years on the soil that has not been disturbed for some time (Abdallahi and Dayegamiye 2000; Robles and Burke, 1997; Romanovskaja, 2001). Therefore, due to the high demand for nutrients, it is most rational to grow winter wheat after legumes. The second cut of perennial grasses can be used as green manure for wheat (Wivstad, 1999; Arlauskienė and Maikstenienė, 2001).

The hypothesis of the trial. In the organic farming system for winter wheat fertilization the green manure-red clover aftermath was used. The mineral fertilizers were used in the sustainable farming system. Hopefully the winter wheat yield obtained from the organic farming system will be close to the yield which will be grown in the sustainable farming system.

The objective of the present study was to determine the biological value of red clover as a preceding crop for winter wheat grown on West Lithuania's *Dystric Albeluvisol*.

Materials and Methods

Experiments were carried out at the Vezaiciai Branch of the Lithuanian Institute of Agriculture (West Lithuania's region) during 2001-2004. The mixture composed of *Trifolium pratense* L. (Tp) cv. Liepsna or *Phleum Pratense* L. (Pp) cv. Gintaras II (80 % red clover + 20 % timothy) was grown in: 1) organic farming system – without pesticides and mineral fertilizers, with 60 t ha⁻¹ solid cattle manure, the second cut of perennial grasses was used as green manure, 2) sustainable farming – solid cattle manure (60 t ha⁻¹) and mineral fertilizers, pesticides were used according to the plant need. Mineral fertilizer needs were calculated according to soil agrochemical indicators. Perennial grasses were grown in the following crop rotation: 1) potatoes, 2) barley with undersown perennial grasses, 3) perennial grasses, 4) winter wheat. The soil of the experimental site is light loam *Dystric Albeluvisol*. Soil agrochemical characteristics in the organic farming system: pH_{KCl} 6.3 ± 0.06, available P₂O₅ and K₂O 155 ± 5.60 and 201 ± 11.4 mg kg⁻¹, respectively, N_{total} 0.11 ± 0.01%, humus 2.0 ± 0.12%. The soil agrochemical characteristics of the sustainable farming system are: pH_{KCl} 6.0 ± 0.07, available P₂O₅ and K₂O 191 ± 9.33 and 201 ± 15.5 mg kg⁻¹, respectively, N_{total} 0.11 ± 0.01%, humus 2.0 ± 0.10%. The chemical composition of solid manure: dry matter 28.9 %, N 0.31 %, P₂O₅ 0.21 %, K₂O 1.16%. The climatic conditions of individual months of the perennial grasses' growing season were diverse. Favourable conditions for perennial grasses were in April, May and June. In terms of temperature and rainfall amount, these months were similar to the long-term average. The most unfavourable conditions for herbage growth were in July, when the rainfall was 50 % lower and the air temperature about 3 °C higher than the long-term average. Perennial grasses were cut twice. The first cut was taken in June, and the herbage was used as hay. The second cut was taken in July, and the herbage was used as green manure.

Soil agrochemical properties (in the 0-20 cm soil layer) were established using the following methods: pH_{KCl} – by electrometric method, available phosphorus and potassium by A-L method, nitrogen by Kjeldhal, humus by Turin. The metabolizable energy was calculated by T. Tamulis (Tamulis, 1986; Jankauskas *et al.*, 2000).

The chemical composition of plants and farmyard manure was determined using the following techniques: nitrogen by Kjeldahl, phosphorus and potassium by flame photometry.

The data were processed using the software package "SELEKCIJA" (Tarakanovas, Raudonius, 2003). Correlations-regressions were computed using *STAT_ENG* programme (*Excel* vers. 1.55). Symbols used in the paper: ** – data significant at a 99 % probability level.

Results and Discussion

Botanical sward analysis of different cuts was done to estimate the effects of red clover as a preceding crop on winter wheat productivity in the two farming systems (Table 1). In both the

organic and sustainable farming systems, the content of clover in the swards in the first and second cuts was similar 98.0 - 99.4 %.

Table1. The effect of farming systems on red clover content, dry matter (DM) yield and metabolizable energy (ME)

Farming system	Cut of swards	Clover content in the sward, %		DM yield, t ha ⁻¹		ME, GJ ha ⁻¹	
		$\bar{x} \pm S\bar{x}$	V, %	$\bar{x} \pm S\bar{x}$	V, %	$\bar{x} \pm S\bar{x}$	V, %
Organic	1 st cut	98.2 ± 0.74	1.50	5.46 ± 0.27	9.80	44.6 ± 2.17	9.74
	2 nd cut	98.7 ± 0.53	1.08	1.17 ± 0.19	33.1	9.54 ± 1.58	33.0
Sustainable	1 st cut	98.0 ± 1.31	2.67	5.28 ± 0.31	11.8	43.1 ± 2.52	11.7
	2 nd cut	99.4 ± 0.51	1.02	1.24 ± 0.21	34.1	10.1 ± 1.73	34.2

The content of metabolizable energy varied depending on the dry matter yield of perennial grasses ($y = 0.1224x + 0.0032$, $R^2 = 0.990$, $r = 0.995^{**}$). In both farming systems (organic and sustainable) the highest metabolizable energy contents (44.6 and 43.1 GJ ha⁻¹) were accumulated in the sward yield of the first cut. Due to the unfavourable climatic conditions, mainly a shortage of moisture, (amount of rainfall 48 mm - half of the long-term rate), which resulted in a reduction in dry matter yield in the second sward cut, the content of metabolizable energy also declined.

The variation coefficient according to red clover content variation in the swards was identified for each cut in the two farming systems. Low variation coefficients (1.02-2.67 %) suggest that the red clover content (%) in the dry matter yield is stable. While analysing the amount of red clover dry matter yield (DM) and metabolizable energy (ME) variation, it was noted that it was far greater than the clover content. In the organic and sustainable farming systems the first cut of the swards is characterised by a medium DM and ME content variation (variation coefficients 9.74-11.7 %). In both farming systems the variation of DM and ME content in the second sward cut was high (33.0-34.2 %).

When crops demanding high nitrogen amounts (potatoes, wheat) are grown in the organic farming system, there is a great chance that the yield will significantly decrease. However, this may not happen if the mineral fertilizer nitrogen is effectively replaced by farmyard manure or other organic fertilizers (Bate and Foster, 1993). Unfavourable climatic conditions had a major effect on the amount of green manure (aftermath of red clover). Due to the shortage of rainfall, the herbage yield of red clover aftermath in the organic farming system was low. The soil received 1.17 t ha⁻¹ dry matter with clover which corresponds to about 4 t ha⁻¹ of solid manure. With the clover aftermath the soil received about 10 % more potassium, but 2.6 times less phosphorus and 2.8 times less nitrogen, and the grain protein content was 3.05 percentage points lower in comparison with the sustainable farming system in which mineral fertilizers were used. In the organic farming system the winter wheat grain yield was 1.8 times lower than that in the sustainable farming system.

Table 2 The effect of farming systems on the content of nutrients incorporated into the soil as well as on the winter wheat yield and its quality

Farming system	N	P ₂ O ₅ kg ha ⁻¹	K ₂ O	Wheat grain yield, t ha ⁻¹	Concentration of albuminous N in wheat grain, %
Organic	31.8 ± 4.54	7.52 ± 0.91	32.8 ± 5.02	3.70 ± 0.14	9.35 ± 0.63
Sustainable	90.0 ± 1.50	20.0 ± 0.50	30.0 ± 1.60	6.72 ± 0.33	12.4 ± 0.68

Conclusions

Red clover used as green manure does not have a acceptable effect on the winter wheat yield. The winter wheat yield obtained in the organic farming system made 3.70t ha⁻¹ or it was 1.8 times lower in comparison with the yield which was obtained using the sustainable farming system. The amount of red clover aftermath (used for green manure) was low (1.17 t ha⁻¹ DM) due to the shortage of rainfall. So the content of nitrogen incorporated into the soil with the red clover aftermath was 2.8 times and phosphorus 2.6 times less when compared with mineral fertilization

treatments. Sustainable farming system provided a better nutrient supply to winter wheat, which had a positive effect on grain yield, which amounted to 6.72 t ha⁻¹.

References

1. Abdallahi M. M., Dayegamiye A. N. (2000) Effect of green manures on soil physical and biological properties and on wheat yields and N uptake. *Canadian Journal of Soil Science*, 80 (1), 81-89.
2. Arlauskiene A., Maikstieniene S. (2001) Biological value of leguminous plants as preceding crops in the agroecosystem. *Agricultural Sciences. The Lithuanian academy of sciences*, 1, 23-29 (In Lithuanian).
3. Bate M. T., Forster D. I. (1993) Organic agriculture in Ohio: An economic perspective. *Production Agriculture*, 6 (4), 536-542.
4. Burke I. C., Lauenroth W. K., Vinton M. A. et al. (1998) Plant – soil interactions in temperate grasslands. *Biochemistry*, 49 (3), 121-143.
5. Jankauskas B., Jankauskiene G., Svedas A. (2000) Comparison of the methods for the calculation of food energy value. *Agriculture. Scientific Articles*, 72, 239-251 (In Lithuanian).
6. Johnston A. E. (1986) Soil organic matter effects on soils and crops. *Soil Use and Management*, 3, 596-624.
7. Larsen W. E., Eynard A., Hadas A. et al. (1994) Control and avoidance of soil compaction in practice. Soil compaction in crop production. Amsterdam, the Netherlands Elsevier Science B.V. 597-625.
8. Tamulis T. (1986) *Chemical composition of forage and sustenance*. Mokslas Vilnius, Lithuanian -278.
9. Tarakanovas P., Raudonius S. (2003) Statistical analysis of the data of agronomical investigations in using computer programs ANOVA, STAT, SPLIT-PLOT from package SELEKCIJA and IRRISTAT. *Akademija*, 57 (In Lithuanian).
10. Tate R. L. (1987) Soil organic Matter-Biological and Ecological Effects. Wiley, New York. 218-237.
11. Robles M. D., Burke I. C. (1997) Legume, grass and conservation reserve program effects on soil organic matter recovery. *Ecological Application*, 7 (2), 345-357.
12. Romanovskaja D. (2001) The effect of organic fertilizers on accumulation of organic matter and on dynamics of mineral nitrogen in soddy-podzolic sandy loam soil. *Agricultural Sciences. The Lithuanian academy of sciences*, 1, 3-10 (In Lithuanian).
13. Wivstad M. (1999) Nitrogen mineralization and crop uptake of N from decomposing N-15 labelled red clover and yellow sweet clover plant fractions of different age. *Plant and Soil*. 208 (1), 21-31.

SEED PRODUCTION OF FODDER GALEGA (GALEGA ORIENTALIS LAM.) AND SEED STORAGE

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Abstract

The objectives of this work were as follows: 1) to identify fodder galega optimal seed harvesting time and method; 2) to study changes in seed germination during storage. Experiments were carried out during 1996-2006. Seed harvesting was studied for four years in the seed production crop of the first-fourth year of use. Fodder galega seed was harvested using two methods after 60 %, 80 %, and 90 % of pods had matured and 14 days after the last term. In 1999 the harvested seed was placed for storage. Seed quality changes were studied for seven years, storing the seed in a heated and unheated storage in paper bags. The highest seed yield was obtained when fodder galega was harvested using direct combine harvesting with prior defoliation, when 90 % of pods had matured. In drier weather the seed can be harvested using the swath harvesting method. Due to the low seed shattering it is not expedient to hasten fodder galega harvesting, and is better to adjust to more favourable weather conditions. In the dry year of 1999 seed germination was not dependent on the harvesting time and method and was 92-98%. After five years' storage in a heated storage seed germination (82-89 %) changed little, in an unheated storage seed germination declined to 19-40 %. In an unheated storage the seed preserved best when was completely mature. A conclusion can be made that in an unheated storage in paper bags the seed can be securely stored for only two years and in a heated storage – for five -six years.