SUMMARIES OF PRESENTATIONS AT THE

PARALLEL SESSION OF THE SECTION A

SUSTAINABILITY OF AGROECOSYSTEMS

CULTIVAR MIXTURE – A MULTIFUNCTIONAL CROPPING SYSTEM LINKING PLANT-PLANT AND PLANT-INSECT INTERACTIONS

Iris DAHLIN, Velemir NINKOVIC
Swedish University of Agricultural Sciences
iris.dahlin@slu.se, velemir.ninkovic@slu.se

Biodiversity in agricultural landscapes has been declined rapidly in recent decades with drastically increased extinction rate of species and threatened ecosystem services as a consequence. If biodiversity is to be restored and opportunities created for sustainable food production, cropping systems must optimize functional diversity instead of minimizing it. Increased plant genotypic diversity in crop fields can promote ecosystem services, but understanding of mechanisms underlying the impact of crop genotypic diversity on productivity and pest responses is limited.

Volatile signals of plants can be exploited by nearby plants as a cue for competitive neighbors, thus inducing growth responses that increase the competitive power of eavesdropping plants. Plants modify their growth in response to different signals by partitioning biomass between above- and belowground. Aphids are sensitive to slight changes in their host plants and might be negatively affected. This PhD project aims to develop high yielding organic cropping systems that are resilient to insect pests and enhance functional biodiversity. We investigated chemical volatile interactions between barley cultivars and how these affect aphids.

The results of laboratory experiments show that plants can perceive the growth pattern of different neighboring genotypes through volatile organic compounds, and adapt their own growth strategy accordingly. These induced growth changes in turn made receiving plants less acceptable for aphid settling. In field experiments barley cultivars were grown in two genotype mixtures and monocultures. We measured plant traits during two growing seasons and studied aphid population development in these systems. Cultivars responded to mixtures with adaptive plasticity in several traits including productivity, and these responses depended on neighbour identity. Further, aphid population development on one cultivar in a mixture was also neighbour-specific, and this was more important for suppression of aphid populations than the overall mixture effect, aphid colonization patterns or natural enemy abundance.

The results of our studies show that combining cultivars in mixtures, based on how they interact with each other, is a promising strategy for the development of sustainable crop production and pest management.

Keywords: adaptability, biodiversity, herbivore suppression, volatile communication, plant plasticity.

INVESTIGATING ENVIRONMENTAL FACTORS CAUSING VARIATION IN GLUTEN QUALITY

Anne Kjersti UHLEN[1,2], Shiori KOGA[2], Katherine Ann Gredvig NIELSEN[1,3], Heidi Udnes AAMOT[3], Ulrike BÖCKER[2], Eva VEISETH-KENT[2], Ingerd Skow HOFGAARD[3]

[1]Norwegian University of Life Sciences, [2]Norwegian Institute of Food, Fisheries, and Aquaculture Research (NOFIMA), [3]Norwegian Institute of Bioeconomy Research (NIBIO)

[1]anne.uhlen@nmbu.no

Variation in gluten quality due to environmental factors can be substantial, but the causes of this variation and the biological mechanisms are not well understood. This type of variation is however challenging to handel for the value chain which aims to produce wheat flour of optimal and stable gluten quality across batches of wheat. In Norway, the environmental variation in gluten quality in spring and winter wheat has been investigated during the period 2005-2017 by yearly analyzing samples from variety trials from 4-8 locations. The results showed large variation in gluten quality between seasons, and also between field trials within season. In some cases, incidents of very weak gluten quality has been found, linked to some environmental conditions.

Several types of experiments have been carried out to investigate environmental factors that may causes the variation in gluten quality. Experiments in controlled climate chambers were set up to study effects of low temperature on composition and polymerisation of gluten proteins. Characterization of the proteins from field samples having very weak gluten showed incidents of enzymatic degradation. As exogenic proteases from *Fusarium* spp. were suspected, effects of Fusarium Head Blight infestations on gluten quality were investigated. Pot experiments in greenhouse and inoculation with several *Fusarium* spp. at anthesis were carried out. Gluten quality of grain samples were analysed by electrophoretic, chromatographic and rheological methods, and protease activity was detected by zymography. Candidate proteases were identified by proteome analyses. Furthermore, experiments have been conducted in field to follow the accumulation and assembly of glutenin polymers during the later part of grain filling, especially in the desiccation phase after yellow ripeness.

The results showed that a low temperature during grain filling *per see* does not cause the large variations in gluten quality that can be found in field samples. The inoculation experiments with *Fusarium* ssp. confirmed that fungal infestations can cause a substantial weakening of gluten, similar to what was observed in some field samples. This was probably caused by proteases originally released by pathogens to utilize plant proteins as their nutritional sources. Frequent precipitation during the desiccation phase seemed to hinder the assembly of large glutenin polymers.

We conclude that infestations by Fusarium Head Blight pathogens during the grain fylling are a environmental factors causing variations in gluten quality. This needs to be investigated further and should include other pathogens that are commonly infesting wheat grains during grain development and maturation.

Keywords: wheat quality, gluten proteins, environmental factors, Fusarium infestations, proteases.

BALTICWHEAT NETWORK FOR SUSTAINABLE WHEAT PRODUCTION IN THE BALTIC SEA REGION

Rita ARMONIENĖ[1], Gintaras BRAZAUSKAS[1], Aakash CHAWADE[2]

[1]Lithuanian Research Centre for Agriculture and Forestry, [2]Swedish University of Agricultural Sciences

[1]rita.armoniene@lammc.lt, [1]gintaras.brazauskas@lammc.lt, [2]aakash.chawade@slu.se

Agriculture is one of the main sources of pollution in the Baltic Sea, causing an enrichment of water by nutrient compounds (Eutrophication) due to the leakage of nitrogen and phosphorus from fields and emissions from fertilizers and manure. Wheat (*Triticum aestivum* L.) is the most widely grown cereal crop in the Baltic Sea region and sustainable wheat cultivation is necessary for reducing pollution in the Baltic Sea. The total area under wheat cultivation and wheat production in the region has grown steadily between 2007 and 2016 and increased on average of 1.18% and 1.26% per annum, respectively. The growth in production is attributed to the increase in acreage and adoption of improved wheat breeding and crop management practices. However, available land for wheat is limited and thus sustained high grain yields of wheat should be produced per given area without compromising the environment. Furthermore, increased risk of abiotic and biotic stresses due to Global warming and expected extreme climate conditions cause serious threat for future wheat production.

For sustainable wheat cultivation in the Baltic Sea region, wheat cultivars with stable and high yields and adapted to the local environmental conditions are necessary. These new cultivars should have better tolerance for freezing and drought stresses, improved nutrient use efficiency (NUE), water use efficiency (WUE) and increased resistance to diseases. A combination of improved wheat cultivars and good farming practices can significantly reduce the impact of wheat cultivation on the environment. To accelerate development of improved cultivars, however, integrated transnational collaborations for pre-breeding and technology sharing are necessary. BalticWheat network focused on wheat breeding was established recently by participants from 10 organisations in 7 countries across the Baltic Sea region with an overall goal of identifying strategies to develop wheat cultivars for sustainable agriculture, involving transnational collaboration with academia and industry and utilizing existing resources and modern breeding techniques. In the presentation, major challenges and possible solutions for sustainable wheat cultivation in the Baltic Sea region will be highlighted and discussed.

Keywords: adaptability, Baltic Sea, breeding, wheat, sustainability, yield.

DEVELOPMENT OF WINTER WHEAT DISEASES DEPENDING ON AGRONOMIC PRACTICE

Biruta BANKINA, Gunita BIMŠTEINE, Ingrīda NEUSA-LUCA, Antons RUŽA
Latvia University of Life Sciences and Technologies
Biruta.Bankina@llu.lv

Soil tillage and crop rotation are described as important tools in wheat disease control; however, the results are different depending on year, site and others factors. The aim of the present study was to determine the effect of the soil tillage and cropping sequence on the level of winter wheat diseases. The development of winter wheat diseases was assessed in a two-factorial experiment at the Study and Research farm "Peterlauki" of the Latvia University of Life Sciences and Technology: A – soil tillage system (A1 – traditional soil tillage with ploughing at the depth of 22–24 cm; A2 – reduced soil tillage with disc harrowing up to the depth of 10 cm); and B – crop sequence (B1 – continuous wheat); B2 – oilseed rape and wheat; B3 – crop rotation where barley and faba beans were included. Trials were started in 2008, but data from 2012 till 2017 were analysed in this study, except for the year 2014, when plots were resown with spring wheat. Incidence (%) of wheat crown rot was assessed visually shortly before harvesting, severity (%) of leaf diseases were notted during all season of vegetation, but total impact of leaf diseases was evaluated by AUDPS (area under diseases progress stairs) calculation.

Severity of all diseases fluctuated depending on year, but impact of agronomic practise have been found.

Tan spot (caused by *Pyrenophora tritici-repentis*) and Septoria tritici blotch (caused by *Zymoseptoria tritici*) were the dominant diseases, also mildew (caused by *Blumeri graminis*) were observed throughout the whole investigation period, althought severity of mildew was too low for evaluation of promoting factors, but other leaf diseases were not detected. Level of Septoria tritici blotch was not influenced by agronomic practise. In opposite, these factors influenced development of tan spot. The level of tan spot was higher in plots without ploughing (except fields with crop sequence). Ploughing mitigated the effect of wheat as a pre-crop or a pre-pre-crop, and short crop rotation decreased the level of tan spot. In ploughed fields, short crop rotation (only wheat and oilseed rape) also provided sufficient control of tan spot, and, in contrast, short rotation was not effective if the fields were not ploughed.

Soil tillage method did not influence development of crown rot, but impact of crop sequence was significant. Continuous wheat sowings promoted development of disease, also short crop rotation, where only wheat and oilseed rape were included did not decreased infection with causal agents of crown rot essentially. Although impact of soil tillage was not proved, but importance of crop rotation was shown more clearly under reduced soil tillage. *Oculimacula* spp. and *Fusarium* spp. were recognized as most important and most widespread causal agents of wheat crown rot.

Soil ploughing and crop rotation have had impact on the some diseases, but did not allow to decrease level of all disesaes, effect of agronomic practise is depending on biological peculiarities of pathogens, also meteorological conditions can mitigate influence of soil tillage and crop rotation.

Keywords: *Pyrenophora tritici-repentis*, *Zymoseptoria tritici*, crown rot, crop sequence.

Acknowledgement. The research was supported by the National Research Programme AgroBioRes, Project *Soil*.

SIMULATION OF GRAIN MAIZE DEVELOPMENT UNDER WATER AND TEMPERATURE STRESS

Renaldas ŽYDELIS[1], Lutz WEIHERMÜLLER[2], Michael HERBST[2], Anne KLOSTERHALFEN[2], Sigitas LAZAUSKAS[1]

[1]Lithuanian Research Centre for Agriculture and Forestry, [2]Forschungszentrum Jülich GmbH

renaldas.zydelis@lammc.lt

Lithuanian farmers face significant risks because of low temperatures and occasional water shortage when attempting to benefit from climate warming by expanding maize growing for grain. The aim of this study was to investigate maize development and to analyse the suitability of two models of different complexity to simulate maize growth under temperature and water stress conditions. Field experiments with a short season maize variety AGIRAXX were conducted in 2015 and 2016 at Lithuanian Research Centre for Agriculture and Forestry on a sandy loam. Experimental plots, applied with N 170, were chosen for the simulation to represent non-limited nitrogen nutrition conditions. Total biomass and leaf area of maize were measured periodically at vegetative and reproductive growth stages. The soil water content was measured weekly at depths of 10, 30 and 60 cm. The AquaCrop and AgroC models were calibrated and validated using data sets of cool/dry (2015) and warm/wet (2016) seasons. Both models reproduced the total biomass development during growth period relatively well. In 2015, the RMSE for AquaCrop was 0.69 t ha^{-1} (R^2 = 0.98) and for AgroC the RMSE was negligibly larger 0.86 t ha^{-1} (R^2 = 0.97). In 2016, the corresponding values were 1.33 t ha^{-1} (R^2 = 0.97) and 0.54 t ha^{-1} (R^2 = 0.99) for AquaCrop and AgroC, respectively. The simulated canopy cover values corresponded to the experimental measurements fairly well: for AquaCrop the RMSE for the 2015 and 2016 seasons was 7.0 and 4.0% (R^2 = 0.99 and 0.97), respectively, and for AgroC the RMSE was inappreciably higher 11.7 and 17.0% (R^2 = 0.71 to 0.76), respectively. Soil water content levels were similar to the field measurements. Under climate conditions of the experimental site, AgroC predicted a fairly high potential grain yield of 11.25 – 11.85 t ha^{-1}, while that predicted by AquaCrop amounted to 10.31 – 10.95 t ha^{-1}. Grain yield reduction due to the abiotic stress simulated by AquaCrop was 3.41 t ha^{-1} in cool/dry season and 2.02 t ha^{-1} in warm/wet season. The respective values for AgroC were 4.32 and 2.84 t ha^{-1}. Our study provides experimental evidence of maize grain yield levels above 9 t ha^{-1} for Lithuania in years with favourable temperature and rainfall regime and optimum management. Despite the climate warming, the low temperatures occurring during the vegetative stage, remain the dominant factor for potential yield losses, while the impact of water stress is of secondary importance.

Keywords: AgroC, AquaCrop, potential yield, temperature stress, water stress.

NEED FOR MORE DETAILED GREENHOUSE GAS EMISSION MODELS TO ESTIMATE CARBON FOOTPRINTS OF AGRICULTURAL PRODUCTS

Hannele PULKKINEN, Jouni NOUSIAINEN, Sanna HIETALA, Kristiina REGINA, Perttu VIRKAJÄRVI, Juha-Matti KATAJAJUURI

National Resources Institute Finland (Luke)

Firstname.Lastname@luke.fi

There are large uncertainties in estimating direct nitrous oxide emissions from soils as well as methane emissions of enteric fermentation of cattle. Still currently, IPCC default factors and methods are widely used in Life Cycle Assessment (LCA). LCA is broadening fast from engineering to agricultural field, and also European Commission is planning environmental information policies based on LCA. But the development of emission models is still on-going and creates large uncertainties. Here, we test new more specific greenhouse gas emission models on beef case study, and analyse their effect.

In national FootprintBeef-project, environmental impacts of Finnish beef production was modelled combining biological animal and crop model with LCA modelling. Direct nitrous oxide emissions from cultivated mineral soils were assessed with IPCC default factor and model 3 presented in Regina et al. (2013). Also two different calculation methods were applied to estimate enteric fermentation emission: 1) methane energy proportion of gross energy as in equation 13 in Ramin and Huhtanen (2013) and 2) gross energy calculation equations based on IPCC 2006 which are also used in Finnish national inventory report (NIR) (Statistics Finland, 2015).

Estimating direct nitrous oxide emissions from mineral soils with a model differentiating between annual and perennial crops increased the emissions of grain cultivation required by a dairy breed bull by nearly 10 per cent while decreasing emissions from silage and pasture by more than 30 percent. In total, the emissions of feed production decreased by 7 per cent in the case study.

Estimating methane emissions of enteric fermentation with a model based on metabolisable energy intake instead of IPCC Tier 2 method based on gross energy intake, increases methane emissions by more than 10%.

With the model of Regina et al. (2013) it was possible to estimate N_2O fluxes from grass and annual spring crops from mineral soils for Finland with more precision than the IPCC default methodology. This is particularly crucial for ruminants, which utilise grass extensively. In the same manner, more detailed and specific models for enteric fermentation are needed. The model by Ramin & Huhtanen (2013) takes into account detailed feed dietary ingredient composition, and thus, seems more robust than methods by IPCC.

Most importantly, the results highlight the importance of developing more specified emissions estimation models to be used in evaluation of products' carbon footprints by Life Cycle Assessment. Consequently they allow more reliable estimates of environmental impacts of agricultural products in the market and can enhance greening production and consumption.

Keywords: greenhouse gas emissions, methane, nitrous oxide, modelling, beef.

MARGINAL ABATEMENT COST CURVES IN ANALYSING GHG EMISSIONS FROM AGRICULTURAL HOLDINGS IN LATVIA: THE CLUSTER APPROACH

Kaspars NAGLIS-LIEPA, Dina POPLUGA, Arnis LENERTS, Dzidra KREISMANE, Peteris RIVZA
Latvia University of Life Sciences and Technologies
kasparsnl.@inbox.lv, dina.popluga@llu.lv, arnis.lenerts@llu.lv, dzidra.kreismane@llu.lv, peteris.rivza@llu.lv

Climate change poses challenges that are relevant to agricultural production both in Latvia and throughout the world. Latvia ranks second in the European Union (EU) by the share of agricultural emissions in total GHG emissions, while agricultural activity in Latvia tended to increase every year, which also contributed to an increase in GHG emissions from agricultural activity. GHG emission reduction measures for Latvia are not new and unusual, as several GHG emission reduction measures are being implemented in the agriculture of Latvia in the long-term, for example, the production of biogas, the incorporation of legumes into crop rotation, and the drawing up of fertilization plans. However, so far, there was a lack of scientific evidence and calculations in Latvia that could demonstrate the potential for reducing GHG emissions, their effectiveness, and whether additional measures are needed in order for Latvia to meet its international obligations. A popular way to analyse GHG emission reduction measures is to use a Marginal Abatement Cost Curve (MACC), which ranks GHG emission reduction measures based on their cost and emission reduction potential. The research analysed 17 measures having GHG reduction potential by using a MACC. In addition, being aware of the diversity of agricultural holdings, the cluster approach was used. The research constructed 5 MACCs for typical groups of agricultural holdings. The research results allow policy makers to develop a precise and effective climate policy in agriculture.

Keywords: GHG emissions, MACC, reduction measures, agriculture.

IMPACT OF NORTH ATALANTIC OSCILLATION ON SWEDISH WINTER CLIMATE AND NUTRIENT LEACHING FROM ARABLE LAND

Barbro ULÉN, Elisabet LEWAN, Katarina KYLLMAR, Maria BLOMBERG, Stefan ANDERSSON

Swedish University Agriculture Sciences

barbro.ulen@slu.se

Winter climate in the Nordic countries may be influenced by the North Atlantic Oscillation (NAO), commonly defined as the difference in air pressure between northern and southern Atlantic points. Its intensity is expressed as an index (NAO_i). A high index is generally associated with warm humid air. NAO_i has been suggested for use in assessing nutrient leaching from arable land to water and the effects of mitigation measures. Using open data from the Swedish Meteorological Institute (SMHI), we found long-term significant ($p<0.05$) positive linear relationships between winter NAO*i* (November-April) and temperature, and between winter NAO*i* and precipitation, in the period 1950-2016 in south-west Sweden. More recent data (2004-2016) revealed significant ($p<0.05$) positive linear relationships with air freezing/thawing indices (AF_i-AT_i) in southern and central Sweden. In 2004-2016, which included one year with unusually low NAO*i* and three years with unusually high NAO*i,* there were also significant negative linear relationships between NAO*i* and a snow depth index (SD_i). However, the relationship between NAO*i* and precipitation was not consistent. Management (farmer interviews) and nutrient leaching (flow-proportional water sampling) were studied (2004-2016) in two artificially drained agricultural catchments: a mini-catchment (20.7 ha, code 11M, siltyclay loam soil) and neighbouring catchment (788 ha, code M36, sandy hills with central, heavy clay plain) in north-west Scania. Total nitrogen (TN) and total phosphorus (TP) leaching increased significantly with winter NAO_i (November-April) in both catchments. Use of slurry was low in catchment M36 and no slurry was incorporated in winter in recent years in catchment 11M. Very low winter NAO_i (-0.98) gave the highest concentration of dissolved reactive phosphorus (DRP) in catchment 11M, while TP concentration in other forms (other P) was moderate (0.12 mg L^{-1}). Concentration of other P (1.02 mg L^{-1}) was elevated in 11M in 2014/15, after a large (32% of area) internal buffer (unfertilised fallow after grass ley, strategically located in a central ravine) was ploughed down in autumn 2014. No general trend in P or N mineral fertilisation was observed in catchment M36. Thus NAO*i* may affect nutrient leaching and could be integrated into climate-chemical indicators and trend analyses of water quality.

Keywords: air freezing/thawing, snow depth, nitrogen leaching, phosphorus leaching.

SOIL BIOLOGICAL PROPERTIES IN FOREST AND AGRICULTURAL ECOSYSTEMS

Jūratė ALEINIKOVIENĖ[1], Jakub HOFMAN[2], Kęstutis ARMOLAITIS[3], Vaclovas BOGUŽAS[1]

[1]Aleksandras Stulginskis University, [2]Masaryk University, [3]Lithuanian Research Centre for Agriculture and Forestry

[1]jurate.aleinikoviene@asu.lt, [2]hofman@recetox.muni.cz, [3]kesarm@mi.lt

Soil management often results in changes of soil biological properties, particularly, of soil microbial communities. Certainly, the management is closely related to reduction of soil organic matter with reduction not only the nutrient availability but also the soil microbial biomass potentials. However, the retention of soil could lead to reduction of organic carbon. To understand how management can change soil biological properties, we studied soil microbial abundance, microbial biomass in soil and content of amino sugars in microbial biomass under agricultural management (conventional tillage under different soil genesis). The biological properties in selected agricultural sites were compared to that of mature forest sites in Lithuania. It was obtained, that management of agricultural soils was evidentially changing the soil microbial abundance. Further, the microbial abundance was decreasing in correspond to management intensity, on the contrary, increasing in soil under the forest sites. It was also reflected, that microbial abundance in managed agricultural sites not only increased with soil depth but also with coinciding intensive soil mineralogical changes. Either, the soil management influenced on the content of soil microbial biomass. The microbial biomass presented to be high sensible to soil tillage in agricultural sites. Thus, the content of amino sugars in microbial biomass decreased associated with the intensification of soil management. Thus, in forest soils the content of amino sugars was changing not significantly, whereas with different soil genesis, it was more expressed.

Keywords: soil, agriculture, forest, microbial abundance, biomass, amino sugars.

DEMO AGROFORESTRY SYSTEMS OF TREES AND PERRENIAL GRASES

Dagnija LAZDINA[1], Sarmīte RANCĀNE[2], Andis BĀRDULIS[1], Arta BĀRDULE[1], Kristaps MAKOVSKIS[1], Mudrīte DAUGAVIETE[1]

[1]Latvian State Forest Research Institute "Silava", [2]Latvia University of Life Sciences and Technologies

[1]dagnija.lazdina@silava.lv, [2]sarmite.rancane@llu.lv

Agroforestry – as the integration of woody vegetation, crops and/or livestock on the same area of land are not included is Latvia agronomy or forestry statistics and are not mentioned in any rules except translation of EU directives in Latvian. However, Latvia has a unique heritage of traditional agroforestry systems with a high environmental and cultural value - as silvopastural system, meadows with bushes and coppicing trees planted on hedges, anyway Latvia has a high potential for more and innovative modern agroforestry systems. Our experimental demo fields are innovation in Latvia, may be even Baltic scale. We established system where trees are growing between parcels or perennial plants – intercropping for multifunctional use.

Aim of research was test intercropping systems of deciduous trees with perennial plants. Fast growing trees Aspen, Poplar, Tilia, Wild cherry, Maple were planted in intercropping system with Festolium, reed canary grass (RCG), lupin and galega. At least two scenarios are possible for use of biomass - for energy and seed production. Trees were planted 2.5 m by 5 m wide rows, between rows perennial plants were sown in 2.5 m wide strips. Tree kind fertilizers - residues of biogass production, waste water sludge, wood ash were used as initial fertilizers.

Seed yield and biomass of grasses and legumes as well dimensions of trees increases under all kind of fertilisers used. The tree measurements and the results of yield and economical calculations made allow announce that mix of agriculture perennial plants and trees as woody crops promote ingrowing of trees and make positive cash flow already at second or third year. Wood ash and waste water sludge as fertiliser were more suitable for reed canary grass and galega, but mineral fertilisation - for reed canary grass and festulolium, without fertilisation - festulolium and galega. Poplars had better growths when wood ash is used. But waste water sludge and biogass production residue, which are nitrogen rich fertilizers, increased growth of and other tree species planted.

Keywords: aspen, poplar, wild cherry, tilia, galega, festolium, reed canary grass, lupin.

CAPABILITY OF TILLAGE PRACTICES FOR WATERLOGGING RISK REDUCTION IN TWO SOIL TYPES OF GLACIAL GENESIS

Virginijus FEIZA, Dalia FEIZIENĖ, Aleksandras VELYKIS, Danutė KARČAUSKIENĖ, Jonas VOLUNGEVIČIUS, Antanas SATKUS, Mykola KOCHIIERU

Lithuanian Research Centre for Agriculture and Forestry

virginijus.feiza@lammc.lt

Predicted increase of precipitation at the Baltic Sea region may result in the risk of waterlogging on glacial soils.

Four field experiments were set up on loamy *Dystri-Epihypogleyic Retisol (Retisol* (L)*, Endocalcari-Epihypogleyic Cambisol (Cambisol* (L) and *Cambisol* (SL) of morainic genesis and on clayey *Endocalcary-Endohypogleyic Cambisol* (*Cambisol* (CL/C)) of limnoglacial genesis in Lithuania. Three typical soil management practices were investigated in each experiment: 1) CT - Conventional tillage (stubble cultivation + deep mouldboard ploughing + presowing shallow cultivation), 2) RT - Reduced tillage (shallow stubble cultivation + presowing shallow cultivation), and 3) NT – no soil cultivation in *Cambisols* or ShPL - shallow ploughing in *Retisol*.

The aim of this study was to evaluate capability of tillage methods as management practices contributing to waterlogging reduction.

Data revealed that content of water stable aggregate (WSA) and the ratio between large pores which governs water regime and micropores were lower in soil with limnoglacial than in soils with morainic genesis. The increase in clay content caused the increase in aggregate stability by sequence from upper to deeper topsoil layer in *Cambisols* (L, SL and CL/C) only. Hydraulic conductivity (Ks) significantly depended on water saturation in morainic but not in limnoglacial soil. The increase in WSA content determined the increase in Ks by sequence from deeper to upper layer in morainic *Retisol* (L) only. The increase in clay content reduced water saturation in all soils and reduced Ks in morainic soils by sequence from upper to deeper layer. The action of soil organic carbon (SOC) as driving factor for Ks was clearly pronounced in fine-textured soils (morainic *Retisol* (L) and limnoglacial *Cambisol* (CL/C)). The decrease in SOC content determined the decrease in Ks by sequence from upper to deeper layer. SOC in morainic *Cambisols* (L and SL) acted as indirect factor. Ks and water flow character determined capability of different tillage systems for waterlogging prevention.

In summary, considering to possible climate change scenarious, the controlling of soil management intensity allows to maintain soil physical state and environment sustainability. Reduction of management intensity is advisable by raising the sequence of benefits: *Cambisol* (CL/C) → *Retisol* (L) → *Cambisol* (L) → *Cambisol* (SL). In *Cambisol* (CL/C) long-term CT, in *Retisol* (L) ShPL, in *Cambisol* (L) RT and in *Cambisol* (SL) long-term NT management could be considered as management practices protecting soil from waterlogging.

Keywords: clay, organic carbon, saturation, soil structure, water flow.

Acknowledgement. This research was funded by a grant (No. SIT-9/2015) from the Research Council of Lithuania.

LONG –TERM IMPACT OF REDUCED TILLAGE UNDER CLAYEY SOIL CONDITIONS IN NORTHERN LITHUANIA

Aleksandras VELYKIS, Antanas SATKUS
Lithuanian Research Centre for Agriculture and Forestry
aleksandras.velykis@lammc.lt, antanas.satkus@lammc.lt

Heavy soils (clay loams and clays) are typical for Northern Lithuania. These soils having poor physical properties by origin require more intensive tillage to maintain proper physical condition for grown crops. On the other hand, intensive tillage often does not meet environmental requirements. Therefore, choose of suitable tillage system and other additional measures are essential for good soil physical state maintenance, suitable crop growth conditions and environmental sustainability. Research objective was to evaluate the long-term agronomic impact of different intensity tillage as well as its combinations with supplementary practices on improving of soil physical conditions and crop productivity. The experiment, established in 2006, examined the influence of deep and shallow ploughing, shallow ploughless tillage, combinations of ploughless tillage with incorporation of lime sludge and cover crop for green manure and application of the same cover crop for mulch during winter without autumn tillage (no tillage) under spring and winter crop growing conditions on clay loam Endocalcary-Endohypogleyic Cambisol (siltic, drainic). Application of cover crop winter mulch without tillage in autumn, shallow ploughless tillage and shallow ploughing causes the compaction of lover (15-25 cm) topsoil layer. However, due to ploughless tillage the soil dry bulk density in subsoil (25-35 cm) layer is less compared to deep ploughing. Soil structure in the seedbed (0-5 cm) and in the upper (0-15 cm) topsoil layer is usually worse when applying the ploughless tillage or no tillage in autumn with cover crop mulch. Incorporation of lime sludge by ploughless tillage helped to avoid the compaction and structure worsening in upper topsoil layer, as well as increase aggregate stability. Application of ploughless tillage increased soil water content at upper topsoil layer immediately after spring crop sowing. However, due to shallow reduced tillage the water content in all topsoil markedly decreased when droughty periods lasted for a long time. It is expedient to use reduced ploughless tillage for winter cereals in clayey soils. Spring crops are more sensitive to reduced tillage than winter crops. Susceptibility (based on productivity) of spring crops due to reduction of tillage increased as follows: spring barley → spring rape → field pea. Spring crop yield decreased most when cover crop was left for mulching without tillage in the autumn. The use of lime sludge in combination with reduced tillage often increased the yield of spring and winter crops compared to the ploughless tillage alone. Combination of reduced tillage with cover crop for green manure and no tillage with cover crop for mulch is significant for preserving the environment. Such application of cover crops reduces the leaching of mineral nitrogen into the deeper soil layers and environmental pollution. This work was supported by the National Science Program "The effect of long-term, different intensity management of resources on the soils of different genesis and on other components of the agro-ecosystems" (grant number SIT-9/2015) funded by the Research Council of Lithuania.

Keywords: cover crop, crop yield, lime sludge, mineral nitrogen, soil physical state.

CHANGES IN THE MAIN HEALTH INDICATORS OF A RETISOL UNDER DIFFERENT MANAGEMENT HISTORY

Danutė KARČAUSKIENĖ, Regina REPŠIENĖ, Dalia AMBRAZAITIENĖ, Regina SKUODIENĖ, Ieva JOKUBAUSKAITĖ, Žilvinas KRYŽEVIČIUS

Lithuanian Research Centre for Agriculture and Forestry

danute.karcauskiene@lammc.lt, regina.repsiene@lammc.lt, dalia.ambrazaitiene@gmail.com, regina.skuodiene@lammc.lt, jokubauskaite.ieva@gmail.com, zilvinaskry@gmail.com

Soil health refers to the ecological equilibrium, functionality and capacity to maintain a well balanced agroecosystem. To use soil health as a tool for sustainability, physical, chemical and biological properties must be employed to verify which of them respond to different soil management. This research focused on an integrative view on indicators of a Retisol health to be used as tools of agroecosystem sustainability. The paper presents achievements of long term research (long-term liming, organic fertilization and tillage of different intensity) carried out in Vezaiciai Branch of Lithuanian Research Centre for Agriculture and Forestry. The study site is LAMMC, Vezaiciai Branch situated in West Lithuania, eastern fringe of the coastal lowland (55°43‘N, 21°27‘E). The object of investigation is a naturally acid soil Bathygleyic Dystric Glossic Retisol (texture – moraine loam with a clay-sized particle content of 12-14%) and the same soil exposed for more than ten years to tillage of different intensity (deep and shallow ploughing and shallow tillage with and without deep loosening every 4 years) and for half a century exposed to different periodic liming (0.5 rates every 7 years and 1.0 and 2.0 rates every 3-4 years) whose rates are calculated accoring to soil hydrolytic acidity and liming (1.0 rate every 5 years) in combination with famyard manure (40 and 60 t ha^{-1}).

Different soil uses (long-term tillage, liming and manuring) were found to lead to changes in Retisol chemical, physical and biological properties under moderately warm and humid West Lithuania’s climatic conditions. The intensive soil tillage (deep ploughing and its combination with deep loosening) disturbs some attributes associated with soil health - decreases organic carbon, deteriorates structure and decreases the stocks of main nutrients, while the less aggresive soil management was shallow soil tillage without deep loosening.

The obtained research findings suggest that soil pH, exchangeble Al and Ca, water soluble aluminium, organic matter and nutrient levels are the main chemical attributes correlated with plant yields and allow a quick improvement by proper liming and its combination with manuring. Soil pH is a key indicator in assesing Retisol’s health because it directly correlates with nutrient availability, dissolved organic carbon and also affects microbial activity and weed seed bank in the soil. Soil organic carbon is also a major attribute of soil health because it generally positively correlates with total organically bound aluminium, aggregates stability, soil bulk density and porosity, storage of nutrients and microbial activity. Soil microbial carbon has been used as a promising indicator of soil health due to its rapid responses to investigated agronomic practices and climatic conditions.

Keywords: soil health indicators, liming, tillage, manure.

THE INFLUENCE OF LONG-TERM TILLAGE AND RESIDUE MANAGEMENT ON TOPSOIL QUALITY IN SOILS WITH DIFFERENT TEXTURE

Dalia FEIZIENĖ, Virginijus FEIZA, Agnė VERŠULIENĖ, Daiva JANUŠAUSKAITĖ, Šarūnas ANTANAITIS

Lithuanian Research Centre for Agriculture and Forestry
dalia.feiziene@lammc.lt

It is known that all processes in different soils act in close interdependence and are site- and soil-specific, and climate and human activity dependent. Many studies have been done worldwide on soil structural composition, soil organic carbon (SOC) sequestration and soil greenhouse gasses efflux investigation, although most of published results were obtained in conditions different from the soil type, texture and climate conditions in the Nemoral-2 environmental / Boreal climatic zone. The effects of long-term tillage practices on soil properties are seldom reported in Boreal conditions.

The objective of this study was to estimate the subsequent long-term cumulative effects of 17 years of conventional (CT) and no-tillage (NT) in combination with straw removal or return, on SOC accumulation, soil pore-size distribution (PSD), water release characteristics (WRC) and CO_2 efflux on loam and sandy loam within a 0–10 cm layer of *Cambisol* during the main development stages of winter wheat.

A more pronounced superiority of NT over CT for SOC sequestration rate within the topsoil layer emerged on loam than on sandy loam. Furthermore, SOC sequestration rate under residue removal was 48% higher than under residue return conditions. In sandy loam, the SOC sequestration rate under NT over CT was similar in both residual backgrounds. The total volume of transition and storage pores, which is responsible for better soil water movement, was higher in sandy loam then in loam and under NT than under CT. However, a higher retention of topsoil moisture during the main growing stages of winter wheat was on loam than on sandy loam.

Straw on loam acted as a material for soil loosening by increasing the total volume of pores securing soil water exchange, i.e. fissures, transition and storage pores. Meanwhile, on sandy loam, the straw acted as a pore clogging material by decreasing the total volume of the same pores. Consequently, on loam, in spite of a high capability of NT with residue return to storage plant available water (PAW), the topsoil moisture during dry weather conditions at the growing of winter wheat was lower than under other soil management practices. On sandy loam, NT with residue returning governed the highest PAW content and maintained the highest topsoil moisture. Nevertheless, the highest potential to reduce CO_2 efflux on both loam and sandy loam has been demonstrated by CT with residue return.

Keywords: no-tillage, residues, top-soil, pore-size distribution, soil organic carbon, water content, soil texture.

Acknowledgement. This research was funded by a grant (No. SIT-9/2015) from the Research Council of Lithuania.

INTERNATIONALIZATION OF SOIL CLASSIFICATION – OBJECTIVES AND POSSIBILITIES

Aldis KARKLINS
Latvia University of Life Sciences and Technologies
aldis.karklins@llu.lv

International communication requires a common framework in different areas, and the soil is not an exception. Historically, every country has its own soil classification system developed and used for decades. These systems are good for national use and well fit to characterize local soil conditions. But unfortunately not for international use, e. g., for EU scale communication or even for Global Soil Partnership organized under the leadership of FAO. Actually, an alternative exists – the World Reference Base for Soil Resources (WRB) – the system designed to correlate the soil information among national classifications. But there is an open question – how to realize it? By intercalibration of national soil classification taxa with WRB ones or by classifying soils parallely according to one system and another? The first option might be more favourable, but – is it feasible?

Several attempts were made to find some correlation scheme for comparison of Latvia Soil classification with WRB. Both systems are constructed using an essentially different approach. Latvia soil classification is based on the principles of soil genesis and evolution, but WRB is strongly morphological oriented. This distinction makes direct comparison next to impossible. A similar problem is common in many countries. Therefore, the only realistic solution is to carry out training programs and to teach students (specialists) direct use of both soil classification systems – Latvia (national) and WRB. To facilitate the teaching and training process, the EU funded project "Freely Accessible Central European Soil" within the ERASMUS+ programme "STRATEGIC PARTNERSHIPS is run by the leadership of Nicolaus Copernicus University in Toruń (Poland). A team from nine universities representing Eastern and Central European countries (Poland, Czech Republic, Slovakia, Slovenia, Hungary, Lithuania, Estonia, and Latvia) is developing teaching tools (both printed and electronic), organizing soil tours and seminars for students, and collecting representative soil data across the countries of participation.

Besides students' training and development of teaching tools, some additional expertise should be obtained during numerous field expeditions in participating countries where soils were studied. The international team comprises soil specialists at different areas of expertise (geology, geomorphology, soil genesis and morphology, etc.) important for multidisciplinary research. These activities help better understand the advantages and shortcomings of both national classification and WRB.

The challenge of any soil classification is to characterize all soils in the region as well (informative, detailed, etc.) as possible. But none of the systems can cover everything, something is always left out. Are missing details important, and should they be incorporated into classification? Or is something too much for practical application of the classification scheme? How does WRB work in specific conditions? How to present the didactical tools for better understanding of the ideas of soil classification using both the national and international system? These are the main topics and outcomes of the realised project. The investigation was carried out within the framework of the project 2015-1-PL01-KA203-016480 "Freely Accessible Central European Soil".

Keywords: WRB, Latvia soil classification, students' training.

YIELD GAP IN NORWAY - AGRONOMIC KNOWLEDGE FOR INCREASED CEREAL PRODUCTION BASED ON NORWEGIAN RESSOURCES

Till SEEHUSEN[1], Anne Kjersti UHLEN[2]

[1] Norwegian Institute of Bioeconomy Research, [2] Norwegian University of Life Sciences

[1]till.seehusen@nibio.no

World food production faces some serious challenges, population is projected to increase by ca. 35% by 2050 and there is an increasing demand for plants for other uses like e.g. biofuels. This will require an up to 100% increase in food production by this date, given the current trends in diets, consumption and income continue. Increasing production is therefore a political aim in many countries today e.g. Norway. Possibilities to extend the crop production area are often limited and higher grain yields are an important measure to meet these challenges.

There is therefore a growing international interest in the potential for increasing crops on existing agricultural land. Stagnating crop yields are reported from many of the main cereal producing countries and new research methods have been established to analyze the yield gap, which is the difference between theoretically achievable crop yields (modelled and from variety trials) and those taken under practical conditions on a farm level (www.yieldgap.org).

Climate change will cause major challenges for many of today's grain producing countries, also in Europe. Norway is one of the few countries where climate change may give an opportunity to increase cereal production. Analyzes of the yield gap in Norway, made in cooperation with Wageningen University (Netherlands), show a gap in cereals around 40% which is higher than in some of the neighboring countries.

Research has shown that the size of the yield gap depends on a number of different factors that cause production potential to not be exploited. Such studies provide the basis for more accurate determination of the most important bottlenecks in production and how the potential can be utilized better in terms of both increased crops and improved resource utilization.

Sustainable intensification could strengthen the primary production in Norway and improve utilization of input factors. This will also help to reduce the negative environmental impact of agriculture and reduce the need for imports of food / feed.

Keywords: yield gap, Norway, cereals, sustainable intensification, reduced need for import.

THE EFFECT OF NON-CHEMICAL WEED CONTROL METHODS ON WINTER OILSEED RAPE CROP WEEDINESS AND PRODUCTIVITY

Rimantas VELIČKA, Aušra MARCINKEVIČIENĖ, Rita PUPALIENĖ, Marina KEIDAN, Lina Marija BUTKEVIČIENĖ, Zita KRIAUČIŪNIENĖ, Robertas KOSTECKAS, Sigitas ČEKANAUSKAS

Aleksandras Stulginskis University

rimantas.velicka@asu.lt, rita.pupaliene@asu.lt

The area of orgnanically grown oilseed rape in the world is about 93,000 ha, in Lithuania about 3,962 ha (in 2017). The yield of oilseed rape in organic farming is low and variable because of pests, weeds and diseases spreading. Weed control in winter rape crops is important especialy at early stages of development. The competitive ability of a rape crop for weed smothering is often used in organically grown oilseed rape, and usage of mechanical weed control is limited. Thermal weed control (steaming) is one of effective weed control methods in organic farming system.

This study aims to investigate the effect of non-chemical weed control methods on winter oilseed rape (*Brassica napus* L. ssp. *oleifera biennis* Metzg.) crop weediness and productivity.

A field experiment was performed in 2014–2017 at the Experimental Station of Aleksandras Stulginskis University (54°53' N, 23°50' E). The soil at the experimental site was classified as *Calc(ar)i-Endohypogleyic Luvisol* (*Drainic*) according to the WRB 2014. The main plot treatments involved plant bio-activators as follows: 1) without application and 2) with application. The subplot treatments included a combination of non-chemical weed control measures, including the following treatments: 1) thermal (water steam; row spacing of 48 cm) – TWC; 2) mechanical (inter-row loosening; row spacing of 48 cm) – MWC and 3) smothering (self-regulation; row spacing of 12 cm) – SMT.

Annual dicotyledonous weeds prevailed in winter oilseed rape crop: *Tripleurospermum perforatum*, *Stellaria media*, *Capsella bursa-pastoris* and of monocotyledonous *Poa annua*. Weed control methods and plant-bioactivators had no significant effect on weed density in winter oilseed crop before harvest. The lowest weed dry mass was in plots were MWC method was used. The stronger effect of TWC method was estimated in plots with plant bio-activators. TWC and MWC methods significantly decreased weed dry mass by 2.1 and 2.5 times in 2015 under dry wether conditions.

The highest density and the best over-wintering percent of winter oilseed crop was in 2015 and 2017 in plots with MWC. No significant influence of weed control methods on this indices was observed in 2016. The significantly highest seed yield was in plots with the use of MWC in 2015, and in plots with SMT and bio-activators in 2016. Bio-activators significantly increased seed yield of winter oilseed crop in plots with TWC and MWC (43.4 and 25.1%) in 2015, and in plots with SMT by 51.5% in 2016.

Keywords: winter oilseed rape, weed control methods, crop productivity, organic farming.

Acknowledgement. This research was funded by a grant (No. SIT-8/2015) from the Research Council of Lithuania.

CONTROL OF PERENNIAL WEEDS IN SPRING CEREALS THROUGH CROPPING SYSTEM

Livija ZARINA[1], Liga ZARINA[2], Dace PILIKSERE[1], Jevgenija NAČAJEVA[3]

[1]Institute of Agricultural Resources and Economics, [2]University of Latvia, [3]Latvian Plant Protection Research Centre

[1]livija.zarina@arei.lv

It is hypothesised that on-farm practices of cropping system are related to weed pressure and species composition. In order to verify this a monitoring was carried out in Latvia during the five–year period. In a study was evaluated perennial weed community responces to cropping system on farms that work accordingly to conventional and organic farming methods. Weeds were monitored by occurrence method, in total in 82 fields. More than 10 perennial weed taxa, at species or genus level, were registered; the most common among them were *Elytriga repens, Equisetum arvense* L., *Cirsium arvense* and *Sonchus arvensis*. Based on weed monitoring data and data from field histories, it was concluded that cropping system affects the amount of perennial weed species, but control of them is less affected by the cropping system than agronomic method (f.e. undersown in spring cereals).

This study is a component of the CORE Organic Plus PRODIVA project and is part of the project 'Integrated pest management for weed control in arable crops for sustainable use of the environment and resources" supported by European Agricultural Fund for Rural Development (EAFRD) and the project "Recommendations for effective control of wild oat and other widespread weed species in Latvia" supported by Latvian Ministry of Agriculture.

Keywords: conventional agriculture, organic farming, weed management.

DEVELOPING DRONE IMAGING BASED METHODOLOGIES FOR APPLICATIONS IN GRASS SWARD MANAGEMENT

Jere KAIVOSOJA[1], Oiva NIEMELÄINEN[1], Jussi NIKANDER[1], Markku KOISTINEN[1], Mikko LAAJALAHTI[1], Niko VILJANEN[2], Eija HONKAVAARA[2], Roope NÄSI[2], Teemu HAKALA[2]

[1]Natural Resources Institute Finland, [2]National Land Survey Finland, Finnish Geospatial Research Institute FGI

[1]jere.kaivosoja@luke.fi, [1]oiva.niemelainen@luke.fi, [2]niko.viljanen@maanmittauslaitos.fi

Silage production of grass swards is a major branch of plant husbandry in the Nordic – Baltic region. The hectare yields obtained from grass swards are difficult to estimate as the swards are harvested from two to four times in a season and high moisture concentration in of the harvest makes estimation of the dry matter yield (DMY) challenging. In the Droneknowledge –project we studied first the possibility to estimate the fresh yield (FY) and DMY of a growing grass sward by images and vegetation indices captured by a drone. We generated variation into the timothy – meadow fescue sward by applying six different rates of nitrogen (0-150 kg N/ha) in Spring, and the primary growth was harvested at four different dates from 6.6. to 28.6.2017. The experiment was carried out at the Natural Resources Institute Finland at Jokioinen, Finland. The experimental design was a split plot with four replicates. Reference data for drone obtained images included the sward height measured by a height stick, and FY harvested by Haldrup forage plot harvester, and DMY calculated from FY and dry matter percentage in the harvested FY. The minimum and maximum treatment means in the studied sward ranged in height from 20 to 69 cm, in dry matter percentage from 19,3 to 36,9, in FY from 1320 to 24710 kg/ha, and in DMY from 490 to 5600 kg DM/ha.

A machine learning method based on a low-cost remote sensing system was developed by the research team at the Finnish Geospatial Research Institute. They first generated an ultra-high resolution photogrammetric canopy height model (CHM) with a point interval of 10 mm and red, green, blue and near-infrared orthophotos mosaics, and then extracted various 3D-features, intensity values and vegetation indices (VI) from the datasets. The best estimation results were obtained by combining the height, RGB and VI features. The Random Forest estimator provided better results than the Multiple Linear Regression. The correlations were at best 0.95-0.97 for the dry matter yield and 0.95-0.98 for the fresh yield estimations. The obtained results indicated that the low-cost multispectral photogrammetric approach could provide highly accurate estimates of fresh and dry matter yield for growing grass swards. This provides a sound basis to the Decision Support System (DSS) study component in the project to examine how using drone-based mapping can affect decision making in silage production. Ous DSS study covers field operations: overseeding, fertilizer application, weed control, and timing of harvests. We formalize the planning processes that take advantage of field maps created from the data. The focus is on the effect the drone-based data can have on the management and decision making processes. We will study how the drone-based data will supplement the tacit farmer knowledge used in traditional decision making. The work will demonstrate the effect of new technology on farm management processes, and contribute to research on knowledge management in agriculture.

Keywords: biomass, drone, DSS, photogrammetry, silage production, vegetation indices.

PROTEIN CONTENT VARIATION IN GRASS OF SPONTANEOUS VETCH AND SWEET PEA SPECIES

Nijolė MARŠALKIENĖ
Aleksandras Stulginskis University
nijole.marsalkiene@asu.lt

Legumes, as a source of proteins and energy, are one of the major plants used for food and forage since olden times. Range of perennial *Lathyrus* (sweet peas) and *Vicia* (vetches) species grow in natural meadows of Lithuania. Due to their current economic value and potential for future utilization, *Vicia* and *Lathyrus* genus had a high priority for organic ruminant farm forage development.

The grass protein content, studies of spontaneous perennial *Vicia* and *Lathyrus* species were carried out. Fife *Vicia* genus (*V. cracca*, *V. sepium*, *V. pisiformis*, *V. sylvatica*, *V. cassubica*) and fife species of the *Lathyrus* genus species (*L. pratensis*, *L. sylvestris*, *L. tuberosus*, *L. palustris*, *L. maritimus*) were studied in collection of university Experimental station of Lithuanian University of Agriculture, Middle Lithuania, on soil – clay loam on sandy light loam *Calc(ar)i-Endohypogleyic Luvisol(LVg-n-w-cc)*.. The evaluation of grass protein content was based on testing of the individual plant grass mass ant parts like foliage, stems and flowers. The crude protein analysis was carried out using the Kjeldahl method.

The protein content in dry matter of grass varied between species and investigated plant parts. The lowest volume of protein was in stems of investigated species and the highest one – in blossoms. The protein content of the blossoms of the tested species ranged from 32.1 % up to 40.5 %, the protein content in foliage ranged from 21.4 % to 29.6 %. The largest portion in the tested species grass mass consisted of leaves (on average 50.8 %). The total foliage protein content of the tested vetch species was on average 25.62 %, and a little less in the sweet pea species – on average 23.13 %. *V. sepium* and *L. sylvestris* were characterized by the highest protein content in the grass. *L. tuberosus* and *V. cracca* were described by the lowest volume of protein. The relationship between the tested parameters and the location of geographical origin was not found during the experimental period.

Keywords: *Lathyrus*, *Vicia*, perennial, grass, protein content.

THE LANDSCAPE SPACE OF THE HISTORIC CENTER OF AIZPUTE

Una ĪLE, Aija ZIEMEĻNIECE
Latvia university of Life Sciences and Tehnologies
una.ile@llu.lv, aija@k-projekts.lv

Historically, Aizpute was first mentioned in the records in the middle of the 13th century. The Order of Livonia, the existence of the Duchy of Courland until the end of the 18th century, and the time of the Courland Governorate until 1918 have produced a very significant overlaying of the landscape space of the town. The river Tebra which enriches the landscape of the town has historically served as the border river between the Bishopric of Courland and the State of the Livonian Order. In turn, in the second half of the 19th century, a dike is constructed on the river and the historic centre acquires a vast waterfront - a mill lake. The left bank as the bluff with the ancient castle, manor brewery, the master's house, and roadside pub form a distinct silhouette of the cultural and historic landscape. Unfortunately, the expressiveness of the silhouette is reduced by a chaotic clumps of trees and a well-considered thinning is required for the existing trees. In summer, when trees sprout their leaves, the main sight lines are hidden. The most picturesque sight lines can be found on both banks of the river along the mill lake. The accessibility to this site remains an unresolved issue. This is one of the first tasks to be carried out in the development plan of the local authority. The scale of the historical building and the trees is particularly well comparable with the photographic material of archives. When researching each of the above sites of the old building in detail, the blue-green structures on both banks of the river Tebra.

The aim of the research is to explore the places of clumps of trees around the lake of the watermill on the Tebra river hiding the historic buildings of the town. The following objectives were set to achieve the aim: to evaluate the main sight line from the shore of the windmill lake; to analyze visual perception of roof landscape of the historic centre's buildings in sight lines from the river Tebra. Historic photos from Aizpute museum have been used for comparing the scenes in the photos with the present situation for the research purpose. A comparative method is used to make conclusions about the transformation processes and anthropegenic load in the historic part of the town that is related to the increased water level zone of the Tebra river. The research accurately explores the historic buildings of the shore line of the mills lake, which includes three dominants of landscape space – the Livonian castle, the church and the ansemble of manor buildings. As one of the most expressive objects of the north part of the Tebra mill lake is the Livonian castle which was originated in the middle of the 13th century as a fortress.

Keywords: historical landscape, aesthetic quality, heritage.

SUMMARIES OF POSTERS

OF THE SECTION A

SUSTAINABILITY OF AGROECOSYSTEMS

RELATIONS BETWEEN SOIL PROPERTIES AND CO_2 GAS EMISSIONS FROM DIFFERENTLY TILLED MAIZE CULTIVATION

Aida ADAMAVIČIENĖ, Sidona BURAGIENĖ, Kęstutis ROMANECKAS, Egidijus ŠARAUSKIS, Vita SMALSTIENĖ, Rita ČEPULIENĖ

Aleksandras Stulginskis University

rita.cepuliene@gmail.com

Soil-degrading factors, such as tillage, can increase the CO_2 emissions from the soil. For this reason a long-term (since 1988) stationary field experiment was carried out at the Experimental Station of the Aleksandras Stulginskis University (ASU), Lithuania in 2009-2012 and 2014. The purpose of investigations was to establish the correlation of soil physico-mechanical, chemical and biological properties with CO_2 emissions from differently tilled soil. Five primary tillage treatments were tested: deep conventional ploughing (23-25 cm depth), shallow ploughing (12-15 cm depth), deep cultivation (27-30 cm depth), shallow cultivation (disking, 12-15 cm depth) and no-till. The soil of experiment was Endohypogleyic-Eutric Planosol (PLe-gln-w). Crop rotation – winter weat, maize, spring barley and spring oil-seed rape. In experiment, the physical-mechanical properties of the soil were tested: penetration resistance, soil bulk density, moisture content, temperature, agregation and agregate's stability, total and aeration porosity; chemical properties: pH, available phosphorus and potassium; biological properties: sacharase and urease activity, number and biomass of earthworms. Soil testing was performed after primary tillage in autumn and after wintering before presowing soil tillage in spring. * - probability at $P < 0.05$, ** - at $P < 0.01$.

Correlation-regression analysis of research data showed, that at the end of vegetation, a strong negative correlation ($r = -0.977^{**}$) was found between soil temperature and CO_2 gas emissions. In each year of investigations, at the end of vegetation, due to different soil temperature and humidity regimes, a negative strong correlation between CO_2 gas emissions and total or aeration porosity ($r = -0.816^{**}$and $r = -0.830^{**}$) in the upper (0-15 cm) layer was found. In the deeper layer (15-25 cm), correlations were similar - $r = -0.836$ ** and $r = -0.878$ **.

After tillage in outumn, strog negative correlations were found between the soil penetration resistance in the upper soil layer ($r = -0.745^{**}$) or in the deeper layer ($r = -0.713^{**}$) and CO_2 gas emissions. In that period, in the upper soil layer, a strong correlation ($r = 0.727^{*}$) was obtained between soil aeration porosity and CO_2 gas emissions.

During all years of investigations, after autumn tillage, an average negative rorrelation was found between CO_2 gas emission intensity and urease activity ($r = -0.617$ *). In spring, in the upper soil layer (0-15 cm depth), a positive correlation was found between soil bulk density and CO_2 gas emissions. The weight of earthworms correlated with CO_2 gas emissions from the soil negatively ($r = -0.745$ **).

Keywords: CO_2 emission, correlation, maize, soil properties.

AGROECONOMIC EVALUATION OF AROMATIC AND MEDICINAL PLANTS USED FOR THE ENRICHMENT OF GRASSLANDS

Aleksandrs ADAMOVICS, Irina SIVICKA
Latvia University of Life Sciences and Technologies
aleksandrs.adamovics@llu.lv, irina.sivicka@llu.lv

For livestock, medicinal plants improve the lack of appetite and facilitate the digestive process of animals, boost their immune system, reduce inflammation, grow up milk secretion, etc. The aim of this research was to clarify the successfulness of seeding medicinal plants in pasture. The trial was carried out in sod gleyic soil, pHKCl 5.7, organic matter content 2.1 g kg^{-1}, Latvia, May 2016. The trial was implemented including two mixtures of seeds. The mixture "Country Horse 2122" contained nine species of medicinal plants: 7% yarrow (*Achillea millefolium* L.), 18% caraway (*Carum carvi* L.), 20% chicory (*Cichorium intybus* L.), 2% wild carrot (*Daucus carota* L.), 15% fennel (*Foeniculum vulgare* Mill.), 1% hedge bedstraw (*Gallium mollugo* L.), 10% parsley (*Petroselinum sativum* Hoffm.), 10% ribwort plantain (*Plantago lanceolata* L.), and 17% salad burnet (*Sanguisorba minor* Scop.). The second mixture contained oregano (*Origanum vulgare* L.) and St. John's wort (*Hypericum perforatum* L.) in equal parts. The seeds were sown in squares that were free from sward: "Country Horse 2122" in eight repetitions, and the mixture of oregano and St. John's wort in seven repetitions. The squares were established in a zigzag pattern. In the trial, the influence of the mixture on the growth and development of plants was studied, the changes in botanical composition were established, and the installation costs were calculated. For "Country Horse 2122", the first sprouts were observed on the 8th day after sowing; for oregano and St. John's wort – on the 21st day after sowing, and also in the further vegetation the plants developed much more slowly. In 2017, the botanical composition of the mixture "Country Horse 2122" changed to 13% and that of the oregano and St. John's wort 'mixture – to 52%. Overall, in the squares with the oregano and St. John's wort mixture, more than 50% of all plants were weeds. The costs of seeds and manual work for the "Country Horse 2122" trial made 139 EUR per 100 m^2, and for the mixture of oregano and St. John's wort – 208 EUR per 100 m^2. When freshly cut plants were fed to dairy cows, the animals consumed the eagerly. It was also observed that the plants' mixture did not change the quality (taste, odour, and colour) of milk negatively. The mixture "Country Horse 2122" can be recommended to farmers – it can be sown mechanically n lines. Though, in this case, the costs are about 250 EUR per ha, the yield can be cut in the year of sowing.

Due to the needs of specific growing conditions, the use of oregano and St. John's wort in grassland may cause problems (the development of plants is weak in the first year). Also, the price of these seeds is more expensive than for the "Country Horse 2122" mixture.

Keywords: medicinal plants, botanical composition, mixture.

ANALYSIS OF MOISTURE CONTENT AND GROSS CALORIFIC VALUE IN THE MIXTURES OF GRASS AND TIMBER BIOMASS FOR PRODUCTION OF SOLID FUEL

Aleksandrs ADAMOVICS[1], Rasma PLATACE[1], Skaidrite BUMANE[2]
[1]Latvia University of Life Sciences and Technologies, [2]Latvian Plant Protection Research Centre
[1]aleksandrs.adamovics@llu.lv,[1]rasmins@inbox.lv, [2]skaidrite.bumane@laapc.lv

Grass biomass is one of the types of solid fuel (pellets), which is considered to be the most promising renewable resource, possessing appropriate energetic qualities and a sufficiently high calorific value. In the production of biomass fuels, moisture content is an essential physical parameter that reduces the amount of combustible substances and influences the process of combustion: makes fuel burning difficult, prolongs drying time, and reduces combustion heat and boiler capacity and efficiency.

In order to make fuel energy efficient, the moisture content of biomass material should not exceed certain limits; therefore, it is important to clarify the indicators of moisture and gross calorific values for the grass and timber biomass and their mixtures to find the optimal biomass application (in pure form or in mixtures) for the production of solid fuels.

Field trials were conducted at the Study and Research farm "Peterlauki" (56°53' N, 23°71' E) of the Latvia University of Life Sciences and Technologies in 2011 – 2015.

The research was carried out on five species of grasses: reed canary grass (*Phalaris arundinacea* (L.) Raush.) cultivar 'Marathon', festulolium (× *Festulolium* Asch. & Graebn.) cultivar 'Vetra', timothy (*Phleum pratense* L.) cultivar 'Teicis', meadow fescue (*Festuca pratensis* Huds.) cultivar 'Vaira', and tall fescue (*Festuca arundinacea* Schreb.) cultivar 'Fawn'.

For the formation of pellets, the following biomass components were used: grasses – reed canary grass, festulolium, tall fescue, timothy, and meadow fescue; and timber – birch (*Betula pendula* Roth.), osier (*Salix* spp.), grey alder (*Alnus incana* (L.) Moench), aspen (*Populus tremula* L.), and hybrid aspen (*Populus tremuloides* × *Populus tremula*). From the obtained timber and grass powder (ø<1 mm), pressed pellets were formed using the manual press "IKA WERKE". The two-component pellets were composed in the following ratios: 3/1 (75% timber + 25% grass), 1/1 (50% timber + 50% grass), and 1/3 (25% timber + 75% grass). Single-component (100%) pellets of timber or grass powder were used for control.

Grass biomass was obtained from the first harvest of grasses in the 1st and 2nd year of use.

The moisture content and gross calorific value were determined at the Laboratory of Testing and Research of Waste Products and Fuels "Virsma" according to the standards ISO 589 and LVS EN 14774 and ISO 1928 an pelletizing d LVS EN 14918, respectively.

The average moisture content of grass biomass samples before pelletizing was 9.0% (from 8.1% for meadow fescue to 10.4% for festulolium); for timber – 7.8% (from 7.0% for osier to 8.5% for hybrid aspen and birch). In timber and grass biomass mixtures, the moisture content decreased with the increase in timber percentage. Adding 1/3 of timber, the moisture content in biomass mixtures decreased by 5% on average, but adding half and 2/3 of timber, the moisture content decreased by 15% and 20%, respectively.

In this study, the highest gross calorific value of grass biomass was determined for timothy (16.9 MJ kg^{-1}) and reed canary grass (16.4 MJ kg^{-1}).

The highest gross calorific value (≥18.0 MJ kg^{-1}) of biomass mixtures was detected for the ratio of 3/1 (75% timber + 25% grass) – in the mixture of birch or osier with reed canary grass, festulolium, and timothy. The gross calorific value of timber and grass biomass mixtures increased when the percentage of timber increased. This suggests that up to 25% of grass biomass can be add in the mixtures of timber and grass biomass in order to obtain a qualitative solid fuel material (pellets).

Keywords: timber and grass biomass, moisture, gross calorific value.

INFLUENCE OF LEAD ACCUMULATION ON PHYSIOLOGICAL PARAMETERS AND MINERAL ELEMENT (Mg, Fe, Mn) UPTAKE IN CROP PLANTS

Vita ALLE, Anita OSVALDE, Uldis KONDRATOVICS, Mara VIKMANE
University of Latvia
vita.alle@lu.lv

Soil pollution with hazardous elements including heavy metals has become a problem all around the world. There are two ways for soil pollution with heavy metals - as a natural process or as an anthropogenic activity. Heavy metals can cause health problems for people through access to the food chain. So, it is important to pay attention to soil, especially agricultural soil, contamination with hazardous elements. Mechanisms of physiological processes in plants are affected under heavy metal pollution. The aim of this study was to find out the impact of different lead (Pb) concentrations in the substrate on Pb accumulation in barley and lettuce leaves and roots, uptake of mineral elements, as well as effect on photosynthesis and chlorophyll *a* fluorescence, thus revealing differences between monocotyledons and dicotyledons. Barley (*Hordeum vulgare* L.) and lettuce (*Lactuca sativa* L.) were selected for the vegetation experiment as representatives of the monocotyledons and dicotyledons, respectively. Plants were grown in quartz sand under controlled growth conditions. The experiment lasted 28 days for barley and 43 days for lettuce. Plant growth and physiological parameters were investigated under increasing level of Pb in substrate: 0, 400, 600, 800, 1000 mg L^{-1} for barley and 0, 200, 250, 300, 350 mg L^{-1} for lettuce. Pb was added as $Pb(NO_3)_2$ in substrate. The following methods were used to analyze the plant material: the concentrations of Pb, Mg, Fe and Mn in air-dry plant material were estimated by atomic absorption spectrophotometry (Perkin Elmer AAnalyst 700); the content of photosynthetic pigments were determined by spectrophotometry method; chlorophyll *a* fluorescence parameters were determined with continuous excitation chlorophyll fluorimeter Handy PEA system. It was observed that the fresh weight of the experimental plants decreased with increasing concentration of lead in the substrate. Pb concentrations in roots were higher than in leaves for both barley and lettuce. There were differencies in the ability of Pb accumulation between model object leaves during the experiment. The results showed that in the conditions of the highest Pb concentrations in the substrate respectively 1000 mg L^{-1} for barley, the concentration of Pb in barley leaves was 414.20 mg kg^{-1}, while three timed lower pollution level for lettuce (Pb 350 mg L^{-1}), caused almost similar Pb in lettuce leaves - 329.74 mg kg^{-1}. In general, the uptake of several mineral elements (Mg, Fe, Mn) in lettuce and barley increased under Pb pollution. An increase of Pb concentrations in substrate resulted in the decreased content of chlorophyll *a*+*b* in leaves of model objects. At the end of the experiment in the conditions of maximum investigated Pb concentrations the content of chlorophyll *a*+*b* in barley leaves was 2.1 times lower and in lettuce leaves 1.3 times lover than that in the control plant leaves. The results showed that increasing Pb concentrations in substrate has a different effect on photosynthesis describing parameters in monocotyledons and dicotyledons. Both exclusion and tolerance strategies operate as plant resistance mechanisms to Pb as a stress factor in the model ojects – barley and lettuce.

Keywords: heavy metals, monocotyledon, dicotyledon, photosynthesis parameters.

ALLELOPATHIC INFLUENCE OF WINTER OILSEED RAPE RESIDUES WITH BIO-PREPARATIONS ON GERMINATION OF *SINAPIS ARVENSIS* L.

Rita ČEPULIENĖ, Zita KRIAUČIŪNIENĖ, Simonas MEŠKAUSKAS, Sandra JUCEVIČIŪTĖ
Aleksandras Stulginskis University
rita.cepuliene@asu.lt, zita.kriauciuniene@asu.lt

The aim of the research was to identify the allelopatic influence of winter oilseed rape residues taken after harvest and after differentt period of decomposition in the soil (2, 7 and 14 months) treated with bio-preparations and slurry on the germination of *Sinapis arvensis* L. seeds. Investigation carried out in a model field experiment at the Experimental Station of Aleksandras Stulginskis University, Lithuania. Samples of different morphological parts of winter oilseed rape were collected after harvesting. They were cut into 2–3 cm size chaffs and samples of 20 g were placed into the 9 × 12 cm size plastic mesh bags. 28 bags with winter oilseed rape threshing remains were treated with bio-preparation Bio1, 27 bags – with slurry, and 28 bags – with slurry and bio-preparation Bio2. Stubble and roots were treated (separately) with bio-preparation Bio1, slurry and slurry with bio-preparation Bio2 (14 bags with each bio-preparation). Bio-preparation Bio1 is used for the soil activation and composting. In the composition three carrier materials included: dolomite, molasses and magnesium sulphate. Bio-preparation Bio2 is used for aerobic conversion of slurry. In the composition two carrier materials included: calcium carbonate and molasses. Sample bags were placed in ploughed up furrow on the experimental site (bare fallow) at the 20 cm in depth and ploughed up. The effect of the residues on germination of *S. arvensis* seeds was studied using Petri dishes with two compartments. Weed seeds were germinated in one compartment, and in the second – placed oilseed rape residues (30 mg cm^{-3} fresh weigh). Treatments of *S. arvensis* germination bioassays: 1) without oilseed rape residues (Control 1); 2) oilseed rape residues without treatment (Control 2); 3) oilseed rape residues with bio-preparation Bio1; 4) oilseed rape residues with slurry; 5) oilseed rape residues with slurry and bio-preparation Bio2.

Treatment of oilseed rape residues (threshing remains, stubble and roots) with bio-preparations and slurry after harvesting increased the allelopathic inhibitory effect of residues on the germination of *S. arvensis* seeds. After two months of the decomposition in the soil of winter oilseed rape threshing remains treated with bio-preparation Bio1, slurry and slurry with bio-preparation Bio2, also roots treated with bio-preparation Bio1 and with slurry statistically significantly reduced ($P<0.01$) germination of *S. arvensis* seeds. Winter oilseed rape stubble, treated with bio-preparation Bio1, slurry and slurry with bio-preparation Bio2 taken after two months of the decomposition in the soil, had no influence on germination of this weed seeds, but after seven months of the decomposition in the soil, had statistically significant ($P<0.05$) influence on seeds germination. Winter oilseed rape threshing remains and roots, treated with all treatments, after seven months of the decomposition in the soil, had no influence on weed seeds germination. After 14 months of the decomposition in the soil, rape threshing remains and stubble, treated with slurry and slurry with bio-preparation Bio2 reduced allelopatic stimulatory effect of threshing remains and stubble on *S. arvensis* seeds germination. Ivestigation showed, that use of bio-preparations and slurry for winter oilseed rape residues, changes the allelopathic properties of winter oilseed rape residues.

Keywords: winter oilseed rape, threshing remains, stubble, roots, slurry, bio-preparations, germination, *Sinapis arvensis*.

Acknowledgements. Research was funded by a grant (No. SIT-8/2015) from the Research Council of Lithuania.

CHALLENGES AND PROSPECTS OF ORGANIC AGRICULTURE IN ICELAND

Ólafur R. DÝRMUNDSSON
Agricultural Consultant
oldyrm@gmail.com

Icelandic agriculture was mainly based on organic practices until the middle of the 20th century. However, only a few pioneers adopted fully organic principles until 25 years ago when VOR, the society of organic producers was founded. Soon followed the foundation of the certifier TÚN, advisory services in the Farmers Association of Iceland, teaching and research at Hvanneyri Agricultural University and the first legislation on organic farming, now fully replaced by EU regulations through EFTA membership. The development has been slower than anticipated but there are clearly great challenges ahead due to a fast growing market for organics, a demand which should be met by increased domestic supply rather than by imports. Looking at the prospects, and in spite of the fact that Iceland is lagging behind most of the Nordic and Baltic countries in developing organic farming, the numbers of certified farmers have grown from 6 to 31 and certified processors from 2 to 29 during the last 25 years. It is estimated that only 1% of the total national agricultural production is organically certified while 2% of the food sales constitute imported organics, mainly cereals, vegtables and fruit products. Exports are mainly seaweed products. In spite of the short growing season, cool climate and difficulties in growing legumes and cereals, such obstacles should be viewed in the context that in Iceland there are relatively few diseases in plants and animals and the use of pesticides and antibiotics is minimal compared to other countries. Moreover, the heritage breeds of dairy cattle, sheep, goats and horses are grassland-based, normally kept under extensive conditions and agricultural soils are virtually free from pollutants. Consequently, the difference between conventional and organic foods is less than in most countries in terms of safety and image. The author believes that in the future sustainable sheep production and geothermal greenhouse cultivation will be amongst the most promising organic enterprises in Iceland. Looking at such prospects in view of the present biological challenges, however, it is important to consider also both institutional and political obstacles. These include the need to increase the acquisition and transfer of knowledge through research, education and extension and the drafting and ratification of a clear governmental policy for the organic sector. Still the potential contribution of organic farming to the reduction of greenhouse gas emissions has not been realized by official bodies in Iceland. Of further concern is the lack of flexibility in EU regulations so as to allow for regional variation within the organic framework.

Keywords: greenhouses, organics, policy, production, sheep.

PERENNIAL LEGUMES FOR PLANT NUTRITION IN ORGANIC AGRICULTURE

Viktorija GEČAITĖ, Aušra ARLAUSKIENĖ
Joniškėlis Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry
viktorija.gecaite@lammc.lt, ausra.arlauskiene@lammc.lt

On farm nitrogen fixation of legumes is driving force in organic agriculture. Including lucerne, red clover (or grass-clover) in arable cropping systems will enhance soil quality in general. Taproot systems especially those of perennial legumes can make soil nutrients plant available from the solid phase and increase the density of vertical biopores in the subsoil thus making subsoil layers more accessible for succeeding crops (Köpke et al., 2015). Research was carried out at the Lithuanian Research Centre for Agriculture and Forestry's Joniškėlis Experimental Station on a clay loam *Endocalcari Endohypogleyic Cambisol*. The study was aimed to explore the belowground and aboveground mass of forage legumes red clover (*Trifolium pratense L.),* lucerne *(Medicago sativa L.)* and festulolium (x *Festulolium*) used as green manure in terms of their quality composition (nitrogen, phosphorus, potassium) and decomposition rate (carbon:N) and to estimate cereal productivity under organic cropping conditions.

Results showed that aboveground and belowground of swards depended by plant species. Forage legumes, with deep roots to produce high dry matter yields. Lucerne and red clover has the greatest dry matter yield – two times more then festulolium. Nitrogen concentration in the aboveground mass of lucerne was higher than that in red clover. Red clover and lucerne accumulated 7849.5-8458.7 kg ha^{-1} of their aboveground biomass and 4868.8-5606.9 kg ha^{-1} of belowground. Nitrogen concentration in the aboveground mass of lucerne was higher than that in red clover. Red clover and lucerne accumulated 253.3 and 284.2 kg ha^{-1} of symbiotic N in their biomass (aboveground and belowground). There seems to be no difference in growing lucerne and red clover. But on the other side, lucerne has intensive and deeper root system and improves properties of top- and subsoil. The festulolium accumulated more less of aboveground – 4952.5 kg ha^{-1}, and less of belowground mass – 4434.6 kg ha^{-1}. Phosphorus and potassium content was greater in the aboveground than that in belowground swards mass. The phosphorus content in the aboveground mass of forage legumes was on average 1.7 times higher than in sole festulolium. The aboveground mass of legumes was rich in potassium.

Nutrients (N, P) become available to plants only after roots and residues decomposition. The mineralization indicators (C:N, C:P) of the belowground and aboveground mass depended on the plant species. The highest C:N ratio of the aboveground mass was identified for festulolium (45-54). The most favourable for decomposition biomass ratio (C:N = 13-20) was of red clover and lucerne mass.

In the crop rotation sequence after red clover, having used part of the aboveground mass as green manure, and when growing winter cereals for two years, a significant increase in the total productivity of plants of crop rotation sequence was established, compared with the crop rotation sequence without forage legumes. Forage legumes, as pre-crops for cereals, significantly reduced nitrogen input.

Keywords: lucerne, red clover, nitrogen, phosphorus and potassium.

PRODUCTIVE SOIL FERTILITY UNDER SPRING WHEAT DIRECT SEEDING IN THE ENVIRONMENT OF EUROPEAN PART OF RUSSIA

Oleg GORYANIN[1], Alexey VASIN[2], Sergey SHEVCHENKO[1], Elena SHCHERBININA[1], Baurzhan DZHANGABAYEV[1]

[1]Samara Research Institute of Agriculture named after N.M. Tulaykov, [2]Samara State Agricultural Academy

[1]samniish@mail.ru, [2]vasin_av@ssaa.ru

In the developed natural and economic conditions of the region, the main direction of maintaining crop production is resource-saving. However the results of researches on studying the influence of soil processing and technological systems on its nutritious conditions and in general on fertility are very contradictory. Therefore, the experimental work on studying the prolonged affect (2011-2016) of direct sowing technologies and intensification levels on elements of efficient fertility of the ordinary chernozem and efficiency of spring solid wheat in the Middle Povolzhye, which is the most demanded crop in Russia, was carried out. Five agrotechnologies with direct sowing of crops and various intensity levels of using arable lands were investigated: Five agricultural technologies with direct crop sowing and different levels of intensity of arable land use were studied: 1. direct sowing + seed treatment + herbicides for vegetation (Background); 2. Background + biologics in the phase of tillering (Bioneks Kemi); 3. Background + mineral fertilizers (including spring wheat – pre - sowing application of ammonium nitrate (N30) - Background 1; 4. Background 1 + insecticides on spring wheat (decis Pro twice) - Background 2; 5. Background 2 + biologics (Kemi Bionex). In the case of control the traditional technology with annual plowing under all crops rotation were used. Nitrates, movable forms phosphorus and potassium, were defined according to state standard specifications 26951-86; 26204-91. The received results were processed by method of a dispersion analysis and according to D.A. Dospekhov. In the years of carrying out the researches of hydrothermal coefficient (HTC) during May-August did not exceed middle annual values and it was 0.45-0.74. At the same time in 2011, 2013 there were good conditions for growing and crop development. In 2015 at the HTC in June was 0.21, the efficiency of spring wheat was lower than middle annual values. It was considered that complex using of technology of direct sowing applying straw as a fertilizer stabilizes soil supply with nitrogen, increases phosphate content by 1.5-16.5%, an exchangeable potassium by 14.6-23.1%. During the research years, the high efficiency of nitrogenous fertilizers applying was set and it provided the increasing of NO_3 quantity by 1.4-1.8 times. The improvement of the nitric soil conditions by direct sowing in which starting doses of nitrogenous fertilizers were combined with integrated plant protection against weeds of diseases and wreckers gave a chance to obtain the greatest productivity of grain – 1.76-1.79 t/hectare that is 0.41-0.44 t/hectare (30.4-32.6%) above monitoring. The harvest increase from application of biological products was 0.15 t/hectare (11.9%), starting doses of N30 nitrogenous fertilizers – 0.17 t/hectare (13.4%), combined with the use of fertilizers and insecticides of 0.50-0.53 t/hectare (39.7-42.0%). On the basis of the obtained data by direct sowing of spring solid wheat, it is recommended to apply calculated doses of mineral fertilizers on productivity of 2.0 t/hectare, using low-cost, high efficient methods and ways of their applying (during sowing, local and band sowing). It is necessary to apply means of plant protection of new generation to fight with two-part weeds, infection diseases in the soil and in the seeds, corn bug thripses and cereal flies.

Keywords: direct sowing, spring wheat, nitrogen fertilizers.

EVALUATION OF FERTILIZATION EFFECT AT PRODUCTION OF STUMP SHOOTS IN POPLAR STANDS

Birger HJELM[1], Tord JOHANSSON[1], Per-Ove PERSSON[2]
[1]Swedish University of Agricultural Sciences, [2]Persson f.N.B. AB
perovelpersson@gmail.com

Landowners with harvested poplar plantations are currently facing the choice of planting with or without stump removal or establishing a new plantation based on stump shoot production. To stimulate stump shoot production by fertilizing around the stumps is an unproven method. A previous project (funded by STEM) established fertilization experiments in three harvested poplar plantations with one-year-old stump shoot 2012 in order to evaluate the short-term fertilization effects (two growth seasons) with two different fertilizer dozes 75 and 150 kg N ha^{-1} respectively. Half of the trial's sample plots were repeatedly treated the following year. Then a significant effect was found with repeated treatment with the higher fertilizer yield 150 kg N ha^{-1} for all three plantations. The present study has been revised in spring and autumn 2016 and autumn 2017 to evaluate the long-term fertilization effects. The results show that there is a long-term effect of fertilizing stump shots.

The results show that there is a long-term effect of fertilizing stump shoots. However, for the lower single dose (75 kg N ha^{-1}), no fertilization effect was noted on the biomass production. For the higher dose (150 kg N ha^{-1}) with repeated treatment, a clear fertilization effect was noted. The effect was noted for the stands and overall higher compared to the other treatments. On the other treatments, (repeated treatment with 75 kg N ha^{-1} and single dose with 150 kg N ha^{-1}), the results were not clear. The effect between them varied between the stands and in some case no effect was noted for either treatment.

In order to calculate the economic outcome of nitrogen fertilization, the results of the three test sites were combined. The overall result was that fertilization can be economically defensible even at today's low chip prices and current nitrogen fertilizer prices for the higher doses 150 and 300 kg N. The calculation is a draw at about 10 öre or lower per kWh. The single dose of 75 kg N spreading can not be economically motivated in any test site.

Keywords: poplar, stump shoot, fertilizer, fertilizer effect, bioenergy, biomass.

A RELAXED EDDY ACCUMULATION SYSTEM TO MEASURE GREENHOUSE GAS FLUXES FROM AGRICULTURAL ECOSYSTEMS

Hannes KECK, Achim GRELLE, Katharina MEURER
Swedish University of Agricultural Sciences
hannes.keck@slu.se

Eddy covariance (EC) systems are currently state-of-the-art in measuring greenhouse gas fluxes from terrestrial ecosystems. Yet, they are limited to a few trace gases due to the lack of fast response analysers. High financial costs and high power consumption may further restrict their suitability. An alternative to EC is the relaxed eddy accumulation (REA) technique. REA avoids the need for a fast response analyser by collecting air from upwards and downwards moving air parcels into separate reservoirs at a constant flow rate (Businger and Oncley, 1990). After collecting the air over a predefined time period the air in the reservoirs is analysed by a slow response analyser and the average flux can be calculated. Currently, we are developing and testing a REA system that is capable of measuring CO2, CH4, N2O, NH3 and H2O fluxes simultaneously with only one gas analyser (Picarro G2805). This system is compatible with virtually any gas analyser and thus supports the flux analysis of a wide range of other tracers like volatile organic compounds, isotopes and aerosols. Furthermore, the modular design and rugged casing makes the sampling system very robust and portable, and DC operation makes it suitable for a wide range of field campaigns. The performance of the system is tested in spring 2018 on an agricultural managed organic soil in central Sweden. The results will be compared to established EC systems for CO2, CH4, H2O and N2O.

Keywords: eddy covariance, greenhouse gas, nitrous oxide, flux measurements.

CO_2 EFFLUX FROM THE SOIL AS INFLUENCED BY THE CONTRASTING VEGETATION COVER AND MANAGEMENT CONDITIONS IN *RETISOL*

Mykola KOCHIIERU[1], Virginijus FEIZA[1], Dalia FEIZIENĖ[1], Alvyra ŠLEPETIENĖ[1], Jonas VOLUNGEVIČIUS[1,2]

[1]Lithuanian Research Centre for Agriculture and Forestry, [2]Vilnius University

[1]mykola.kochiieru@lammc.lt

Soil CO_2 efflux is a physical process driven primarily by the CO_2 concentration diffusion gradient between the upper soil layers and the atmosphere near the soil surface. Soil CO_2 production is heavily influenced by environmental factors (soil temperature, soil moisture, organic content, etc.). In this research the temporal dynamic changes of CO_2 efflux from the soil surface using a closed chamber method (LI-COR LI-8100A Automated Soil CO_2 Flux System) were investigated. The measurements were done on *Retisol* in grassland and in arable land under conventional tillage (CT) on hilly landscape, Western Lithuania. Soil CO_2 efflux was measured every 3-4 weeks during the vegetation season from May to August, 2017. Each measurement was performed in triplicate.

The soil vegetation cover and the amount of humus significantly influenced the soil respiration rate. The greatest efflux values ranging from 1.59 to 2.25 μmol CO_2 m^{-2} s^{-1} were recorded in the grassland site and from 0.85 to 2.16 μmol CO_2 m^{-2} s^{-1} were observed in the arable land under CT. These efflux values were lower than in the grassland. Agro chemical data revealed that the content of humus amounted from 0.45 to 2.3 %, total N from 0.05 to 0.1 %, organic C from 0.26 to 1.33 % in the soil depth of 0-60 cm of the grassland site, while the content of humus (0.25-1.67 %), total N (0.02-0.71 %), organic C (0.15-0.97 %) at the same soil depth were recorded in arable land under the CT. These values were lower than in the grassland. Soil temperature and moisture are the main factors exerting influence on soil gas origination rate. The relationship between soil CO_2 efflux and temperature at a 5 cm depth can be described by a simple multiple regression model ($y = 0.1908x^2 – 7.1208x + 67.621$, $R^2=0.78$, n=5, p=0.549, valid for temperature from 14.93 to 21.47 °C). Soil CO_2 efflux displayed a typical polynomial relationship with soil volumetric water content (VWC) at a 5 cm depth ($y = -0.0361x^2 + 1.463x – 12.737$, $R^2=0.48$, n=5, p=0.937, valid for VWC from 15.43 to 31.80 vol.%).

According to the results of topsoil respiration under contrasting vegetation cover and management conditions in *Retisol*, the CO_2 efflux differed in quantity and was directly related to humus, nitrogen and carbon content. The content of humus, total N and organic C in the arable land site under CT was lower than in grassland. The same trend of efflux originating from the soil during vegetation period was observed in all experimental sites. The soil experiments indicate that the amount of soil humus contributed significantly to the soil-atmosphere exchange of trace gases.

Keywords: Soil CO_2, soil temperature, soil volumetric water content, humus.

SEED COMPOSITION OF DIFFERENT *CAMELINA SATIVA* AND *CRAMBE ABYSSINICA* CULTIVARS

Nijolė MARŠALKIENĖ[1], Liuda ŽILĖNAITĖ[1], Birutė KARPAVIČIENĖ[2]
[1]Aleksandras Stulginskis University, [2]Nature Research Centre
[1]nijole.marsalkiene@asu.lt, [1]liuda.zilenaite@asu.lt, [2]birute.karpaviciene@gamtc.lt

Biodiesel is produced mainly from rapeseed oil in European Union. With an increase in demand for oilseeds, two alternative oilseed crops for Europe, camelina (*Camelina sativa* (L.) Crantz) and crambe (*Crambe abyssinica* Hochst. ex R.E. Fries), identified as major candidates for the future European bio-based economy.

The aim of study was to evaluate seed oil composition of five camelina and four crambe cultvars as an interaction of genotype and meteorological conditions in Lithuania.

Seed were sown and grown at the Experimental Station of Lithuanian University of Agriculture, Middle Lithuania, on soil – clay loam on sandy light loam *Calc(ar)i-Endohypogleyic Luvisol(LVg-n-w-cc)*. To determine fatty acids, the oils were extracted by the Folch method (Folch & Less, 1957) and NIRS method was used to determine the glucosinolate content.

The oil content in dry matter of seeds varied between species, years of cultivation and cultivars. This characteristic varied from 22.07 to 42.47% in camelina seeds and was 34.89% on average in years of investigation. The oil content in seeds of crambe varied in slightly narrower range (23.35–36.60%) with average of 29.33%, and was significantly lower than oil content in camelina seeds ($p = 0.035$). The glucosinolates content varied from 61.82 to 68.63 μmol g^{-1} in oil of crambe, and from 14.70 to 30.51 μmol g^{-1} in oil of camelina and differed significantly between species ($p < 0.001$). The result of factorial Anova revealed that plant species had the highest effect on variation of glucosinolates content in oil. By analogy to oil content, the increase of precipitation had significant negative effect on glucosinolates content. Camelina oil was characterized by predominating of linolenic acid which amount varied from 34.8 to 41.6% and was 36.6% on average, while crambe oil was predominated by erucic acid, which varied from 53.2 to 60.9% with average of 57.74%. The second the most abundant fatty acid in oil of both species was oleic acid, which amount did not differ between species. While the content of all other studied fatty acids differed significantly between both species (Mann-Whitney U test, $p < 0.001$).

The PCA distinctly separated both species, while intraspecific cultivars are was grouped according years of cultivation. It is obvious, that variation of fatty acid composition in camelina and crambe seed oil was much less affected by inheritable features of cultivars than by meteorological conditions of different years.

Keywords: *Camelina sativa*, *Crambe abyssinica*, cultivar, oil composition, glucosinolate.

EFFECT OF 50-YEAR CROP ROTATIONS ON SOIL ORGANIC CARBON CONTENT

Lina SKINULIENĖ, Vaclovas BOGUŽAS, Jūratė ALEINIKOVIENĖ, Vaida STEPONAVIČIENĖ, Aušra SINKEVIČIENĖ

Aleksandras Stulginskis University

lina.skinuliene@asu.lt, vaclovas.boguzas@asu.lt, jurate.aleinikoviene@asu.lt, vaida.steponaviciene@asu.lt, ausra.sinkeviciene@asu.lt

Identification and implementation of land use and soil management practices which create a positive agricultural soil/ecosystem carbon budget and restore soil quality is specific challenge worldwide. Moreover, soil carbon sequestration is almost only negative emission technologies which are readily available at a low cost and crop rotation is one of those. The objective of our investigation was to compare effect of 50-year term application of different crop rotations on soil organic carbon.

Long-term field experiment was established in 1966 at the Experimental Station of Aleksandras Stulginskis University at 54°52'50 N latitude and 23°49'41 E longitude. 9 different crop rotations were arranged in time and space. In addition *Rye monoculture* as well as *Continuous bare fallow* were included as control treatment. Soil – *Calc(ar)i-Endohypogleyic Luvisol*. All cereal straw was incorporated as organic residues. Soil organic carbon content was evaluated in 2015 and 2016, after 50 years from the beginning of this long-term field experiment.

Winter wheat grown in *Cereal, Field with raw crops* and *Norfolk* crop rotations. In this crop the highest (15.2 g kg^{-1}) organic carbon content was found in *Norfolk* crop rotation. *Cereal* crop rotation has an organic carbon content of less than 1.1 to 1.2 times, compared to other crop rotations.

Winter rye were grown in *Intensive, Field with raw crops, For green manure* and *Three course* crop rotations, as well as in *Winter Rye Monoculture*. In this case the highest amount of organic carbon was observed in *Intensive* (15.6 g kg^{-1}) and *Field with raw crops* (14.9 g kg^{-1}) crop rotations. The lowest – in crop rotations *For green manure* (11.3 g kg^{-1}) and *Three course* (12.0 g kg^{-1}).

Barley also were grown in 6 different crop rotations: *Intensive, Cereal*, *For green manure, Norfolk, Fooder*. The highest organic carbon content (from 6.5 to 20.7 %) was found in *Norfolk* (15.5 g kg^{-1}) and *Fooder* (14.5 g kg^{-1}) crop rotations compared to other crop rotations. The lowest organic carbon content was found in *Intensive* crop rotation. Similar amount of organic carbon also found in crop rotations *Cereal* and *For green manure*.

Soil organic carbon in *Continuous bare fallow* obtained 2 times less. Bare fallow without farmyard manure application decreasing soil productivity mostly. Crop rotation design in modern agriculture persist as one of major instruments for soil organic carbon management and sustainable intensification.

Keywords: soil organic carbon content, crop rotation.

Acknowledgements. This work was supported by the National Science Program "The effect of long-term, different-intensity management of resources on the soils of different genesis and on other components of the agro-ecosystems" (grant No. SIT-9/2015) funded by the Research Council of Lithuania.

INFLUENCE OF LONG-TERM CROP ROTATION ON WINTER AND SPRING CEREAL PRODUCTIVITY

Lina SKINULIENĖ, Vaclovas BOGUŽAS, Marija BUTKEVIČIENĖ, Ingė AUŽELIENĖ
Aleksandras Stulginskis University
lina.skinuliene@asu.lt, vaclovas.boguzas@asu.lt, lina-marija.butkeviciene@asu.lt, inge.auzeliene@stud.asu.lt

Long-term field experiment was established in 1966 in the Experimental station of Aleksandras Stulginskis University. This paper presents productivity data of winter and spring cereals in 2015 – 2017 from this long-term field experiment. Winter wheat, winter rye and spring barley was grown in 9 different crop rotations arranged in tame and space as well as rye monocrop were included. Soil – Calc(ar)i-Endohypogleyic Luvisol.

The highest winter rye productivity results were obtained while rye growing after manuring in grassland and fallow crop rotation sequences. Notwithstanding winter rye is not sensitive to preceding crop, majority of cases showed lower productivity of rye yield in a fifty years term rye monocrop to compare with crop rotation. In our experiment the biggest effect on rye productivity elements obtained from preceding crop and from total rainfall and temperature on grain formation time. The correlation between these indices was significantly strong.

Winter wheat is more sensitive to preceding crop, the influence of crop rotation was significant in all years of these experiment. The best preceding crop for wheat was vetch-oat mixture fertilized with animal manure in cereal crop rotation.

Spring barley were not so demanding to preceding crop, they can be grown after winter cereals. However their productivity was higher in row sequence or in case of animal manure application during crop rotation.

Keywords: winter rye, winter wheat, spring barley, crop rotation, proceeding crop.

Acknowledgements. This work was supported by the National Science Program "The effect of long-term, different-intensity management of resources on the soils of different genesis and on other components of the agro-ecosystems" (grant No. SIT-9/2015) funded by the Research Council of Lithuania.

THE EFFECT OF SOWING DATE ON COVER CROP BIOMASS PRODUCTION

Merili TOOM[1], Enn LAURINGSON[2], Liina TALGRE[2], Sirje TAMM[1], Lea NARITS[1]

[1]Estonian Crop Research Institute, [2] Estonian University of Life Sciences

[1]merili.toom@etki.ee

The primary objective for using cover crops is to reduce fallow periods and losses of nutrients remaining in the soil after harvest of the main crop. For effective soil protection and nutrient binding it is essential to produce adequate biomass in the fall. The biomass production depends on the length of the growing season and the sum of effective temperatures. In northern climate, there is a limited time between cash crop harvest and first winter frosts.

Species of the *Brassicaceae* family are commonly used as cover crops because of their rapid growth in the fall and effectiveness of taking up residual nutrients from the soil. White mustard (*Sinapis alba* L.) has been one of the most used autumn cover crops in Estonia. Tillage radish (*Raphanus sativus* L.) is widely used in many parts of the world and in recent years it has also been introduced to Estonia. Both crops have been the biggest biomass producers in recent years when sown at the beginning of August. White mustard is incorporated in the soil in autumn, because it does not overwinter in Estonia. Tillage radish is more cold tolerant and its large taproot decomposes during winter leaving relatively residue-free and weed-free seedbed by spring. Therefore it is also suitable for no-till systems. A field experiment at Estonian Crop Research Institute was conducted in 2017 with white mustard and tillage radish to compare cover crop biomass production at different planting dates.

Cover crops were sown on August 3, 8, 14 and 18, the previous crop was winter wheat. The above and below ground biomass samples were collected before frosts. Dry matter (DM) yield was determined after drying the material to a constant weight.

At the earliest sowing time, the biomass of white mustard was 4900 kg DM ha^{-1} of which 18% consisted of roots. The biomass of tillage radish was 3800 kg DM ha^{-1}, root percentage was 48%.

With delayed sowing at 8.08, 14.08, and 18.08 the above ground biomass of white mustard decreased 27.9, 70.3 and 72.6%, respectively. At the same time the root percentage remained nearly the same (14–18%).

The biomass of tillage radish biomass decreased 44.1, 63.5 and 69.7%. Tillage radish's root percentage decreased more than white mustard's, but radish had significantly greater root system.

Studies in Estonia have shown that the biomass of cover crops is significantly reduced when sown after mid-August.

Keywords: white mustard, tillage radish, biomass, sowing time.

PHOTOSYNTHETIC ACTIVITY INDICATORS AND YIELD POTENTIAL OF CORN HYBRIDS WITH MINERAL NUTRITION AND GROWTH STIMULATORS TREATMENT

Vasily VASIN, Alexey VASIN, Irina KOSHELEVA
Samara State Agricultural Academy
vasin_vg@ssaa.ru, vasin_av@rambler.ru, irinakosh@inbox.ru

To evaluate the parameters of corn photosynthetic activity and determine the productivity of different hybrids with early maturity while applying mineral fertilizers and growth stimulators.

This research was conducted in 2015-2017 years. The soil of location was a typical heavy loam chernozem with residual-carbonate and medium-humid content. Before plowing on 25-27 cm, mineral fertilizers were applied: diammophos and ammonium nitrate. Rates were calculated with balanced method. Planting depth: 5-6 cm. Method of planting: broad-band. Planting density – 65 th. seeds /ha. Growth stimulators Aminocat and Megamix N_{10} were applied in 5-6 leaves stages with 0.5 l/ha dosage. Standard moisture to calculate grain yield was 14%. Assimilation leaf area was counted with own Samara SAA methodology. Photosynthesis potential (PP) and pure photosynthesis productivity was calculated with methodology of A.I. Begishev and A.A. Nichiporovich.

The design of experiment #1 to study the influence of mineral nutrition on different maturity hybrid was following: Application NPP on planned yield 7 t/ha – background 1; 8 t/ha – background 2, 9 t/ha – background 3 (Factor A);Corn hybrids (Factor B): Falcone, Delphin, Krasnodarsky (FAO 180); Gitago, TK 202, Eurostar (FAO 200).

The design of experiment #2 to study the influence of growth stimulators on early hybrids was following: Aminocat, Megamix N_{10} (Factor A); Hybrids Falkone, Delphin, Krasnodarsky 194 (Factor B).

Yield level of corn hybrids with mineral nutrition in 2015-2017 years was 4,70…7,17 t/ha. While applying the growth stimulators the yield level was 4,86… 5,86 t/ha with maximum observed yield on Delphin with Megamix N_{10} treatment. Based on the results from 2015-2017 years, corn hybrids formed 21,27…35,84 th. м^2/ha of leaf area while applying fertilizers and the maximum amount was observed on TK 202 hybrid on background 3. The largest leaf area on the variants with growth stimulator application was noticed on Delphin and Krasnodarsky 194 – 35,78 and 37,06 th. m^2/ha., accordingly, where Aminocat was applied. Maximum photosynthesis potential was observed on TK 202 and Delphin hybrids – 1,95 and 1,92 million m^2/ha. days, on background 3. Maximum photosynthetic potential with growth stimulators application was 2,50 million m^2/ha. days. The biggest pure photosynthesis productivity was observed with mineral nutrition application on Falcone hybrid (FAO 180) – 10/06 gr/m^2 per day.

Closer to milky-wax ripeness stage – leaf area was 35,84 th. m^2/ha., with mineral fertilizers application. Growth stimulators are facilitating the enlargement of leaves on corn. Application of mineral nutrition increasing the photosynthesis potential to 1,95 million m^2/ha. days. When applying the growths stimulators the parameter of photosynthesis potential is increasing up to 2,36…2,50 million m^2/ha. days. Pure photosynthesis productivity increasing in variants with both big doses of mineral fertilizers, and with growth stimulator treatments. Growth stimulator treatment increasing the grain yield up to 10,8 – 14,2%.

Keywords: corn, fertilizer, growth stimulator, leaf area, photosynthesis potential.

THE FIELD PEA YIELD AND NITROGEN BALANCE DEPENDING DIFFERENT FERTILIZER RATES

Ivo VOOR, Viacheslav EREMEEV, Maarika ALARU, Evelin LOIT
Estonian University of Life Sciences
ivo.voor@student.emu.ee

The aim of this study was to compare and analyse the impact of organic and conventional growing system treatments to the dry matter yield (DM) of field pea (Pisum sativum), nitrogen use efficiency (NUE) and nitrogen leaching.

The data was collected during the period of 2012- 2016 and carried out on the experimental fields of the Estonian University of Life Sciences (58º 22´ N, 26º40´E). Soil type was Stagnic Luvisol (sandy loam surface texture, C 1,38% and N 0,13%, pH_{KCL} 6,0).

The experiment was set up in systematic block design with four replicates of each treatment and plot size was 60 m2. The field was divided by nitrogen treatments: three different treatment in organic plots (M 0, M I- cover crops, and M II- cover crops and manure) and four different treatment in conventional plots (N0, Nlow, Naverage, and Nhigh). The five-field crop rotation based on following order of the crops: barley undersown with red clover – red clover – winter wheat – field pea – potato. Field pea mineral fertilizer treatments were N0P0K0 and N20P25K95.

The average yield of field pea was higher in conventional plots where mineral nitrogen fertilizer was used. The highest yield was 2,60 t/ha, obtained from conventional N1 treatment. Lower yield in N2 and N3 plots can be explained by the after effect of high mineral fertilizer rate given to winter wheat the year before. Organic farming with cover crops gave the average yield 2,06 t/ha that is 21% lower compared to conventional farming. However, the difference of yield in different farming systems varies from year to year: in 2015 it was 25%, but in 2016 it was 35%.

The nitrogen use efficiency was calculated as 1 kg total DM yield per 1 kg of N applied, fixed symbiotically and collected by cover crops. Higher NUE revealed in treatments with lower amounts of N but relationship was not linear. The nitrogen uptake efficiency is obviously higher where pre crop got up to 50 kg N per hectar. Furthermore the yields of field pea stay lower in higher N rate of pre crop. It´s reasonable to grow such pre crops before field pea which have lower N demand. Otherwise the N losses will be happen.

Obviously the pea as leguminous fixing N2 from atmosphere and riching soil for next crop. Soil samples to measure N% in this were taken in spring before pea sowing and next spring before next crop. These measurements shows significally N leaching which depends on active temperatures in springtime. For detail view please see the poster.

Keywords: field pea, nitrogen balance.

PRODUCTIVITY OF GRASS AND LEGUMES MIXTURES WITH *POTERIUM POLYGAMUM* TREATED WITH GROWTH STIMULATORS

Vasily VASIN, Alexey VASIN, Arina KOZHAEVA, Irina KARLOVA
Samara State Agricultural Academy
vasin_vg@ssaa.ru, vasin_av@ssaa.ru, kuichinskaya.arina@yandex.ru, Irishka_karpova@list.ru

Objective of research was to evaluate parameters of photosynthetic activity of perennial grasses. The productivity determined of grass and legumes mixtures with *Poterium polygamum* treated with growth stimulators "Matritsarosta" and "Gumi 20M".

The research was conducted in year 2015-2017. The soil of the experimental plot is typical black soilaresidual-carbonate medium-humus medium-heavy heavy loam. Growth stimulators "Matritsarosta" and "Gumi 20M" were applied during the tillering phase on grasses and third leaves phase on legumes. The yield of green mass was determined by decade. The assimilation surface of the leaves was determined by the method of the Samara State Agricultural Academy (contour method). The photosynthetic potential and the pure productivity of photosynthesis were calculated by the method of A.I. Begisheva and A.A. Nichiporovich.

The planting scheme for evaluating the influence of stimulators: stimulators "Matritsarosta", "Gumi 20M" (factor A); Plants mixtures *Bromus inermis* + *Poterium polygamum*, *Bromus inermis* + *Bromus erecta* + *Poterium polygamum, Bromus inermis* + *Bromus erecta* + *Onobrychis arenaria* + *Poterium polygamum, Bromus inermis* + *Bromus erecta* + *Medicago* x varia Martyn + *Poterium polygamum*, *Bromus inermis* + *Bromus erecta* + *Lotus corniculatus* + *Poterium polygamum*; *Agropyron pectinatum* + *Poterium polygamum, Agropyron pectinatum* + *Elytrigia* + *Poterium polygamum, Agropyron pectinatum* + *Elytrigia* +*Onobrychis arenaria* + *Poterium polygamum*, *Agropyron pectinatum* + *Elytrigia* +*Medicago* x varia Martyn + *Poterium polygamum*, *Agropyron pectinatum* + *Elytrigia* + *Lotus corniculatus*+ *Poterium polygamum* (factor B).

It was concluded that he yield of green mass while applying growth stimulators on the whole variants is increasing before flowering phase. Mixes with *Bromus inermis* the field level in average in years 2016-2017 was: tillering phase – 5.94…14.27t/ha, budding phase – 9.27…22.34t/ha, blooming phase –12.76…28.07 t/ha, fruit formation phase – 17.52…32.77t/ha; with *Agropyron pectinatum* in branching stage – 4.76…19.18 t/ha, budding phase – 7.05…23.04 t/ha,blooming phase – 11.52… 29.52 t/ha, fruit formation phase – 14.58…31.29 t/ha, where four-component mixtures with *Onobrychis arenaria* are leading with the application of "Gumi 20M". The largest area of the assimilation apparatus was formed by grasses *Bromus inermis* +*Bromus erecta* + *Onobrychis arenaria* + *Poterium Polygamum* – 83,96 th.m^2/ha and *Agropyron pectinatum* + *Elytrigia* + *Onobrychis arenaria* + *Poterium polygamum* - 89,64 th.m^2/ha while applying "Gumi 20M". The dry matter amount was highest on mixture of *Bromus inermis* +*Bromus erecta* +*Onobrychis arenaria* + *Poterium polygamum* – 14.45t/ha and *Agropyron pectinatum* + *Elytrigia* + *Onobrychis arenaria* + *Poterium polygamum* – 10.26 t/ha with growth stimulator "Gumi 20M".

Application of growth stimulants "Matritsarosta" and "Gumi 20M" increased the intensity of leaf formation, the formation of photosynthetic potential, which largely forms a crop yield. The maximum productivity, the collection of dry matter and the digestible protein are distinguished by crops with traditional leguminous crops of the region: *Onobrychis arenaria*, *Medicago* x varia Martyn, provide a green yield of up to 32.77 t/ha, dry matter 14.45 t/ha and 1.25 t/ha.

Keywords: *Agropyron pectinatum*, *Bromus erecta*, *Poterium polygamum,* growth stimulators, green mass, dry matter.