# Modelling the onset of phenological phases of spring barley (*Hordeum vulgare* L.)

**Petra Dizkova, Lenka Bartosova, Lenka Hajkova, Jan Balek, Monika Blahova, Jakub Bohuslav, Eva Pohankova, Miroslav Trnka, Zdenek Zalud**

The onset of phenological phases of plant species is influenced mainly by air temperature. Each phenophase has its temperature limits (base temperature and temperature sum), which must be reached for each phase to occur. With knowledge of these limits, it is possible to predict the onset of phenological phases in localities where only meteorological data are available and also in future climate conditions. In this work, we used phenological ground-based data from 33 stations within the Czech Republic to calculate the most relevant meteorological predictors. PhenoClim software was used for phenological and meteorological data calibration and modelling. The smallest error that allows us to predict the term of the phenophases was found for the heading of spring barley (*Hordeum vulgare* L.), as the best predictor was the maximum daily temperature and the statistical error was 3.6 days.

Keywords: **phenology, temperature, PhenoClim, climate parameters**

# Seed vigour effected by total polyphenols content

**Ivana Jovanovic, Jhonny Edison Alba-Mejia, Vratislav Psota, Tomas Streda**

Phenolic compounds are important products of secondary metabolism in plants and cannot be synthesized in the human body, so they are mainly taken from food. For the performance of crop seeds a key is the complex trait of seed vigour. It defines their ability to emerge across diverse environmental conditions. It was published, an increase in total phenolic content correlated with enhanced seed vigour in some plant species. The aim of this work was to investigate whether higher content of total polyphenols in seeds affects seed vigour. For the purpose of this study four varieties of spring barley from four localities were tested. Seed vigour was conducted in two ways: in the first one, seeds were placed between two layers of germinating paper in the germinating box, whereas in the second barley kernels were placed in Petri dishes without filter paper under the same environmental conditions. Effect of drought and temperature stress (10°C) was simultaneously induced. Drought stress -0.5 MPa was induced using polyethylene glycol (PEG 6000). Evaluated parameters for seed vigour were root and plumula length and surface area performed through digital image analysis with WinRhizo software. The content of total polyphenols in the grains was determined spectrophotometrically from the previously prepared extract. The total polyphenols content (TPC) was significantly affected both by variety and locality. The statistically significant correlation between total polyphenols content and seed vigour was found.

**Keywords:** **total polyphenols, human health, emergency, drought stress, cold stress**

# The effect of different technical details of drip irrigation on fruit yield and annual increments of "Gala" apple

**Lukas Vastik, Vladimir Masan, Patrik Burg, Pavel Zemanek, Pavel Hic**

The entire Earth's climate system is changing which causes significant changes in precipitation conditions in the various seasons within Central Europe. The dry season in the summer months is growing, while forcing fruit and vegetable growers to think about the economic and ecological water consumption used for irrigation and to make the best use of it. Therefore, the experiment deals with various technical details of implementing the drip irrigation in an orchard. Four variants of technical details were monitored: IR+F-A (drip hose placed on the wire – common method), IR+F-B (drip hose placed on the auxiliary structure from the left and right side of trees, 0.5 m above the soil surface), IR+F-C (drip hose located on the left and right side of trees, 0.3 m below the soil surface), NON-IR (without irrigation). A drip hose with a drip flow of 2.1 l/h and a drip distance of 0.75 m from each other was used to irrigate the variants. The best results were found in the IR+F-C variant and demonstrably the worst in the NON-IR variant, where the importance of irrigation and fertilization of fruit plantations was shown. The highest weight was found for the IR+F-C variant of 178 g and the lowest for the NON-IR variant of 148 g. The largest diameter of apples was achieved with the IR+F-C variant 73.7 mm and the smallest with the NON-IR variant 66.4 mm. Also, when measuring the length of annual increments, the longest increments of shoots were measured for the IR+F-C variant, namely 797.1 mm, demonstrably the shortest increments were measured for the NON-IR variant of 501.2 mm.

**Keywords:** **drip flow, irrigation, fertigation, apple tree, orchard**

# The effect of milk thistle cultivation technology [*Silybum marianum* (L.) Gaertner] on the yield and contained compounds

**Lucie Fojtikova, Marta Bradacova, Barbora Kudlackova, Marie Bjelkova, Helena Pluhackova**

The method of milk thistle cultivation can have a significant effect on both the yield and amount of contained compounds. The active complex of milk thistle is a mixture of flavonolignans composed of 4 compounds: silibinin, isosilybinin, silychristin and silydianin. It is used as a cyto-protective agent for the treatment of liver disease, for the treatment and prevention of cancer and as a supportive medicine against green toadflax (*Amanita phalloides*) poisoning. Studies have also shown other therapeutic effects against cancer, diabetes, Alzheimer's and Parkinson's disease. Milk thistle is also significant by its oil content and composition. The aim of this study was to compare four cultivation variants with a treatment against dicotyledonous weeds using the registered product with selective postemergent effect and a wide spectrum efficacy against annual dicot weeds and certain annual with a combination of desmedifam active substances: desmedifam (4.35 %), ethofumesate (6.94%), fenmedifam (5.56%) and lenacil (2.50%), in the text referred as “ethofumesate”, in combination with another product with the active substance chizalofop-p-ethyl. Weeding was also carried out in the plots and the importance of row width was evaluated. The results showed that the average yield of milk thistle achenes was 0.59–0.82 t/ha. The oil content varied in the range of 26.24–26.34% and the most important component of the silymarin complex was silychristin at the concentration 4.02–4.32 mg/g. Statistically significantly higher yield of achenes was found for variants 3 and 4. Higher average content of the silymarin complex was observed for variants 1 and 2. The oil content was higher in the achenes from experiment variants 3 and 4.

**Keywords:** **milk thistle, oil, herbicide, cultivation technology, silymarin complex**

# A variety of transpiration in the young spruce stands with different thinning management

**Ina Kyselova, Justyna Szatniewska, Lukas Vagner, Jan Krejza, Marian Pavelka**

Managing the spruce forest growing beyond its favourable conditions is trading between water consumption and increasing biomass. We examined tree transpiration in four stands with different thinning intensities in a 40-year-old spruce forest in South Moravia. Tree transpiration was significantly higher under moderate and heavy intensity compared to low intensity and control plots. Tree transpiration differed also among trees of different sizes within the treatments and also between the treatments. The stem increment was visibly increasing with the intensity of treatment, particularly for suppressed trees. The findings show an ecological tree response two years after the thinning.

**Keywords:** **Norway spruce, tree size, water consumption, sap flow, biomass production, thinning treatment**

# Estimation of winter wheat yield using machine learning from airborne hyperspectral data

**Marian Svik, Miroslav Pikl, Ruzena Janoutova, Barbora Vesela, Lukas Slezak, Karel Klem, Lucie Homolova**

Methods based on optical remote sensing allow nowadays to assess crop conditions over larger areas. The assessment of crop conditions and potential estimation of crop yields in the early growth stages can help farmers to better target their management practice such as application of fertilizers. In this study we analysed airborne hyperspectral images acquired several times during the growing season over two experimental sites in the Czech Republic (Ivanovice and Lukavec). The field experiments on winter wheat included 12 levels of fertilisation (combination of organic and mineral fertilisers). Such an experiment design and the possibility of combining the data from two sites together increased the variability in our wheat yield dataset, which varied between 2.8 and 10.0 t/ha. Further, we used a machine learning method – namely gaussian process regression from the ARTMO toolbox to train two variants of models: a) combining the spectral data from both sites and from the multiple acquisition days and b) combining the spectral data from both sites for individual acquisition days. The results showed that it was feasible to predict wheat yield already at the beginning of April with R2 > 0.85. This promising result, however, requires more thorough validation and therefore we plan to include more data from other sites in the next steps.

**Keywords:** **hyperspectral, machine learning, remote sensing, winter wheat, yield**

# Influence of vermicompost on growth parameters and content of chlorophylls in maize during vegetation

**Jakub Neupauer, Peter Kovacik**

The influence of vermicompost on the growth parameters of cultivated crops is the subject of research by many authors around the world. In the present work was observed the effect of the increasing dose of vermicompost (vermicompost at dose of 170 kg/ha N; 10% and 20% of vermicompost in the substrate). During vegetation was recorded the effect of vermicompost on plant height, stem perimeter, growth phase, weight and content of chlorophyll *a* and *b* in maize (*Zea mays* L.). The results show that increasing the dose of vermicompost had a positive effect on the measured parameters. The highest plants with the largest stem perimeter were found in the variant with the highest amount of vermicompost in the soil substrate. The 10 and 20% proportion of vermicompost in the substrate resulted in an earlier onset of growth phases compared to the control variant. The weights of the plants were significantly the highest in the variant with the highest proportion of vermicompost 20%. The content of chlorophyll *a* and chlorophyll *b* was the highest in the variant with the content of vermicompost 10%. The lowest content of chlorophylls was recorded in the control variant without vermicompost. However, it showed the highest ratio of chlorophylls *a*/*b*.

Keywords: **growth parameters, earthworm, leaf dyes, corn**

# Use of unmanned aerial remote sensing for in-season diagnosis of winter wheat nitrogen status

**Igor Horniacek, Vojtech Lukas, Lubomir Neudert, Renata Duffkova, Jiri Mezera, Vladimir Smutny**

Unmanned aerial survey allows more precise diagnosis of the plants in the site-specific crop management by the ultra-high spatial resolution of raster data. This study is focused on the selection of the most suitable sampling size by analysis of multispectral UAV images and its comparison with Sentinel-2 satellite data, both aimed on the diagnosis of the nutritional status of winter wheat. The data used for this study were collected in 2020 from the field experiment located in Kojčice (Pelhřimov, Czech Republic) on two plots with the area of 16.2 ha and 12.1 ha. The survey was realized by plant sampling in irregular grid for estimation of N content, total biomass, Nitrogen uptake (Nupt) and Nitrogen Nutrition Index (NNI) in two vegetation stages important for the application of nitrogen fertilizers to cereals (BBCH 31, BBCH 51). Simultaneously, aerial imaging was carried out by UAV equipped with a MicaSense Altum multispectral camera. The results of statistical evaluation by correlation and regression analysis showed a significant relationship between the monitored crop parameters and vegetation indices from UAV survey and from Sentinel-2 images. Higher sensitivity to the amount of aboveground biomass was proved by the NDVI and SRI indices, on the other hand, the NDRE and RENDVI indices showed higher correlations to the Nupt. The comparison of different buffer zone analysis of UAV data showed the improvement of the estimation accuracy by the increase of the sampling size to the 10 m. Explanation of this result requires further study concentrating on the detailed investigation of the micro-variability of crop parameters within the sampling site

**Keywords: crop status diagnosis, plant sampling, remote sensing, vegetation index, UAV, precision agriculture**

# Comparing of observed and simulated field crop production in HERMES2Go model at Hněvčeves locality

**Jakub Bohuslav, Kurt Christian Kersebaum, Mikulas Madaras, Petr Hlavinka, Miroslav Trnka, Zdenek Zalud**

The main objective of this study was calibration and testing of crop growth model HERMES2Go under long–term field experiment in Hněvčeves locality (coordinate 50°18´N, 15°43´E, altitude 265 m.a.s.l.). Observed data of yields and the other parameters like a weather data, soil parameters, management practice, phenology phases etc. monitored in last 38 years was used for model calibration. Input parameters were available for 4 different fertilizer practices: i) control, ii) manure, iii) mineral fertilizer and iv) manure together with mineral fertilizer on each plot. Observed data are available for yields of main and by–product and above ground biomass. The main grown crops were sugar beet, spring barley, winter wheat, silage maize, oat and alfalfa. Outputs of the model for main product are relatively accurate, but values of by–product requires additional calibration parameters settings together with above–ground biomass.

Keywords: **HERMES2Go, long–term experiments, simulation, yield, field crops**

# Effect of elevated $CO_2$ concentration and nitrogen nutrition on mais response to short-term high temperature and drought stress

**Jan Simor, Karel Klem**

Within an experiment conducted in open top chambers in which two mais genotypes differing in stay-green trait were cultivated under elevated atmospheric $CO_2$ concentration (EC) in comparison with ambient $CO_2$ concentration (AC), and in two contrast levels of nitrogen nutrition, the effect of acclimation to these factors on photosynthetic performance and water use efficiency, and subsequent response to short-term high temperature and drought stress was studied. Although EC improved water use efficiency, this effect did not alleviate the response to drought stress, and under some combinations of factors even led to a decrease in $CO_2$ assimilation rate under drought stress. Differences in the stay-green trait between genotypes did not have a major effect on the response to high temperature and drought stress. Differences between genotypes were manifested mainly in the interaction with nitrogen nutrition, while in the Korynt genotype, non fertilised variants showed a lower response of $CO_2$ assimilation rate to drought. Slight alleviating effect of higher nitrogen dose was found under EC conditions, while no nitrogen fertilisation rather increased drought resilience under AC conditions.

**Keywords:** **mais, elevated carbon dioxide, nitrogen nutrition, drought stress**

# A comparison of the efficiency of pheromone lures on the *Cydia pomonella* (codling moth)

**Zaneta Prazanova, Hana Sefrova**

In May 2021–August 2021, the effectiveness of differently aged pheromone lures from Propher and Pherobank on *Cydia pomonella* L., 1758 (codling moth) was compared. Monitoring was carried out in the gardens of two villages in Malá Lhota and Újezd u Černé Hory. A total of six green delta traps were put up by Propher. Pheromone lures from Propher from the years 2013, 2015, 2019 and 2020 were used. Pheromone lures from Pherobank with normal and increased pheromone content were used from 2020. A total of 220 male *Cydia pomonella* was captured. *Cydia pomonella* was recorded in all traps. The greatest number of individuals were captured in the trap with 2019´s pheromone lure, with 66 in total. The 2013´s lure from Propher captured the lowest number of imagoes, with a total of seven. A total of three non-target species were recorded, all of them *Agrotis segetum*. Based on the monitoring, the effectiveness of two-year-old lures (2019, 2020) on *Cydia pomonella* was demonstrated.

**Keywords: codling moth, *Cydia pomonella,* pheromone lure, monitoring, orchard**

# Estimation of winter wheat nitrogen status and prediction of crop yield by satellite and proximal sensing

**Jiri Mezera, Vojtech Lukas, Jakub Elbl, Lubomir Neudert, Igor Horniacek, Vladimir Smutny**

Remote and proximal sensing of crop has been widely used in the last decades for agricultural applications, both for assessing vegetation condition and for subsequent yield prediction. In this work, we take advantage of vegetation indices for an advanced monitoring of spatial variability of winter wheat biophysical parameters, nitrogen status and prediction of crop yield estimation. Input data were obtained from farm field trials with winter wheat in 2019 and 2020 at Zdounky and Rašovice (Czech Republic) with a total area of 136 ha. To estimate the crop parameters, a plant sampling was realized in the stem elongation vegetation phase and later the grain sampling before harvest. Spectral properties were obtained from the satellite imagery of Sentinel-2 as the set of broadband vegetation indices (GNDVI, NDRE, NDVI, NRERI, RENDVI) and proximal crop sensor systems (Fritzmeier ISARIA, AgLeader OptRx). Spatial data were processed and analyzed using tools of geographic information systems and then statistically evaluated relationships between variables by using correlation analysis. The finding of high level of correlation between in-vegetation crop sensing and grain yield showed the possibility to identify yield spatial variability by both sensing systems in early stage of crop growth. This can be implemented for development of decision support tools for yield zoning in site specific crop management – precision farming.

**Keywords:** **precision agriculture, vegetation indices, crop sensing, Sentinel-2, grain yield**

# Interactive effects of adaptation technology, based on no-till sowing into the mulch of cover crop residues, and nitrogen nutrition on photosynthetic performance of maize under drought stress

**Emmanuel Opoku, Petr Holub, Hana Findurova, Barbora Vesela, Karel Klem**

The aim of this study was to evaluate the interactive effect of adaptation technology based on no-till sowing into cover crop mulch and nitrogen nutrition on photosynthetic performance of maize under short term drought stress induced by rain-out shelters. The experiment was established in two locations in the same climatic condition but differing in soil fertility. The negative effect of drought on $CO_2$ assimilation rate was modulated by nitrogen nutrition. However, while nitrogen nutrition led to alleviating effect at the location with higher fertility, the opposite effect was found at the site with lower fertility. Adaptation technology had only a minor impact on photosynthetic response to drought, but it generally increased $CO_2$ assimilation rate at the site with higher soil fertility and decreased at the site with lower soil fertility. We can conclude that adaptation technology, despite of assumptions, did not significantly change the resilience of maize to drought, and probably longer use of such technology is required to improve soil water retention and thus also balanced supply of water to plants. At the same time, we did not find a negative impact of adaptation technology on photosynthesis which can be related to cooler soil during maize emergence and slower mineralization, although the use of adaptation technology seems to be more effective in soils with higher fertility.

**Keywords: climate change adaptation, cover crops, drought, nitrogen nutrition, photosynthetic rate**

# The effect of biochar co-application with soil prebiotic on biomass production and soil basal respiration

**Daniel Ruzicka, Vojtech Polach, Jaroslav Zahora**

One of the most important problems of this century is an increase in abundance of atmospheric $CO_2$. Because of this phenomenon, slowing down the climate change through sequestration of carbon in soil has been a popular topic of discussion during the last decade. At the same time, we are as a society dealing with another urgent problem of soil degradation. The goal of this contribution is to assess co-application of biochar combined with soil prebiotic in context of its biomass production and basal respiration influence. Two kinds of biochar were used to conduct the pot experiment (composted biochar – beech wood feedstock and fresh sewage sludge biochar). Co-application of composted biochar with soil prebiotic resulted in decrease of shoot biomass meanwhile no significant change in root biomass occurred compared to composted biochar treatment with no prebiotic applied. Co-application of fresh sewage sludge biochar with prebiotic leaded to significant decrease in root biomass meanwhile there was no significant difference in shoot biomass observed compared to the control whatsoever. Application of both types of biochar in combination with soil prebiotic significantly decreased soil basal respiration in comparison with only biochar addition.

**Keywords:** **biochar, soil prebiotic, biochar co-application**

# Yield formation parameters of winter wheat under two $CO_2$ levels in water sufficient and depleted environment

**Marcela Hlavacova, Karel Klem, Barbora Vesela, Hana Findurova, Petr Hlavinka, Pavlina Smutna, Vladimira Horakova, Petr Skarpa, Miroslav Trnka**

Agricultural production faces with ongoing climate that in Europe takes form of changing seasonal precipitation pattern with more frequent drought spells. These changes come on top of rising air temperature and did and will affect productivity as well as onset and duration of key developmental stages for yield formation of major staple crops such as wheat. In order to ensure stable agricultural production and satisfy demand of the increasing human population, it is crucial to know responses of major field crops to these abiotic stress factors to assess suitability of genotypes to specific environmental conditions. The aim of this study was to evaluate final yield formation parameters of five winter wheat genotypes cultivated in pots and exposed to two different levels of $CO_2$ concentrations (400 ppm as ambient and 700 ppm as elevated $CO_2$ concentrations) and two water treatments (well-watered control and drought-stressed plants). The experimental treatments were set up in growth chambers from the end of heading stage (BBCH 59) to the beginning of ripening stage (BBCH 71) to simulate the conditions under future climate. The results showed that elevated $CO_2$ concentration led to: (1) mitigation of reduction in final yield formation parameters of drought-stressed plants compared to those of control, (2) enhanced results of drought-stressed treatments compared to those of drought-stressed treatments exposed to the ambient $CO_2$ concentration. Pannonia NS was found out as the less responsive genotype to the exposition of $CO_2$ concentration (no statistically significant differences among ambient and elevated $CO_2$ concentrations in all yield formation parameters were identified). On contrary, harvest index of genotype Bohemia was identified as the most sensitive parameter in response to drought stress as well as to the atmospheric $CO_2$ concentration.

**Keywords: drought stress, elevated $CO_2$, *Triticum aestivum* L., growth chamber, yield formation parameters**

# Evaluation of nutritional potential of selected sorghum varieties in relation to different types of soil localities

**Michal Rihacek, Jakub Novotny, Dana Zalesakova, Lucie Horakova, Eva Mrkvicova, Leos Pavlata, Ondrej Stastnik, Vladimir Smutny, Michal Rabek**

The aim of this study was to evaluate selected sorghum varieties and their nutritional potential in relation to different types of soil locations. The comparison was done at the Field Experimental Station in Žabčice at two different locations Obora (clay loam soil – fluvial soil) and Písky (light sandy soil). Sorghum varieties were analysed for basic laboratory parameters – ash, fat, crude protein, acid detergent fibre (ADF), neutral detergent fibre (NDF) and digestibility of dry matter and organic matter using in vitro pepsin by cellulase method. The analyses were performed according to the relevant standards. The results of this research prove that the differences in selected nutritional parameters between the compared locations are not very high. A statistically significant difference (P> 0.05) were found for crude protein at Písky location.

**Keywords:** **sorghum, nutritional values, climate change**