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ABSTRACTS OF PAPERS
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KURZFASSUNGEN DER BEITRÄGE

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ORAL CONTRIBUTIONS – CONTRIBUTIONS ORALES – VORTRÄGE

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YIELD GAPS OF OUR MAJOR FOOD CROPS: WHAT DO THEY MEAN AND IMPLY?

ABSTRACT

Yield gap analysis has been a well know notion in crop science since the late 1980s, but it has become popular only recently. Yield gaps are defined as the difference between actual farmers' yields and potential yield. Potential yields assume optimal crop growth achieved by competent crop and soil management that avoids yield limitation and reduction from nutrient deficiencies, weeds, pests and diseases. Potential yields are location-specific and depend on crop genetics, solar radiation, temperature and water supply during crop growth and they can be calculated for both rainfed (water-limited potential) and irrigation conditions.

Yield gap analysis is generally regarded a helpful starting point for mapping the opportunities for sustainable intensification of agricultural systems, i.e. where can we produce how much (more) food on existing cropland. In the global yield gap atlas project (GYGA – www.yieldgap.org) we aim to map yield gaps of all important food crops in every food producing country. A global protocol has been developed to map the yield gaps in an agronomically robust and reproducible manner. The global protocol is always applied with local data and local experts are involved in the evaluation of modelling and yield gap analysis results. It has now been applied for cereal crops to 25 countries and another ca. 25 countries are on their way, thus creating a unique database.

In this presentation examples of yield gaps will be presented and the implications of it for global food security now and in future will be estimated. After estimation of yield gaps, the causes of yield gaps can be investigated and yield gaps can be translated into input gaps. Yield gap closure is never an aim in itself – yields will need to be balanced with resource use efficiency and environmental and economic objectives.

The presentation will start with cereals crops and then proceed with opportunities and examples to apply the same concepts to sugar crops.

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HOW DO WE CLOSE THE YIELD GAP?

ABSTRACT

Potential yield in sugar beet and in sugar is high: in France in 2015, ITB experimental stations achieved, with currently available varieties and optimized agricultural practices, 27 tons of sucrose per hectare. In comparison, in field conditions, productions spread today from 12 to 17 tons of sugar per hectare. Improvements by closing those yield gaps and by gathering both economical and ecological improvements are within our immediate reach.

Factual knowledge of current practices and understanding why yield gap exists between farms are necessary so we can develop and improve communication to farmers allowing them to reach the best achievable agricultural practice. There is never a factor too little to be studied. Any step to improve current practices will help us reach this goal!

Some already available techniques are not yet thoroughly used in France. Adjusting sowing density to actual seed germination potential can now be advised; French average still reaches 1.21 when 1.1 is possible. New seeders can allow farmers to reduce the 26-day current sowing period in favour of growing period.

Tools to choose the most suitable sugar beet variety for local conditions (weather, diseases and pests) and advice to accurately adjust fertilization according to plant needs are already available.

Farmers and the whole sugar beet sector have to be informed of their availability and how to make the most of them. Further information is available to organize harvesting and storage period in order to deliver to factories with the best achievable quality roots to respond to industrial expectations.

By closing the yield gap we will improve profitability of our whole sector, securing it and preparing it to further new improvements.

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NEW GENETICS FOR A NEW ERA – A SEEDS COMPANY PERSPECTIVE ON HOW TO UNLOCK THE POTENTIAL OF SUGAR BEET

ABSTRACT

Over the past decades, breeding for sugar yield, coupled with other technical advances, has delivered an annual yield increase that has exceeded the other crops by at least 1%. This is a considerable achievement which has been unmatched by any other arable crop. The vision and win-win approach taken by the sugar industry was the key driver for the innovation that led to this growth.

However, significant changes to the market can be expected post-2017 and sugar beet will undoubtedly enter into a VUCA world (Volatility, Uncertainty, Complexity, and Ambiguity).

How can we as a sugar industry overcome this?

Innovation is, and will remain, the key driver. On the genetic side, new breeding techniques combined with complementary technologies (including marker-assisted selection, genomic selection, genotyping, double haploids, cat-scan and digital mapping) will facilitate the move towards predictive breeding. This will increase the performance of the crop together with its sustainability. On the other side, this genetic yield potential will need to be protected by Seed Care and Crop Protection technologies. Active ingredients are therefore key assets to growers and they will need to be preserved, and managed, in a sustainable way.

However, innovation and technology will not solve all the challenges, and consequently, there will need to be an in-depth review to address the remaining cost inefficiencies. One example is variety registration and testing where the savings from a cross-country approach could be re-directed to further enhance collaboration with the Institutes and promote further innovation. The challenge will be to develop cost savings without damaging the current successful win-win approach.

The combination of continuous innovation and technology development from the seed companies coupled with the vision and strategy of the sugar beet industry and growers will enable us to overcome this post-2017 challenge and to remain competitive with sugar cane, isoglucose and other crops in the rotation.

Innovation, technologies, diversity of offers and improved agronomic practices will enable the industry to close the yield gap between the official variety trials and real-life commercial crops. This will further liberate the potential of the sugar beet crop and secure the future of the industry as a whole.

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YIELD PROGRESS AND SUSTAINABLE PRODUCTION DURING LONG CAMPAIGNS – THE CHALLENGE FOR BEET SUGAR VALUE CHAIN

ABSTRACT

For long term competitiveness of the beet crop and sugar production in Europe higher sugar yields/ha are crucial and have to be achieved at lowest possible costs in the beet sugar value chain from seed to white sugar.

This means that the higher sugar yields have to be achieved in parallel with improvement of factors as e.g. disease resistance, 'clean beets without root groove', and high sugar content which results in lower costs in growing, beet logistics and sugar production.

Long campaigns >130 days require breeding and technical development measures to secure high yield and beet quality both at the start and in the end of the campaign. Further development of the sugar beet crop's ability to use the full vegetation period would be a success factor, i.e. bolting resistance and varieties adapted to growth under low temperature conditions in spring and autumn. Resource efficiency – high output/ unit input – in all parts of the beet sugar value chain is the key for sustainable beet sugar production.

SESSION 2:
YIELD POTENTIAL – YIELD GAP / POTENTIEL – ÉCART DE RENDEMENT / ERTRAGSPOTENZIAL – ERTRAGSLÜCKE

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YIELD POTENTIAL OF SUGAR BEET – PERSPECTIVES AND POSSIBLE LIMITATIONS

ABSTRACT

Starting with the yield increase of sugar beet in the past decades, the importance of breeding progress as the main driver is demonstrated. The changes in beet composition during the breeding process may lead to possible limitations for further yield increase. The yield potential of sugar beet has been derived from a series of field trials and greenhouse experiments, making the gap to sugar yield in practice obvious. Calculations of the biomass production with ongoing breeding progress point to a strong limitation due to water supply in most sugar beet cultivation areas.

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CLOSING THE SUGAR BEET YIELD GAP – A FARM CASE STUDY IN SWEDEN AND DENMARK

ABSTRACT

Sugar beet development were followed on ten (2014) resp. eleven (2015) farms in Denmark and Sweden. The goal is to make continues improvement by a close sharing of both R&D and grower generated knowledge and reaching a sugar yield of 20 ton sugar by 2020. The beet crop as well as all activities are followed during the beet year and documented. Key output data are:

- Field activities during the beet year
- Weather data from each farm
- Comprehensive soil sampling including soil nutrients, soil texture, BCN, free living nematodes, soil fungi and N min
- Achievable yield taken from 6 hand harvested plots in mid June, September and November
- Farmer yield taken from three sprayer wide areas by the farmer standard harvester directly delivered to the factory in mid November. A harvest loss investigation is included.
- Potential yield calculated from ABB growth model.

A demonstration part is linked to the project. Various activities are organized on the farms. Activities on the farms as well as output data can be followed on a project web site.

First results on the yield gap between farmer yield and achievable yield are presented as well as possible reasons for its variation between farms.

The project is named 5T Together To Twenty Tons 2020.

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UNDERSTANDING SOIL-PLANT INTERACTIONS TO IMPROVE SUGAR BEET PRODUCTIVITY

ABSTRACT

The British Beet Research Organisation (BBRO) has funded a five year programme of research at the University of Nottingham entitled 'Understanding soil-plant interactions to improve sugar beet productivity'. The programme comprises three interrelated work packages: 1) Evaluating and mitigating limitations to water uptake; 2) Identifying rooting traits for optimal nutrient uptake; 3) Improving establishment and early growth.

The first work package aims to understand how much water the crop can take up in non-limiting conditions and to explore the main limitations to water uptake from depth. Once these are established, we will explore how the limitations to water uptake can be mitigated.

The second work package aims to identify the optimum root structure of young sugar beet plants to facilitate nutrient uptake. We are working with a number of breeders to extend the range of genetic material examined and the eventual aim is to provide a screening tool, or genetic markers, that breeders can use to select for varieties with more efficient nutrient uptake.

The final work package aims to use soil physical properties at sowing to predict crop establishment. We have achieved this previously in winter wheat and are testing to see if the approach can be extended to sugar beet. In the first year we have measured a wide range of physical properties across a range of soil textures including: penetration resistance, shear vane, bulk density, temperature, moisture content and aggregate size. The aim is, over a number of years, to build, test and refine a model to predict establishment from soil properties at sowing. In the longer term, we hope to use this model to support grower decision making.

Recent results from the project will be outlined in the oral presentation.

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4D-PHENOTYPING OF GERMINATING SUGAR BEET SEEDS AND DEVELOPING SEEDLINGS

ABSTRACT

The quality of sugar beet seed is of the utmost importance for the sugar yield and therefore the profitability of the sugar beet production. The standardized ISTA-germination test based on the visual assessment of seedlings is an analysis with a simple statement about the percentage of normal and abnormal seedlings and non-germinating seeds. This approach has several disadvantages: It is difficult to standardize regarding the assessment of abnormal seedlings as objective criteria are missing, and is not giving any information about the quality of the plants such as size of the roots, the hypocotyls and cotyledons – important parameters for the vigour of a seedling under stress conditions.

The presented method is an innovative technology for the contactless, automated, high-through-put 4D-phenotyping of germinating seeds and their corresponding seedlings in an undisturbed germination medium. From volume data of closed germination boxes obtained at different points in time by 3D X-ray-tomography, single seedlings can be isolated using automatic image analysis. A segmentation of different parts of the tissue makes it possible to measure them separately. Finally the whole seedlings can be 3D-visualized and documented. The method allows quantitative statements about the development of the normal and abnormal seedlings and therefore a qualitative differentiation of seed quality. It is suitable to assess seed quality – mainly the vigour of sugar beet seedlings – more objectively and more reliably and can be used to measure the influence of genetics, seed quality, priming, pelleting, chemical treatment, ageing and a lot of other factors on the speed, dynamic, homogeneity and time course of germination and the quality of the seedlings.

4D-PHÄNOTYPISIERUNG VON KEIMENDEN ZUCKERRÜBENSAMEN UND SICH ENTWICKELNDEN KEIMLINGEN

KURZFASSUNG

Die Qualität von Zuckerrübensaatgut ist von entscheidender Bedeutung für den Zuckerertrag und damit die Rentabilität des Zuckerrübenanbaus. Der standardisierte ISTA-Keimfähigkeitstest auf Basis der visuellen Beurteilung von Keimpflanzen ist ein qualitativer Test mit einer einfachen Aussage über den Prozentsatz von normal gekeimten, anomal gekeimten und nicht keimenden Samen. Dieser Test hat mehrere Nachteile: Er ist aufgrund mangelnder objektiver Kriterien zur Beurteilung von Keimanomalien schwer standardisierbar und macht keine Aussage zur Qualität der normal gekeimten Pflanzen wie Größe und Volumen von Wurzel, Hypokotyl und Keimblättern – ein wesentlicher Faktor für die Triebkraft unter Stressbedingungen.

Die vorgestellte Analysemethode ist eine innovative Technologie zur berührungslosen, automatisierten 4D-Hochdurchsatz-Phänotypisierung von keimenden Samen und

Keimpflanzen im ungestörten Keimmedium. Aus den zu verschiedenen Zeiten mittels 3D-Röntgen-Computertomographie gewonnenen Volumendaten geschlossener Keimgefäße lassen sich die Einzelpflanzen mit Hilfe automatischer Bildanalyse isolieren. Eine Segmentierung einzelner Gewebeteile erlaubt deren individuelle Vermessung. Anschließend können die kompletten Keimpflanzen und ihre Segmentierung in 3D visualisiert und dokumentiert werden. Die Methode ermöglicht quantitative Aussagen über die sich normal und anomal entwickelnden Pflanzen und damit eine qualitative Differenzierung der Saatgutqualität. Diese zerstörungsfreie Keimanalyse ist geeignet, die Beurteilung der Qualität von Zuckerrübensaatgut, vor allem auch im Hinblick auf die Triebkraft, objektiver und sicherer zu machen und erlaubt es, den Einfluss von Genetik, Saatgutqualität, Saatgutaktivierung (Priming), Wirkstoffbehandlung, Alterung und vieler anderer Faktoren auf die Geschwindigkeit, die Dynamik und Homogenität des Keimvorganges und die Qualität der Keimpflanzen zu messen.

PHÉNOTYPAGE 4D DE GRAINES DE BETTERAVES À SUCRE EN STADE DE GERMINATION ET DES PLANTULES CORRESPONDANTES

RÉSUMÉ

La qualité des graines de betteraves à sucre est de la plus haute importance pour le rendement en sucre et par conséquent aussi pour la rentabilité de la production de betteraves à sucre. Le test standardisé de la germination ISTA est basé sur l'évaluation visuelle des graines germées et c'est une analyse avec une identification du pourcentage de graines germées de façon normale, anormale ou de graines non-germées. Cette approche présente plusieurs inconvénients: En ce qui concerne l'évaluation de graines germées anormales, il est difficile de standardiser car il n'existe pas de critères objectifs et ce test ne donne aucune information sur la qualité des plantes comme la taille et le volume des racines, des hypocotyles et des cotylédons – des paramètres importants pour la vigueur d'une plante en condition de stress.

La méthode présentée est une technologie innovante pour le 4D-phénotypage sans contact, automatisée, et de haut débit de graines germées et de ses plantules correspondantes dans un milieu de germination non-perturbé. En partant des données de volume obtenues dans des boites de germination fermées à différents points dans le temps par la tomographie X-ray 3D on peut isoler les plantules en utilisant l'analyse d'image automatique. La segmentation de différentes parties du tissu permet de les mesurer séparément. Finalement toutes les graines germées peuvent être visualisées et présentées sous forme de documents en 3D. La méthode permet de donner une déclaration quantitative concernant le développement des plantules et par conséquent une différentiation qualitative de la qualité de semences. Il convient d'évaluer la qualité des graines – principalement la vigueur des graines – de manière plus objective, plus fiable et on peut l'utiliser pour mesurer l'influence de la génétique, de la qualité des semences, de la pré-germination, de l´enrobage, du pelliculage avec le traitement chimique, du vieillissement et de beaucoup d'autres facteurs sur la vitesse, la dynamique, l'homogénéité et le temps de processus de germination et sur la qualité des plantes.

SESSION 4:
MECHANICAL WEED CONTROL – HOW FAR CAN WE GET? / DÉSHERBAGE MÉCANIQUE – JUSQU'OÙ PEUT-ON ALLER? / MECHANISCHE UNKRAUTBEKÄMPFUNG – WAS KÖNNEN WIR ERREICHEN?

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STATE OF PLAY AND PERSPECTIVES OF USE OF MECHANICAL WEED CONTROL IN SUGAR BEET CULTIVATION

ABSTRACT

Since 2007, l'ITB launched or developed several programs in order to study the possibilities of reducing uses of herbicides which contribute to more than 50% of total use of pesticides in sugar beets in France. Among those projects, mechanical weed control as a complementary tool to herbicides has been particularly studied. Different types of equipment are under investigation:

- Conventional hoes, using different kinds of steering systems including GPS RTK systems;
- Band spraying combined with classical hoeing using diverse systems to guide the machines
- Rotary hoe and 'rubber stars' directly on the row once the beets are over 4 true leaves stage

After eight years of study, it is possible to establish the benefits and constraints of using these materials as technical, economic than environmental but also to assess the degree of ownership of these technologies by farmers.

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DIFFERENT MECHANICAL WEED CONTROL STRATEGIES IN SUGAR BEET

ABSTRACT

Weed infestations and associated yield losses require effective weed control measures in sugar beet. Besides chemical weed control strategies, mechanical weeding plays an important role in integrated weed management systems. The target of this field experiment at different locations in Germany was to investigate weed control efficacy with the use of: (i) different hoeing and band spraying technologies (ii) the use of automatic steering technologies, and (iii) the use of different intra row weed control implements in conservation tillage systems. The number of uprooted sugar beets (iv) were also measured.

Weed densities of up to 91 plants m^{-2} were detected in the untreated control plots with *Chenopodium album*, *Polygonum convolvulus*, *Stellaria media* being the most abundant weed species. Band spraying in combination with inter-row hoeing reduced herbicide input by 50 to 75% compared to overall herbicide applications. Weed control efficacy was similar for conventional herbicide treatments and for the combination of weed hoeing and band spraying. Hoeing with the use of automatic steering technologies reduced weed densities in sugar beet by up to 82%. The use of finger weeders, rotary-harrow and torsion finger weeders reduced weed density by 29% compared to common hoeing strategies. Differences in the number of uprooted sugar beets were not measured across all treatments. Weed control treatments tested significantly increased white sugar yield (WSY) compared to the untreated control. We revealed the possibility of a more intense use of mechanical weeding technologies in combination with precision farming technologies in sugar beet.

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THE POTENTIALS AND RISKS OF USING GPS/RTK GUIDED ROW CLEANERS IN SUGAR BEET

ABSTRACT

The latest GPS-RTK/camera guided system for mechanical weeding in combination with different levels of chemical weed control was evaluated as an IPM tool to decrease the use of chemical hebicides.The research questions were focused on the efficiency of weed control, but also on the impact of mechanical weeding on beet growth under weed free conditions. The treatments included different share distances to the row (2, 4 & 6 cm), different weeding intensities and different driving velocities. The treatments were conducted under different intensities of chemical weed control. The results show that mechanical weeding alone cannot control weeds sufficiently in sugar beets. It is possible to mechanically control weeds as close as 2 cm from the row but weeds within the rows are not sufficiently controlled. As weed intensity increases, the benefits of weeding close to the row increases. Mechanical weeding may, in weed free conditions, significantly decrease sugar yield. Yield penalties increase with decreasing distance to the row, increasing amounts of passes and the later the weeding is conducted.

SESSION 5:
KEEPING ONE STEP AHEAD OF PESTS AND DISEASES / GARDER UNE LONGUEUR D'AVANCE SUR LES PARASITES ET MALADIES / KRANKHEITEN UND SCHÄDLINGEN EINEN SCHRITT VORAUS

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CHARACTERISATION OF SUGAR BEET VARIETIES BY DIFFERENTIAL REACTION TO *CERCOSPORA BETICOLA*

ABSTRACT

Cercospora beticola is the most widespread foliar pathogen in sugar beet worldwide. In Germany, Cercospora leaf spot disease (CLS) occurs on ca. 80% of the sugar beet acreage and is mainly controlled by fungicides. Resistance breeding started already in the 1920s, but due to the yield penalty of less susceptible varieties in the absence of the pathogen they still lack acceptance in commercial agriculture.

The objective of this study was to develop a method to evaluate yield performance of sugar beet varieties as affected by CLS in variety trials. Data from 182 variety trials in Germany from 2009-15 were analysed. All trials were set up in a split-plot design with two fungicide levels (non-treated/treated) as the main plot and variety as the sub-plot. Based on assessments of disease severity of CLS, trials were assigned to groups with no/low, medium or strong infestation. To evaluate susceptibility/resistance of the tested varieties, the effect of infestation level and fungicide treatment on white sugar yield was analysed.

Changes in variety ranking among infestation levels were minor in the fungicide treatment but considerable without fungicide, indicating that superiority of varieties depends on infestation level of *C. beticola*. To prove this effect, the formation of two groups of infestation levels (no/low to medium vs. strong infestation) was sufficient. The results showed furthermore that due to breeding progress, current resistant varieties are able to catch up with susceptible ones in environments without infestation of *C. beticola*, indicating a new generation of resistant sugar beet varieties.

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THE INTERACTION OF FUNGICIDE RESISTANCE AND VARIETY RESISTANCE

ABSTRACT

Management of Cercospora leaf spot (CLS) relies in part on using a sugar beet variety with good resistance to CLS; in the northcentral area of the USA we recommend a KWS rating of < 5.0. Our previous work demonstrated significantly reduced disease control in susceptible sugar beet varieties inoculated with *C. beticola* isolates with EC_{50} values >1 µg/ml and treated with tetraconazole in greenhouse trials. The objective of this research is to determine if similar reduced disease control occurs with CLS resistant varieties. Plants of a CLS susceptible and a CLS resistant sugar beet variety were grown in the greenhouse, sprayed with field-strength tetraconazole (Eminent) or water and inoculated with mixtures of *C. beticola* isolate groups from sensitive to highly resistant. Plants were incubated hot and humid for three days and evaluated for disease by counting CLS spots four weeks later. *C. beticola* caused significantly more disease on susceptible varieties compared to resistant varieties on plants without tetraconazole, but there is no difference in disease between susceptible or resistant varieties treated with tetraconazole across all isolates. Disease is significantly reduced when tetraconazole is present compared to no fungicide. *C. beticola* isolates with EC_{50} values of 10 µg/ml or greater cause more disease than isolates with EC_{50} values of 5 µg/ml or less on both susceptible and resistant sugar beet varieties without tetraconazole, but EC_{50} values >10 µg/ml are necessary to reduce disease control in resistant varieties when treated with tetraconazole. It appears that isolates with EC_{50} value of >10 µg/ml can overcome variety resistance. *C. beticola* isolates with EC_{50} value >10 µg/ml have been identified in the EU and USA in recent years. It will continue to be important to develop sugar beet varieties with high levels of resistance to CLS.

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OF SYMPTOMS AND TRANSCRIPTOMES – *APHANOMYCES COCHLIOIDES* IN SUGAR BEET

ABSTRACT

Aphanomyces cochlioides belongs to the economically most important pathogens in worldwide sugar beet production. The soil-borne oomycete causes damping-off in seedlings as well as Aphanomyces root rot (ARR) in mature beets. As fungicidal control is restricted to seedling infection, cultivar resistance is the only strategy available to avoid severe losses due to ARR. However, little is known about the genetic basis of ARR resistance. A bioassay with genotypes differing in their reaction to *A. cochlioides* was developed in the greenhouse. At 10 days post inoculation (dpi), beets of the susceptible genotype uniformly displayed severe ARR symptoms; thus allowing for a clear visual distinction. In order to identify key events in the early infection process and to determine sampling dates for transcriptome analysis, confocal laser scanning microscopy was applied. Subsequently, pathogen-induced differentially expressed genes in a susceptible and a resistant genotype at 4 and 7 dpi were identified by RNA-sequencing. On average, 95.8% of the reads were mapped to the sugar beet genome. In order to validate potential resistance-associated genes, a subset of the 37 (4 dpi) and 62 (7 dpi) differentially expressed genes was further analyzed by quantitative RT-PCR. The results of this study will increase the understanding of host-/pathogen-interaction in this important plant-oomycete pathosystem.

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INTERFERENCE OF *HETERODERA SCHACHTII* AND CANOPY HEIGHT IN SUGAR BEET VARIETY TRIALS

ABSTRACT

The white beet cyst nematode (*Heterodera schachtii*) is one of the most important pests in sugar beet in Europe. Varieties susceptible, tolerant or resistant against *H. schachtii* are available for growers. In previous studies it was shown that in variety trials interference between varieties occurs due to differences in canopy height. It is unknown whether *H. schachtii* may play a role on interference in variety trials as well.

Field trials were conducted in 2013 and 2014 at sites with high or very high nematode infestation in Belgium, Germany, Sweden and the Netherlands. In two different trial setups, the different variety types were grown to a) assess neighbouring effects due to canopy height or *H. schachtii*, and b) quantify the effect of different trial setups (harvest of 2 or 4 central rows or all 6 rows out of 6-row plots, or 3 rows out of 3-row plots) on yield performance of the varieties. The effect of the trial setup was additionally assessed based on data from variety trials from 2006 to 2013.

It was concluded that interference due to canopy height was larger than that by *H. schachtii*. Yield of the resistant variety was underestimated by 3% in a system, where 3 rows are sown and 3 rows are harvested. The susceptible variety was not influenced, but yield of the tolerant variety was overestimated by 9% as the tolerant variety could profit from the lower canopy of the resistant and susceptible variety. Nematode populations were influenced in border rows by the neighbouring effect in 2013 only, but this did not have an effect on yield. Although, yield of the resistant and tolerant variety was respectively under- and overestimated, resistant varieties did not perform better than tolerant ones in trials with different trial setups from 2006 to 2013.

This is a joint project by COBRI and Syngenta.

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WATER USE EFFICIENCY OF SUGAR BEET VARIETIES SUSCEPTIBLE, TOLERANT AND RESISTANT TO BEET CYST NEMATODES

ABSTRACT

Heterodera schachtii is an important pest in many sugar beet growing regions. At field scale, sugar beet yield response to *H. schachtii* can be highly variable depending on the infestation level and further site-specific conditions, but also on the variety. Beet cyst nematodes cause root damages which might limit root water uptake and thus reduce biomass production, especially in susceptible varieties. Tolerant varieties should show more stable yields across a wide infestation range. A better developed rooting system of tolerant varieties presumably enables them to take up more water and nutrients, which might be the reason for their yield advantage compared to susceptible varieties under nematode infestation. Field experiments were carried out in the years 2013 and 2014 at sites with varying initial nematode infestations to evaluate the effect of nematode infestation on sugar and dry matter yield, evapotranspiration (ETc) and water use efficiency (WUE, defined as yield per water consumed).

Total ETc was estimated using the FAO-56 dual crop coefficient approach. Crop coefficients were calculated for each variety and environment and were adjusted to nematode induced variation in crop canopy and soil cover.

There was no significant correlation between nematode infestation and ETc valid for all environments. Higher biomass production of the tolerant and the resistant variety under nematode infestation compared to the susceptible variety was not associated with higher water consumption. Differences in WUE between varieties were primarily associated with differences in yield. We concluded that differences in ETc between varieties were negligibly small and did not affect yield formation in the studied environments.

SESSION 7:
QUALITY, STORAGE, AND ALTERNATIVE USE OF BEET / QUALITÉ, STOCKAGE ET UTILISATIONS ALTERNATIVES DES BETTERAVES / QUALITÄT, LAGERUNG UND ALTERNATIVE NUTZUNG VON ZUCKERRÜBEN

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RECOMMENDATIONS FOR BEET STORAGE TRIALS UNDER CONTROLLED CONDITIONS

ABSTRACT

At the last meeting of the IIRB Working Group "Beet Quality and Storage" (Tulln, April 2015), a proposal was prepared to provide recommendations for conducting beet storage trials under controlled conditions (not set in clamp). These recommendations are related to the origin of the samples, type and quality of their harvest, storage parameters, measurements and analyses carried out on the samples before and after storage, and the evaluation of the storage losses. These recommendations are intended to standardize the methodology for beet storage trials in order to interpret the results and findings of such trials properly.

RECOMMANDATIONS POUR DES ESSAIS DE CONSERVATION DES BETTERAVES EN CONDITIONS CONTROLÉES

RESUME

Lors de la dernière réunion du Groupe de Travail « Qualité betteravière et Conservation » de l'IIRB (Tulln, 2015), une proposition de recommandations pour la réalisation d'essais de conservation des betteraves, en conditions contrôlées, a été rédigée.Ces recommandations se rapportent : à l'origine des échantillons, au mode et à la qualité de leur récolte, aux paramètres de conservation, aux mesures et analyses réalisées sur les échantillons avant et après conservation, au calcul des pertes de conservation.Ces recommandations sont destinées à uniformiser les méthodologies des essais de conservation de betteraves afin de pouvoir interpréter correctement les résultats et les conclusions de tels essais.

EMPFEHLUNGEN FÜR LAGERUNGSVERSUCHE MIT ZUCKERRÜBEN UNTER KONTROLLIERTEN BEDINGUNGEN

KURZFASSUNG

Auf dem letzten Treffen des IIRB Arbeitsgruppe "Rübenqualität und Lagerung" (Tulln, April 2015) wurde ein Vorschlag ausgearbeitet, um Empfehlungen für die Durchführung von Lagerungsversuchen mit Zuckerrüben unter kontrollierten Bedingungen (nicht in einer Feldmiete) zu geben. Diese Empfehlungen beziehen sich auf die Herkunft der Proben, Art und Qualität der Ernte, Lagerungsparameter, Messungen und Analysen an den Proben vor und nach der Lagerung sowie die Berechnung der Lagerungsverluste. Die Empfehlungen sollen dazu dienen, die Methode für die Anlage und Durchführung von Lagerungsversuchen mit Zuckerrüben zu standardisieren, um die Ergebnisse und Schlussfolgerungen richtig interpretieren zu können.

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EFFECT OF AGRONOMIC FACTORS ON INVERT SUGAR ACCUMULATION IN SUGAR BEET

ABSTRACT

The activity of endogeneous and exogeneous sucrolytic enzymes in sugar beet results in the cleavage of sucrose into invert sugar. Besides sugar loss due to invert sugar formation, accumulation of invert sugar in sugar beet decreases the beet processing quality. It results in increased consumption of energy and processing aids and reduction of the sugar yield. Therefore, the invert sugar content has to be minimized to maintain an acceptable technological beet quality.

Since 2013, the glucose content of all beet samples from beet reception and field trials is routinely analyzed in The Netherlands using a biosensor which is integrated into the automatic beet laboratory system. The invert sugar content is subsequently calculated from the glucose content using a conversion factor which has been determined previously. This additional information helps to identify beet deliveries with a questionable beet quality at an early stage and provides valuable information on various agronomic factors that increase invert sugar accumulation in the beet.

Based on results obtained during the past years, different factors will be highlighted that affect the invert sugar content in the beet. Among these factors, presence of root rot due to infestation by pests and diseases and beet deterioration following frost damage have shown to increase the invert sugar content dramatically. In addition, unfavorable storage conditions and bad harvesting quality had a substantial impact on invert sugar accumulation. Growth conditions and beet variety also influenced the invert sugar content markedly, although to a much lesser extent.

Using the obtained data, the most important control measures that enable growers to prevent undesired invert sugar formation in their beets will be discussed.

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ASSESSMENT OF EXTERNAL AND INTERNAL QUALITY OF SUGAR BEET VARIETIES WITH REGARD TO ITS HANDLING IN THE PROCESS OF PREPARING THE SUBSTRATE FOR BIOGAS PRODUCTION

ABSTRACT

Because of their high amount of carbohydrates in dry matter, sugar beets can be an alternative to maize as an energy crop. But to provide sugar beet as a substrate for the process of fermentation and in this context for long term conservation and supply it has to be cleaned and crushed.

In this study twelve different sugar beet varieties were tested with regard to physical properties such as hardness and strength of the texture. Further the influence of each genotype on the amount of adherent soil which stays in the characteristic root groove of the beet after washing was tested.

To assess these criteria the different sugar beet varieties were tested with a material testing machine. The external quality of the beets was tested by a punch test, the “Kramer Shear Cell” was used to determine the internal quality.

Both methods of material testing will be presented with the results of two years experiments. The punch test showed force differences of more than 20 percent between the sugar beet varieties in both years.

With regard to the amount of adherent soil in the root groove it has been determined, that there is a much bigger influence of soil and weather compared to the influence of the genotype.

The results contribute to a better understanding and classification of sugar beets in the process of biogas production. Related to the political goal of sustainable energy production the study improves the use of sugar beets in the biogas process.

SESSION 8:
OPEN SESSION / SÉANCE OUVERTE / OFFENE THEMEN

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SUSTAINABILITY IN THE IRRIGATION MANAGEMENT – SUCCESS CASES WATERING BY SOLAR ENERGY

ABSTRACT

Irrigation is a must in semiarid climates' agriculture, where the rainfall is below 400 mm, the humidity is below 50% and summer's precipitation is negligible, so water crop needs have to be complemented by watering.

Most of the Spanish sugar spring area belongs to the previously mentioned climate. This means a disadvantage due to the extra cost in fuel, but on the other hand the advantages are the sugar beet crops grow in optimum conditions, the last season average was 105 t/ha adjusted sugar and the records are broken every year, and the yields are very uniform, insurance and little weather dependent.

An irrigation system using just solar energy was established in several farms in Northern Spain. A reduction on energy cost of 80% and 100% reduction on CO_2 emissions were reached. The main innovation is the system allows to irrigate without neither additional batteries nor stored water in ponds. The irrigated area in these pivot installations ranged from 50 to 120 ha, and photovoltaic power ranged from 70 till 120 kW-p. The cost of watering moved from 0.17 €/m^3 to 0.03 €/m^3, and the saving on energy allows paying back the investment in 5 years. As an additional advantage the facilities are easy to control fully automatically for a comfortable management.

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DOES THE INCREASED YIELD OF SUGAR BEET INFLUENCE THE NUTRIENT UPTAKE?

ABSTRACT

The yield of sugar beet and internal quality increased considerably during the last 20 years. Reasons are breeding progress with increased yield potential, the change in root-top ratio and reduction of α-amino-nitrogen, potassium (K) and sodium (Na) in the roots. Furthermore, improved agricultural methods like higher plant densities and an appropriate fertilization were implemented into farmers practice. This led to the question of how the increased yield of sugar beet has influenced the nutrient uptake. Therefore, field trials were conducted in the area of Südzucker AG from 2010 to 2013 with fertilization treatments for nitrogen, potassium and sulfur (114 environments). The yield of roots and top were determined as well as the concentration of macro- and mirconutrients. The nutrient uptake is defined by the amount of nutrients taken up in root and top of sugar beet at harvest time. The results are compared with earlier findings from field trials to sugar beets of Hessian state research center for agriculture (LLH – Landesbetrieb Landwirtschaft Hessen), and other results from literature.

The results show, that the N concentration in sugar beets has declined over a period of 20 years by about 25 percent. Despite of increasing yields of sugar beets the N uptake almost remained unchanged. This finding is also true for further nutrients like phosphorous, potassium and sodium.

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PERFBET -
IMPROVE PERFORMANCES AND USES OF HARVEST MACHINERY

ABSTRACT

Usually, ITB is studying the beet harvest in terms of beet quality: soil tare, defoliation, broken tips. The objective of this project was to improve the assessment of beet harvesting equipment through the creation of performance indicators. To answer these questions we developed a new experimental device and a method of original analysis. The collection and analysis of data on the behaviour of operators, monitoring of machines and power consumption have been done on an entire harvest period (with 4 harvest machines, different soil types, climatic conditions, drivers). The machines were equipped with: GPS recording and Can-Bus Stream recordings. They recorded all machine travels and harvested fields and their form, and each seconds the consumption and some adjustments that the drivers can do. Indicators like harvesting performance (ha/h) and harvest consumption (l/ha) were designed from field data. These indicators were related to the type of machinery, harvest conditions, the driver or the complexity of the field. All the data collected have been used in a web-based tool to educate the driver to the harvesting conditions according to its schedule workload, to calculate an economic cost and to better know the characteristic of the different harvest machinery.

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FINDING THE NEEDLE IN THE HAYSTACK

ABSTRACT

Advanced breeding technologies giving new perspectives for sugar beet breeding. They help to enable to source genetic variation for innovative new traits in sugar beet.

The presentation will give an overview about basic principles of genetic variation, identification of new variability and breeding schemes and show how new technologies like back crossing programs can be heavily assisted and speeded up by markers. The diversity of potential new resistance traits can be largely expanded.

The examples of CONVISO SMART varieties and other development of other traits are given.

POSTER SESSION – SÉANCE DE POSTERS – POSTERSEKTIONEN 3 & 6

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TAXONOMIC, SPATIAL AND ADAPTIVE GENETIC VARIATION OF *BETA* SECTION *BETA*

ABSTRACT

We investigated the genetic diversity of *Beta* section *Beta*, which includes the wild and cultivated relatives of the sugar beet. The taxa included in the study were: *Beta vulgaris* subsp. *maritima*, *B. vulgaris* subsp. *adanensis*, *B. macrocarpa*, *B. patula* and *B. vulgaris* subsp. *vulgaris* (garden beet, leaf beet and swiss chards). We collected 1264 accessions originating from the entire distribution area of these taxa and genotyped them for 4436 DArT markers (DArTs). We showed that the genetic variation of these accessions is structured into four taxonomic and spatial clusters: i) samples of *Beta macrocarpa*, ii) samples of *Beta vulgaris* subsp. *adanensis*, iii) Mediterranean and Asian samples and iv) Atlantic and Northern European samples. These last two clusters were mainly composed of samples of *Beta vulgaris* subsp. *maritima*. We investigated in deeper detail the genetic structure of *B. vulgaris* subsp. *maritima*, which constituted the majority (80%) of the wild samples and is the closest wild relative of the sugar beet. This subspecies exhibited a clinal genetic variation from South-East to North West. We detected some markers significantly associated to environmental variables in *B. vulgaris* subsp. *maritima*. These associations are interpreted as results of natural selection. The environmental variable most often involved in the associations was annual mean temperature. Therefore, these markers can be useful for the development of frost-tolerant winter beets and drought-tolerant rain-fed beets.

1.2 BRIGITTE MANGIN[1,2,3], FLORIAN SANDRON[3], KARINE HENRY[4], BRIGITTE DEVAUX[4], GLENDA WILLEMS[5], PIERRE DEVAUX[4], BRUNO DESPREZ[4], ELLEN GOUDEMAND[4]

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BREEDING PATTERNS AND CULTIVATED BEETS ORIGINS BY GENETIC DIVERSITY AND LINKAGE DISEQUILIBRIUM ANALYSES

ABSTRACT

Genetic relationships and linkage disequilibrium (LD) were evaluated in a set of 2035 worldwide beet accessions and in another of 1338 elite sugar beet lines, using 320 and 769 single nucleotide polymorphisms (SNPs), respectively. The structures of the populations were analyzed using four different approaches. Within the worldwide population, three of the methods gave a very coherent picture of the population structure. Fodder beet and sugar beet accessions were grouped together, separated from garden beets and sea beets, reflecting well the origins of beet domestication. The structure of the elite panel, however, was less stable between clustering methods, which was probably because of the high level of genetic mixing in breeding programs. For the linkage disequilibrium analysis, the usual measure (r^2) was used, and compared with others that correct for population structure and relatedness (r_S^2, r_V^2, r_{VS}^2). The LD as measured by r^2 persisted beyond 10 cM within the elite panel and fell below 0.1 after less than 2 cM in the worldwide population, for almost all chromosomes. With correction for relatedness, LD decreased under 0.1 by 1 cM for almost all chromosomes in both populations, except for chromosomes 3 and 9 within the elite panel. In these regions, the larger extent of LD could be explained by strong selection pressure.

1.3 CHIARA DE LUCCHI[1], LINDA HANSON[2], MITCH MCGRATH[2], PIERGIORGIO STEVANATO[1], MARCO DE BIAGGI[3], LEE PANELLA[4]

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HIGH RESOLUTION MELTING (HRM) ANALYSIS IN SUGAR BEET: IDENTIFICATION OF SNP MARKERS ASSOCIATED TO FUSARIUM RESISTANCE

ABSTRACT

Fusarium spp. cause severe damage in many agricultural crops including sugar beet. Sugar beet needs to be protected from these soil borne pathogens to guarantee an optimal sugar yield in the field. The genetic control is the key to overcoming this disease. Identification of single nucleotide polymorphism (SNPs) markers linked to the resistance can be a powerful tool for the introgression of valuable genes needed to develop Fusarium-resistant varieties. The use of molecular markers to breed for Fusarium resistance is a cost effective tool to enhance conventional selection. An association study is in progress at the University of Padova (Italy) to identify SNP markers linked to Fusarium resistance. DNA was isolated from 12 sugar beet lines, each using 4 resistant individuals and 4 susceptible individuals to *Fusarium oxysporum*, for a total of 96 samples. Twenty resistant analogue genes (RGAs) were screened by means of HRM analysis, and results were validated by Sanger sequencing. The difference in genotype distribution between resistant and susceptible samples was assessed by the Chi-square test. This study identified a mutation in one of the screened resistance candidate genes, which was significantly associated ($p<0.01$) with Fusarium resistance. This mutation can be accurately identified in the HRM difference plot curves. Further validation by Sanger sequencing indicated the allelic status of resistant individuals. The frequency of the resistant allele was 83% in individuals with the resistant phenotype. Our results demonstrate that HRM analysis is a rapid, feasible and reliable method for detecting SNP mutations linked to disease resistance traits in sugar beet. The next step will be to validate the identified SNPs in a wider germplasm base segregating for Fusarium resistance.

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DETECTION OF SNPS ACCOMPANYING DIFFERENT RHIZOMANIA RESISTANCE SOURCES IN BREEDING MATERIALS OF SUGAR BEET

ABSTRACT

The aim of this study was to identify selected rhizomania resistance accompanying SNPs in breeding materials of sugar beet. The populations defined for the study were provided by Kutnowska Hodowla Buraka Cukrowego Ltd. In order to perform molecular characterization of the materials, the following methods were applied: 1) DNA isolation according to Davis *et al*. (1986), 2) HRM analysis in the Gene Scanning module (LightCycler 480) using Luminaris Color HRM Master Mix (Thermo Scientific), 3) PCR, 4) verification of sequential variants within several PCR products following restriction site design with RestrictionMapper version 3, 5) agarose gel electrophoresis of digestion products, documentation (Gel DocTM 2000, BIO-RAD; Quantity One, version 4.0.3), 6) real-time PCR analysis of BNYVV content (after RNA isolation and reverse transcription) in the Relative Quantification module as compared to actin gene (LightCycler 480) using SYBR Green I Master (Roche Applied Science). Among investigated SNPs three turned out to be polymorphic, thus allowing for unequivocal distinction between homozygous and heretozygous sugar beet materials and further selection. As shown in this study, HRM analysis may be supported/replaced by RFLP for several sequences. The presence of two different rhizomania resistance sources was confirmed for the sugar beet breeding materials under study. Within delivered populations genetic heterogeneity was found, which may also correspond to variable levels of BNYVV. The work was fulfilled as a part of the PBAI-NRI Multiyear Programme 2015-2020, task 2.4.

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SUGAR BEET DHLS PRODUCTION: ESTIMATION OF DNA PLOIDY LEVELS AND GAMETES ORIGIN CONFIRMATION

ABSTRACT

Doubled haploidy technology is a fundamental tool in plant breeding as it provides the fastest way to generate populations of meiotic recombinants in a genetically fixed state. Diploid gynogenic plantlets should be investigated for their source of origin before using in breeding programs to avoid mistakes in assessing the homo/heterozygosity of progeny. Rapid screening techniques are needed to validate that the regenerated in vitro putative DHLs are indeed homozygous. Enzymatic mismatch cleavage (EMC) techniques commonly used for TILLING (Targeting Induced Local Lesions IN Genomes) were adapted for the evaluation of heterozygosity in parental F1 and putative DH plants. 28 amplicons were tested. Experiments were performed using self-extracted single-strand-specific nuclease (CEL1) and standard native agarose gels. Some primer pairs did not produce a PCR product, while others produced a high yield of PCR product, but weak or no detectible enzymatic cleavage. Seven primer pairs produced a high yield of PCR product and high yield of banding. In addition, cleavage products in synthetic mixtures of genomic DNA of the two parents prior to PCR were observed indicating homozygous polymorphisms between the parents. This resulted in the validation of 7/28 primer pairs suitable for DH screening. Ultimately this technique allows to replace the widely used isozymes or SSR methods to identifying of the maternal origin in spontaneous occurred putative Doubled Haploid plants.

1.6 KAMILA KOZAK-STANKIEWICZ[1], JOANNA NOCEŃ[1], JAN BOCIANOWSKI[2], ADAM SITARSKI[1]

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UTILIZING DOUBLED HAPLOID (DH) TECHNOLOGY FOR IN VITRO DROUGHT TOLERANCE SCREENING

ABSTRACT

Drought is one of the main abiotic stresses that delimit the sugar beet growth and productivity. The cultivation of varieties which will be able to withstand low water supplies while maintaining high productivity will become even more important due to global climate change. The aim of this study was to find and evaluate morphological, physiological and biochemical parameters that are the most relevant in evaluating tolerance to progressive drought in plants under controlled environment. The non-ionic water soluble polymer polyethylene glycol (PEG) of molecular weight 6000 was used as osmoticum to simulate water stress. Sterile shoots of in vitro regenerated Doubled Haploid genotypes were multiplied on standard nutrient medium for micro-propagation and then placed on media with different PEG concentration (0-5%). Significant differences were observed among genotypes and treatments for the evaluated plant traits suggesting a great amount of variability in relation to low water supplies. Homozygous lines derived from ovule culture of F1 hybrids of drought tolerant parents in combination with tissue culture selection allowed to shorten the time necessary for screening and created new valuable in vitro germplasm.

1.7 F. DESMET[1], GUY LEGRAND[2], ANDRÉ WAUTERS[2], X. DRAYE[1]
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DYNAMIC ANALYSIS OF ROOT ARCHITECTURE OF SUGAR BEET (*BETA VULGARIS*) USING AN AEROPONIC PHENOTYPING PLATFORM

ABSTRACT

Aeroponics has proven to be a cost-effective way to capture root traits in a non-invasive and dynamic way, yielding precise estimates of elongation rates, emergence and branching for a large number of plants. Dynamic phenotyping enables novel image analysis strategies that exploit a model-based formalism of root architecture to streamline data processing and escape the «phenotyping bottleneck». Sugar beet seedlings from several varieties (nematode tolerant or not) were grown for a few weeks in a automatized aeroponics platform to predict the expected root architecture based on dynamic root traits estimates. The root architecture of these varieties is discussed in relation with different aspects of their field performance, including varietal nematode tolerance.

ANALYSE DYNAMIQUE DE L'ARCHITECTURE RACINAIRE DE LA BETTERAVE À SUCRE (*BETA VULGARIS*) AU MOYEN D'UNE PLATEFORME DE PHÉNOTYPAGE AÉROPONIQUE

RESUME

La culture en aéroponie a démontré qu'elle est une méthode peu coûteuse qui permet d'observer les caractéristiques morphologiques racinaires d'une manière non-invasive et dynamique, menant à des estimations précises des taux d'allongement, de la formation et de la ramification sur un grand nombre de plantes. Le phénotypage dynamique supporte des stratégies nouvelles d'analyse d'image qui exploitent des formalismes-modèles de l'architecture racinaire, ce qui permet d'accroître le débit du traitement des données et d'éviter le goulot d'étranglement du phénotypage. Des plants de betterave sucrière de différentes variétés (tolérantes au nématode de la betterave ou non) ont été mis en culture pendant quelques semaines dans une installation aéroponique automatisée afin de prédire l'architecture racinaire sur base de caractéristiques dynamiques observées. L'architecture racinaire de ces variétés est discutée selon les différents aspects de leur performance au champ, en ce compris la tolérance variétale aux nématodes.

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THE EFFECT OF SUGAR BEET SEED VARIETIES ON TECHNOLOGICAL QUALITY AND ITS PHYSICAL PROPERTIES (IRAN-HAMADAN)

ABSTRACT

To evaluate the physical and qualitative characteristics of sugar beet, a study on the different varieties of sugar beet seeds produced by companies active in the Iranian market. In this regard, in 2014, in the completely randomized design of relief shipments to the Hamadan sugar factory, of different varieties of sugar beet cultivated in farms under the Treaty of factories were sampled. A total of 72 samples were prepared and a variety of seeds belonging to the 5 seed production companies were as follows:

- Maribo company, Denmark (variety of Flores)
- KWS company, Germany (Letitia)
- Florimond desprez company, France (Rosier and Morel)
- Syngenta company, Sweden (Puma and Dorothy)
- Research institute of improving and obtaining sugar beet seed, Iran (SBSI 004)

The result of ANOVA showed that there is no significant difference between varieties in terms of root diameter and sugar content. In terms of sugar content, variety of rosier with 17.62%, better than the other cultivars. Also, according to the results between varieties studied, significant differences at 1% in terms of impurities in the root such as sodium, potassium and amino nitrogen were observed. Low impurities such as sodium and potassium can be effective to enhance the quality in selection of sugar beet varieties. The results of this study showed that variety of rosier between cultivars had the best result, although it is necessary for the next studies to consider the role of place of cultivation, growing period and other crop factors.

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GENETIC PROGRESS ON SUGAR BEET IN FRENCH VCU REGISTRATION TRIALS

ABSTRACT

Following the study carried out by A. Luciani in 2004 on genetic progress in the VCU registration trials, data from of the registered varieties 1990 to 2014 were calculated for sugar yield, sugar content and industrial quality.

For each characteristic and each generation of varieties, adjusted means were calculated for registered and control varieties with a mixed model analysis of variance, considering genotype effects as fixed and environmental effects as random. Evolution of adjusted means measured genetic progress.

This study was conducted on 2 categories of varieties: 1) varieties resistant to rhizomania (main category in France) from 1990 to 2014, 2) varieties resistant to rhizomania and tolerant to beet cyst nematodes from 2002 to 2014, in fields with and without nematodes. For the rhizomania varieties on the 1990 to 2014 period, an annual increase of 194 kg per ha was observed; sugar content was also improved, with an annual rate of 0.04 percent of sugar since 2004. The quality also improved until 2011 and reached a level considered as satisfactory. Significant progress has been achieved for the nematode varieties since 2005, for yield in fields with nematode (+340 kg per ha) and without nematode (+240 kg/ha), but also for sugar content and industrial quality. In 2012, the nematode varieties reached the level of rhizomania varieties.

This study led to a change in the rules of registration: the genetic progress is now taken into account to fix objectives and thresholds for the three main characteristics.

ETUDE DU PROGRES GENETIQUE DANS LES ESSAIS POUR L'INSCRIPTION AU CATALOGUE EN FRANCE

RESUME

A la suite de l'étude effectuée par A. Luciani en 2004 sur le progrès génétique dans les essais officiels d'inscription, nous avons poursuivi le calcul des données de 1990 à 2014 pour le rendement en sucre, la teneur en sucre et la qualité industrielle.

Pour chaque critère et chaque génération de variétés, nous avons calculé les moyennes ajustées pour les variétés inscrites et les témoins en utilisant un modèle mixte d'analyse de variance dans lequel les variétés sont considérées comme un effet fixe et l'environnement comme un effet aléatoire. L'évolution de ces moyennes ajustées permet de mesurer le progrès génétique.

L'étude a été conduite sur les variétés résistantes à la rhizomanie (principale catégorie en France) de 1990 à 2014, et les variétés résistantes à la rhizomanie et tolérantes au nématode de 2002 à 2014, en champs avec et sans nématode. Pour les variétés rhizomanie, on observe un gain annuel de 194 kg par ha pour la période 1990 – 2014; la teneur en sucre a également progressé (augmentation annuelle de 0.04 % de sucre

depuis 2004). La qualité industrielle s'est améliorée et a atteint en 2011 un niveau considéré comme satisfaisant. Des progrès très significatifs ont été enregistrés pour les variétés tolérantes au nématode depuis 2005, qu'il s'agisse du rendement en champs avec nématode (+340 kg/ha/an) ou sans nématode (240 kg/ha/an), mais aussi pour la teneur en sucre et la qualité industrielle. En 2012, les variétés nématode ont rattrapé l'écart de rendement avec les variétés rhizomanie.

Cette étude a conduit à un changement des règles d'inscription : le progrès génétique est maintenant pris en compte pour fixer des objectifs et des seuils d'acceptation pour les 3 principaux caractères.

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GENOTYPE × ENVIRONMENT INTERACTIONS IN SUGAR BEET AND IMPLICATIONS FOR VARIETY CHOICE IN GERMANY

ABSTRACT

Differences in performance among sugar beet varieties are caused by genotype and environment (combination of site x year). To assess the influence of these factors on corrected sugar yield, data from 79 variety trials in Germany conducted from 2011 to 2014 were evaluated. Environment had a significant and predominant effect on corrected sugar yield. The influence of variety was also significant, but much lower. By contrast, the interaction of environment and variety was not significant. During the last years, occurrence of the fungal disease *Cercospora beticola* has increased in German production areas. Differences in variety ranking in corrected sugar yield were mainly evident in trials with high infestation of *C. beticola* without the application of fungicide. The less susceptible varieties showed an increase in corrected sugar yield under disease free conditions compared to susceptible varieties. Furthermore, the calculation of heritability proved that 20 assessed trials are sufficient to gain a reliable estimate of variety performance.

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PERFORMANCE OF SUGAR BEET HYBRIDS IN THE VARIETY REGISTRATION TRIALS IN SERBIA UNDER THE EXTREME CLIMATIC CONDITIONS

ABSTRACT

In the last few years Serbian weather conditions extremely varied from extreme droughts in 2012 and 2015 to enormous rainfalls and flooding in 2014. Newly registered sugar beet hybrids must be highly adaptable to these conditions, so they could be able to provide high and stable yields. In order to approve registration of new sugar beet hybrids, the Ministry of Agriculture and Environment, Republic of Serbia, is performing two-year field trials in the major sugar beet growing areas. In the trials, value and quality of new hybrids are assessed through the basic indicators such as root yield and sugar content, as well as disease resistance. Cercospora leaf spot, caused by the fungus *Cercospora beticola* Sacc., is the most important foliar disease of sugar beet in our environmental conditions, so all registered varieties must have a certain level of resistance to be successfully grown in Serbia. The weather conditions in 2014 were characterized by a large amount of precipitation during the vegetation (280 mm more than the sugar beet needs), which led to epidemical attacks and uncontrolled spread of leaf spot. Although these conditions were not favourable for the sugar beet production, it was possible to detect differences in the level of resistance to *Cercospora beticola* Sacc. of the tested cultivars. Conditions in 2015 were characterized by extreme summer drought with high temperatures, which caused decrease in root yield, while leaf spot occurred only sporadically. Production in such harsh conditions enabled the better evaluation and registration of the best new sugar beet hybrids who expressed a high level of tolerance to Cercospora leaf spot in 2014 and a good tolerance and broad adaptability to drought in 2015.

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OPTICAL REMOTE SENSING OF CANOPY NITROGEN CONTENT IN SUGAR BEET CROPS FOR PHENOTYPING APPLICATIONS

ABSTRACT

Nitrogen content is one of the most important limiting key nutrients in sugar beet crops, so plant nitrogen status has to be carefully monitored throughout the plant life. In particular, for phenotyping applications, it is essential to better understand why genotypes differ in the use of nitrogen sources so as to create new cultivars that consume less nitrogen. For this purpose, following up the nitrogen status of crops using optical remote sensing has appeared as a powerful tool because it allows a high throughput and non-destructive vegetation characterization.

In this study, we evaluated the potential of ground-based spectro-radiometric measurements to estimate canopy nitrogen content. Along the 2015 growing season, 44 reflectance spectra of sugar beet canopies and the associated canopy nitrogen contents were measured, encompassing three cultivars and two locations with different soil and weather conditions. Numerous vegetation indices originally designed for retrieving the chlorophyll content (which is known to be correlated with the nitrogen content) and computed from the visible and near-infrared spectral range were compared based on their correlation with nitrogen content.

As expected, the nitrogen content was strongly correlated to the chlorophyll content when integrated at the canopy level (R^2=0.97 at the canopy level, R^2=0.39 at the leaf level). Overall, the MERIS Terrestrial Chlorophyll Index (MTCI) obtained the best correlation with canopy nitrogen content (R^2=0.90) and a cross-validated error of prediction of 0.805 g/m² (i.e., 19% of the mean value). Compared with the leaf-level relationship, the canopy-level relationship was much more robust among development stages and cultivars, thus proving that optical remote sensing is a promising tool for sugar beet phenotyping.

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SUGAR BEET SEED QUALITY RELATED TO FIELD EMERGENCE: AUTOMATED PHENOTYPING IN LABORATORY TO PREDICT CROP ESTABLISHMENT

ABSTRACT

In order to enhance the competitiveness of the sugar beet industry, faced to the productivity of sugar cane, the AKER project, based on exploring variability in genetic resources, aims at creating new varieties with agronomical important traits, such as yield, sugar content, and tolerance to abiotic and biotic stresses.

Phenotyping the characteristics of the genotypes in the field at high throughput is a challenge. But another challenge is to develop testing methods in laboratory conditions on seeds or seedlings that could be predictive of differences in genotypes at early or later stages in the field. We have especially focused on the prediction of early stages in the field as they have a huge effect on the final yield.

For this purpose 5 genotypes of sugar beet have been phenotyped for their germination in optimal and stressful conditions (20, 15 and 10°C) using high throughput phenotyping image analysis systems. Early heterotrophic seedling growth (root and shoot) has also been measured at 20°C. The same genotypes have been sown in different locations in France and several criteria of early field emergence have been recorded: plant number and emergence rate, growth after emergence, as well as the final root and sugar yields.

Results obtained in field conditions showed a strong relation between early growth in the field and final yields. Early growth in the field was correlated with traits measured in laboratory conditions: speed of germination in cold temperature, radicle elongation rate and cotyledon area. This led to first interesting proposals of laboratory tests related to early field emergence.

These traits could be measured with high throughput on the large panel of genotypes that will be generated at the end of the project, due to automated tools previously or currently developed in the project. Traits of seed internal morphology are also currently explored and will be compared to germination and growth performance in laboratory and in field trials.

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IMPROVING PLANT ESTABLISHMENT WITH MICROORGANISMS

ABSTRACT

Microorganisms exist naturally in the field. The root of the plant is surrounded by beneficial as well as harmful microorganisms. Some of the beneficial microorganisms have a direct growth stimulating effect on the plant whereas others are able to keep the harmful microorganisms away from the plant's roots.

A development project in Maribo Seed has focused on isolation of root rot protecting Gram-negative bacteria and the invigoration and stabilization of these bacteria in carriers for seed treatment. The project has now resulted in a patented system for stabilization and application of dehydration sensitive bacteria onto seeds.

The microorganisms are applied to the seed by means of an especially designed carrier, allowing the microorganisms to survive in a dormant state on the dry seed until sowing. Moreover, a special treatment gives the bacteria an enhanced adaptive response: the bacteria survive the transfer to another environment (soil) much better than without this treatment. Green house trials as well as field trials proved that sugar beet seeds coated with specific root colonizing Gram negative bacteria are protected against root rot diseases at level comparable to fungicide treatments.

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EFFECT OF PRIMING INTENSITY ON THE STORABILITY OF SUGAR BEET SEED

ABSTRACT

Priming/activation of sugar beet seeds gives many benefits to the grower, as a result of the faster more uniform emergence it provides. The faster emergence under the cool spring conditions maximises the amount of sunlight captured by the crop, and means the crop spends less time as small vulnerable plants. The improved uniformity of plant size makes crop management such as spray timings easier and it also optimises the harvesting performance. These ultimately lead to increased yields giving more income to the grower. As with most things you do not get something for nothing, and with priming there is optimal level between getting the fastest germination and emergence out of the seed and maintaining storability. Unprimed raw seed can be stored under cool dry conditions for many years. Primed seed can also be stored under cool dry conditions for several years, if the correct settings are used, however allowing the seed to go too far along the germination process during priming can dramatically reduce shelf life of the primed seed. Using accelerated storage conditions we have investigated different intensities of priming, to understand how aging affects germination speed and final germination.

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USE OF THE SEED VIABILITY EQUATION TO RELATE DIFFERENT STORAGE CONDITIONS AND PREDICT SHELF LIFE OF A SEED LOT

ABSTRACT

In the UK as in other countries some treated seed is not used in the season it is produced and is stored for about 18 months before it is planted in the subsequent season. Stocks of unopened boxes of seed are stored in warehouse conditions at roughly 50% RH and 20°C on average. However this is not always the case, as some seed can be stored on farm under various conditions. Any seed, if not stored properly can deteriorate quite rapidly, especially if the storage conditions are damp and/or warm. Understanding what a difference of a few degrees in temperature or a few percent in relative humidity has on storage potential is useful when storing seed and managing stocks. The seed viability equation developed by Ellis and Roberts describes how seed populations deteriorate over time at different conditions of seed moisture and temperature. We have used the principles set out by the equation to calculate how long it will take under different conditions for seeds to deteriorate to the same level, and results from initial storage tests are confirming these predictions.

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MORPHOLOGICAL CHARACTERIZATION OF MOROCCAN WILD BEET GENETIC RESOURCES AND STUDY OF THE HERITABILITY OF CHARACTERS

ABSTRACT

Biologically cultivated beets are recently developed species. They are the results of human genes manipulations. Thus, beet genetic resources still have a major importance as source of germplasm for breeding programs and cultivated beet varieties production.

One of the main goals of genetic resources is to preserve biodiversity to recover genes of interest for the beet and sugar market. This research aims to characterize moroccan wild beet populations and species of Morocco and to study the heritability of characters through interspecific crosses between sugar beet and beet wild populations.

In the present investigation, a set of 66 beet genotypes resulting from five different crosses between *Beta maritima* and cultivated *Beta vulgaris* Cr1, Cr2, Cr3, Cr4 and Cr5) were studied and compared within and between generations

Results showed successful crosses between the two forms of wild and cultivated beets. Indeed the analyzed genotypes revealed a low level of genetic diversity compared to their wild relatives. Leaf traits (length, width and petiole of the leaf blade and pigmentation) were very similar to wild genotypes, especially for the Cr4 cross. The flowering period of wild populations is coincided with Cr1, Cr4 and Cr5 crosses. Cr1 was the best crossing that has inherited the most of phenotypic characters from cultivated parents. Results showed a success of over 80% crosses. Evaluation based on morphological and genetic traits showed a difference in inherited characters between the crosses according to the parent genotypes.

The encouraging results of interspecific crosses of evaluated germplasm shows that the Moroccan collection is of great interest for interspecific breeding programmes, diversity enhancement and genes of interest introgression to cultivated beet.

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CONTRIBUTION TO THE GENETIC IMPROVEMENT OF A MOROCCAN SUGAR BEET GERMPLASM

ABSTRACT

Sugar beet (*Beta vulgaris* L.) is the first source of sugar in Morroco. In order to develop adapted cultivars to the local conditions, INRA-Maroc has initiated a selection breeding program, including seed production, disease resistance and high sugar content. Maternal pedigree selection method is used, since this crop has specific conditions requirements. For seed production, the principal climatic requirements to initiate bolting are low temperatures (vernalization) followed by long photoperiod needed to induce flowering. Temperate climate conditions are suitable environment to plant growth and sugar production. The objective of the present study is to evaluate selected germplasm behavior under local conditions, for seed and sugar production potentials.

Nineteen selected families, at their second selection cycle, were evaluated for their ability to produce seeds and to cross through open-pollination at Merchouch experimental site. In parallel to seed production evaluation, the 19th half-sib family progeny was screened for its sugar content at a major sugar beet production area.

Seed production data shows 100% bolting induction and proved Merchouch as suitable site for vernalization. Flowering induction dates showed a wide variation between families, starting from 231 to 309 days after sowing. Family grain yield varied between 40 g and 210 g. Sugar content exhibits the high potential of the selected germplasm. Several families had higher sugar content than the controls by 0.12 to 2.32%.

Data showed a big potential in most selected material for seed production and sugar content traits under local conditions, however more evaluation study is needed for stability purposes.

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A LONG TERM SURVEY OF CULTURAL PRACTICES

ABSTRACT

Sugar beet technical management is variable according to years, regions and sometimes even within the farms themselves. The knowledge of these practices is fundamental for analyzing the temporal and geographical heterogeneousness of the agricultural practices, for researching the efficiency of the implementation of these practices and finding their controlling factors and their evolution.

A survey has therefore been led by ITB since 1997 with 500 farmers each year. All technical aspects are concerned in the annual questionnaire, from the previous harvest, till the storage of the beets. Some open questions are added to have a better understanding of the conditions of practices. Around 2500 farms are investigated, with a good return rate of 20 percent.

The results of the survey are synthesized in a written report. Beyond the analysis of the annual events and their repercussion on the cultural conduct, more ambitious studies can be produced on diverse subjects, as well as raw data to feed models or research. Lately, in order to answer a changeable context, where the practices must be more and more justified, the questions asked in the survey have been increased and improved upon.

The data processing is being automated to answer questions more easily and to produce the most possible different outcomes of this important and long term dataset.

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CROP ROTATION TRIAL IN FINLAND. RESULTS 2012-2014

ABSTRACT

In sugar beet growing, crop rotation has a crucial role in farm practice. It has been known that to maintain or even improve farms yields the crop rotation must be adopted. When talking about long term farming the crop rotation will clearly decrease nematodes, diseases and weeds.

Sugar Beet Research Centre has started a long term trial on crop rotation in 2012 which aims to clarify the effects of crop rotation in sugar beet farming. Meaning is to find an optimum rotation plan for sugar beets and also to improve farmer´s knowledge on the benefits of crop rotation. The trial is still ongoing but when looking at results today it is no surprise that monoculturalism has a bad effect on yield especially on years when the weather conditions are challenging. In this trial there are different rotation lengths; beet every year, beet every other year, beet every third year and beet two times in a row. Also different pre-crops are tested.

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THE EFFECT ON SUGAR YIELD IN DIFFERENT CROP ROTATIONS WITH SUGAR BEET, OIL SEED RAPE AND INTERCROPS

ABSTRACT

In this three year study on six crop rotation trials in Sweden, it was shown that oil seed rape as a pre-crop to sugar beet increased sugar yield by 1280 kg/ha (11%) compared to winter wheat as pre-crop.

Introduction of oil seed radish twice in the rotation also showed a tendency for increased sugar yield already in the first beet crop. Soil resistance was measured in each plot and was found to be lower in plots with oil seed radish compared to plots with winter wheat as pre-crop.

The occurrence of beet cyst nematodes in some of the trials had an impact on the results. Sugar yield in rotations with oil seed rape as pre-crop to sugar beet showed no increase in sugar yield if nematodes were present in the soil.

This research project has shown that crop rotation management is a good way to increase sugar yields, increase soil structure and control diseases.

The project was financed by the Swedish farmers association for Agricultural research.

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INTERCROPPING SUGAR BEET AND POPPY SEED: OPPORTUNITIES AND CHALLENGES

ABSTRACT

Production of sugar beet in Serbia was halved in the season of 2015, due to summer drought and low root price. The low sugar price on the world market makes the future of sugar beet cultivation in Serbia uncertain. Neither poppy production in Serbia is in the better position, although it has a long tradition and the growing conditions are favourable. Intercropping of these crops looks as one of the possible solutions to overcome the current problems and improve production of both sugar beet and poppy. Therefore we intercropped the two species in a field experiment which is to our knowledge the first such trial. The trial was established in the growing season of 2015, at the experimental field Backi Petrovac, Institute of Field and Vegetable Crops, Novi Sad. Since the suppression of broad leaf weeds in such production was impossible, the production was organized in organic form. The field trial consisted of control in which only sugar beet was sown and the treatment where the sugar beet and poppy plants were grown together. After germination Tanymecus dilaticollis Gyll destroyed all sugar beets not intercropped with poppy. Additional intercropping benefits are sowing at the same time, the same distance between the rows, a good coverage area, the different length of vegetation (organisation of field works) and more efficient use of land. Also many challenges are defined in this type of production such as: difficulty in performing mechanical sowing, incompatibility in terms of weed control and the inability of poppy mechanical harvesting. The results present the basis for further research in this area, which are planned to be implemented in the coming years.

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IRRIGATION FOR OPTIMIZING SUGAR BEET PRODUCTION IN PO' RIVER VALLEY

ABSTRACT

Irrigating sugar beet in Po' valley river is undoubtedly useful especially considering the climate changes occurred in recent years as the worst rain distribution and the high temperature during summer time. An anticipation of the drought stress at the end of May or at the begging of June has been reported during the last ten years. Sugar beet roots are not enough developed in this period in order to reach the shallow water table.

Choosing which irrigation system is a very important question for the Italian farmer. The pivot is undoubtedly the better option for big farms for economical and organizational reasons. Generally speaking farm area in the Po' river valley is not enough to justify such an important economic investment and most of the sugar beet growers use the boom despite this instrument is more suitable for occasional irrigation.

Fixed installations like irrigation or mini sprinklers are more suitable for systematic applications but even in this case it is necessary evaluating the cost-effectiveness as part of a multi-year period. The analysis of costs and benefits in real scale obtained in different years in some farms reveals the advantages and weaknesses of irrigated sugar beet grown in the Po Valley.

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UNIFORMITY OF IRRIGATION IN NEW SPRINKLERS AT LOW PRESSURE

ABSTRACT

Beet crop in irrigation is closely linked to the sprinkler system. The main irrigation system is full sprinkler coverage, but today irrigation machines (pivot) are gently being introduced.

In 2015 AIMCRA and IFAPA made an agreement to improve the efficiency and energy saving sprinkler irrigation by the use of new sprinklers and nozzles in a bank sprinklers. Previously AIMCRA studied irrigation uniformity and its influence on the yield (Salvatierra *et al*., 2010). We know that with a uniformity below the acceptable (Distribution Uniformity, DU <75%) crop losses of 20% occur (Mantovani *et al*., 1995).

In an automatic sprinkler test bank with wind, property of IFAPA (Andalusian Agricultural Institute) in Chipiona (Cádiz) we studied the behavior of 9 sprinkler models from five irrigation houses (Senninger, Vyrsa, Nelson, Unirain, NaandanJain) with 20 nozzles in different combinations of single, double and with or without pods. The operation of the sprinklers is measured in real conditions. The instalation allows the direction and wind speed and is possible to analyze the distribution of water at different pressures and flow rates. They were tested normal pressure (3.5 bar) and reduced pressures of 2.5 to 2 bar. The objective is clear, find a combination of sprinkler and nozzle able to distribute well the water at low pressure to save energy.

Each trial is to test a model of sprinkler and nozzle for at least two hours with the same speed and wind direction at a given pressure. There have been a total of 78 trials. A program displays frames DU for irrigation from 10 x 10 m between sprinklers to 18 x 18 m for square or triangular frames.

There are changes that improve the UD. Some combinations of sprinklers and nozzles work well at low pressures. Sometimes just removing the sheath jet prolonging it would a DU value of 73% to 76%, thereby obtaining an acceptable value of DU.

The framework could be changed to rectangular array. It is noted that otherwise improves the DU to 79%.

All this results in significant energy savings.

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YIELD AND QUALITY OF TWO SUGAR BEET VARIETIES AS AFFECTED BY WATER REGIMES AND SOIL TREATMENTS

ABSTRACT

The field experiment was conducted at Agriculture Research Station in Nubarya, Alexandria Governorate during 2011/2012 and 2013/2014 seasons to study the effect of water regimes (60%, 80% and 100% evapotranspiration ETP) and three soil treatments on yield and its components of two sugar beet varieties. The field experiments were carried out in split split plot design with three replications. Water regimes were randomly distributed in main plots, cultivars were occupied the sub plot and soil treatments were allocated at random in sub sub plots. Plot area was 21 m^2 (6 rows x 0.5 m width x 7 m length). The important results could be summarized as follows:

A highest root length was 36.6 recorded with the combination between Marathon variety with 80% potential evapotranspiration (ETP) and Aquita component.

Highest response in root diameter was with Aquita compound which recorded the highest values of root diameter whether for the tested varieties and/or the studied water regimes.

Highest value of sucrose percentage was recorded with variety Marathon under soil treatments Potassium humate and 80% potential evapotranspiration.

The various interactions in the two seasons were insignificant with respect to their influence on juice purity percentage.

The higher root yield was produced with the combination between Farida variety and Aquita compound.

Farida variety recorded the highest significant increase in sugar yield when the plant irrigated with 100% potential evapotranspiration in the 1st season, meanwhile Marathon variety recorded the highest sugar yield with water regime of 80% potential evapotranspiration in the 2nd season.

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TILLAGE SYSTEM, NITROGEN FERTILIZER, AND IRRIGATION EFFECTS ON INSECT, WEEDS AND SUGAR BEET YIELDS

ABSTRACT

Much is not yet clearly understood about the interactive effects of tillage level, nitrogen (N) fertilizer application rates, and irrigation amounts in sugar beet production. A field study was conducted in 2013 and 2014 at the University of Idaho Kimberly Research and Extension Center to study the effects of tillage, N fertilizer rate, and irrigation amount on weeds and pestiferous insects, root and sugar yields, nitrates, and conductivity. Three tillage treatments were established: conventional tillage (CT), strip tillage (ST), and direct seeding (DS). Four N fertility rates were applied at 50, 75, 100, and 125% of recommended rate for CT sugar beet. The irrigation treatments were based on sugar beet evapotranspiration (ET) and were: 50, 100, and 150% of ET. Experimental design was a split plot randomized complete block design with tillage as the main plot, irrigation as the sub-plot, and N rate as the sub-sub-plot. By the 12 leaf sugar beet growth stage, *Chenopodium album* and *Setaria viridis* densities did not differ between CT, ST, and DS at optimum irrigation and N rate. In 2013 leafminer egg and larval densities were greatest in CT compared with DS and ST. Averaged over 2 years, root yield was 8.7 and 6.7 Mg ha^{-1} higher in CT and ST, respectively, than DS, but estimated recoverable sucrose did not differ between CT, ST, and DS. Combined yield and quality results over the 2 years indicated no significant interactions among tillage, irrigation, and N rates suggesting that N and irrigation recommendations do not need to be adjusted for tillage.

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EFFECTS OF TILLAGE PRACTICES IN SUGAR BEET ON ABUNDANCE AND DIVERSITY OF PREDATORY ARTHROPODS

ABSTRACT

Strip tillage provides many potential agronomic benefits, including reduced fuel and labor costs, reduced erosion, improved soil tilth, and enhanced water retention. Reduced soil disturbance and increased water retention associated with strip tillage also may affect density and diversity of arthropods. We examined the effects of tillage as well as various irrigation regimes on predatory arthropod fauna in sugar beet. Experiments were conducted over three growing seasons at the University of Idaho Kimberly Research and Extension Center. Carabid abundance and species richness did not differ between tillage treatments during the course of the study. Staphylinidae and Opiliones were more abundant in strip-tilled plots early in the season and more abundant in conventionally tilled plots late in the season. Spiders generally were more abundant in strip-tilled plots. Enhanced ground cover, higher humidity, more moderate temperatures, and higher numbers of potential prey in strip-tilled plots may have favored predacious arthropods. Abundance of foliar-inhabiting predators and parasitoids was not affected by tillage treatment, but parasitoid numbers decreased with higher irrigation input during one year of the study. The results suggest that strip tillage favors certain soil-dwelling groups of predatory arthropods, which might contribute to pest suppression in sugar beet systems with reduced tillage. Ongoing studies are clarifying the effects of direct seed production of sugar beet on predatory arthropods.

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INTERACTIONS BETWEEN SOIL TILLAGE AND WEED CONTROL IN PRACTICE - DATA OF SURVEYS IN GERMANY

ABSTRACT

A reliable and representative database from farming reality is available for sugar beet cultivation from 2010 - 2014 by a nationwide survey. Amongst others the database includes details about soil tillage, occurrence of weeds and application of herbicides.

In the course of erosion control, the acreage of plough tillage systems decreased within the last two decades, while the acreage of mulch tillage systems increased. Corresponding, the use of non-selective herbicides increased over the years. Data of this study show that these trends seem to stabilize during the surveyed period. Both tillage systems were applied approximately in equal parts. Roughly 30% of all farms used non-selective herbicides. In 2014 plough tillage was used in 45.8% of surveyed farms, while mulch tillage was applied in 53.3%. 46% of ploughless working farms and 11% of ploughing farms applied a non-selective herbicide (mostly one application/field). Additionally, selective herbicides were applied with a higher intensity at farms using mulch tillage: In the mean, the treatment index for herbicides (TIH) is significantly lower if the field was ploughed. This indicates a modified occurrence of weeds. However, obviously the quantity of weeds is higher with mulch tillage but the spectrum of variety of weeds did not alter. An exception is the incidence of rapeseed which is referred to as “hardly treatable” more often after mulch tillage compared to plough tillage.

Generally, it is expected that the occurrence of weeds increases in abstinence of plough tillage making an adaption of the herbicide strategy indispensable. Our study confirms this expectation for increased TIH and more frequent glyphosate application. In contrast the farmers did not document changes in weed varieties. The conflict of erosion control vs. pesticide reduction illustrates importance of the adaption of the cultivation management to the location.

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AUTUMN STRIP TILLAGE FOR SUGAR BEET GROWN ON LOESS SOIL IN GERMANY

ABSTRACT

The aim of the present study was to investigate effects of strip tillage in autumn on field emergence and yield of sugar beet crops grown on loess soil in typical sugar beet areas of Germany. Standard tillage practices which had proved to be optimal for the respective sites served as reference. Therefore, trials were carried out as on-farm experiments (strip design) at a total of 30 sites in the years 2012/13, 2013/14 and 2014/15. On average, field emergence was lower for strip tillage than for standard tillage practices. Plant population did not correlate with white sugar yield, presumably because differences between tillage treatments were mostly in the range of the optimal plant density of 82,000–110,000 plants ha^{-1}. In the mean of all trials, white sugar yield was 3.5% lower for strip compared to standard tillage. Lower yields for strip tillage were probably caused by delayed early development and occurred more frequently on heavier soils.

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EVALUATION OF STRIP-TILLAGE SYSTEM IN COMPARISON WITH OTHER TECHNOLOGIES IN THE SUGAR BEET PRODUCTION

ABSTRACT

In the climatic conditions of Poland, the sugar beet (*Beta vulgaris*) is the only raw material for the production of sugar (sucrose). Sugar, whereas, is the raw material or addition to many food industry products, fermentation, pharmaceutical and others.

Regardless of the use of sugar beet roots, it is important to obtain high quality of the yield, both in terms of internal and external quality.

In many Western European countries, as well as in Poland, greatly increased the interest in simplifications in cultivating, that are commonly used for many years in the USA and Canada. Foreign research proves that the strip-till technology in the cultivation of sugar beet, provides the high root yield that has high quality, thus giving the expected economical effect, while minimizing interference in the natural environment. To date, scientific research in the field of technology cultivation of sugar beet production in Poland did not include strip tillage. The usefulness of this technology for the cultivation of sugar beets consequently requires carrying out scientific research, and on this basis, the agrotechnical evaluation and assessment of meet the quality requirements of sugar beets.

Therefore, the aim of the study was the analysis of simplified production technologies of sugar beets in terms of crop yield and internal and external quality of the yield, and an indication of such technological solutions in the range of soil cultivation in sugar beet production, which will be beneficial in terms of agricultural technology.

In order to execute the aim of study in 2011 and 2012 it was established one-factor experiment in two-way classification model in the set of complete random blocks. Experimental facility consisted of six sugar beet cultivation technology, including strip-till technology, diversified in terms of stubble tillage, type of mulch and pre-sowing cultivation system and depth of tillage.

The results indicate that the simplification in tillage in the sugar beet production process involving the strip-till systems do not cause decline in root yield, nor the lower values of the internal and external quality, while reducing the costs of cultivation.

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CHANGES IN THE PHYSICAL SOIL PROPERTIES DURING THE GROWING SEASON OF SUGAR BEET INCLUDING THE DIFFERENT TILLAGE TECHNOLOGIES

ABSTRACT

Modifications of tillage affect not only the quantity and quality of harvested crops, but also the physical soil properties. Sugar beet requires soils with good physico-chemical and biological properties, because the structure of the soil, the moisture content and compaction have a significant impact on proper development and consequently the industrial value of roots yield. Modern cultivation technologies should have a positive effect on soil environment, therefore usage of simplified systems of soil cultivation is getting more popular (among them mainly the strip tillage). Replacing of conventional tillage systems by the new simplified technologies can bring benefits by reduction of the risk of soil erosion and to improve physical properties. Simultaneously the usage of simplifications in the cultivation of the soil carries the risk of excessive compaction, which can lead to deterioration of plant development conditions.

Therefore, the aim of this study was to assess changes in humidity and compaction of soil including the different tillage technologies of sugar beets. In order to execute the aim of study in 2011 and 2012 it was established one-factor experiment in two-way classification model in the set of complete random blocks. Experimental facility consisted of six sugar beet cultivation technology, including strip-till technology, diversified in terms of stubble tillage, type of mulch and pre-sowing cultivation system.

The analysis showed that none of the terms (before sowing of sugar beet, 6 leaf phase and meeting, covering rows of plants and after harvest) simplified tillage systems did not significantly affect on the increase of the amount of soil water. However it has been stated, that the simplifications of tillage cause an increase of soil compaction, which is undesirable.

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EFFECTS OF DIFFERENT SOIL MANAGEMENT SYSTEMS ON NITROGEN AVAILABILITY IN A LONG-TERM TRIAL

ABSTRACT

The influence of different soil management systems on the growing process, yield and essential quality criteria has been tested in a long-term field experiment, set up in 1996 by the University of Natural Resources and Life Sciences, Vienna. Three systems with reduced tillage (mulch farming) respectively minimum tillage (shallow mulch farming and non tillage) were compared to conventional ploughing. Another system combined conventional and minimum tillage (integrated tillage). The effects on sugar beet were tested in 2010 and 2011 in two parallel crop rotations as well as in 2014 in one of these. Supplementary focus was set on the description of the nitrogen availability in the tested systems. Soil analysis was done by the electro-ultrafiltration method (EUF).

For 2010 and 2011, in case of insufficient water supply during critical growing stages of sugar beet, reduced and minimum tillage show an increase in yield. Principally, the results 2014 confirm these observations. At pre-crop harvest 2010 – compared to plough – reduced tillage causes increased nitrate content in the top soil layer, while concentration for the whole layer 0-30 cm remains comparable. Only non tillage shows a higher content, which may be observed in the layer 30-60 cm as well. Data for spring 2011 record stable amount of nitrogen for the layer 0-60 cm for all systems, except non tillage, where distinct reduction can be observed. Lower nitrate content in this system was already observed in spring 2010. As for nitrate, a higher concentration in the top soil layer of the systems with reduced tillage can be reported for phosphorous and potassium.

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THE EFFECT OF DIFFERENT INTERCROP SPECIES ON THE NITROGEN AVAILABILITY

ABSTRACT

In Austria intercrops are grown in 75% of the fields before sugar beet. The advantages of intercrops are diverse. Species with ability of nitrogen fixation may induce additional nitrogen availability for sugar beet. Different intercrop species respectively varieties as well as mixtures of these intercrop species were grown in 2012 to 2014 on two sites, differing in water supply, each year. Reactions in sugar beet yield and quality can be reported. Additionally, soil samples were taken to a depth to 90 cm at several times in 2012 to understand the development of the nitrogen content in different soil layers in dependence of the tested intercrops. Soil analysis was done by the electro-ultrafiltration method (EUF).

Following the pre-crop wheat and a nitrogen content of 2.35 mg NO_3/100g soil intercrops formed under dry conditions 1 - 2 t/ha dry matter. On the second site 4.45 mg NO_3/100g soil were recorded after onion. There, under sufficient water supply intercrops produced 2 - 5 t/ha dry matter. At both sites, in autumn, nitrate content in plots with yellow (*Sinapis alba*) or brown mustard (*Brassica juncea*) resp. cress (*Lepidium sativum*) exceeded that of oil radish (*Raphanus sativus* var. *pleiformis*) by approximately 20%, fallow, oil flax (*Linum usitatissimum*) and buckwheat (*Fagopyrum esculentum*) by more than 100%. Similar values are recorded for lentil (*Lens culinaris*) and vetchling (*Lathyrus sativus*). Additional nitrogen fixation was not observed. Especially oil radish and yellow mustard were able to keep nitrate in the upper soil layer till spring.

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POTENTIAL YIELD OF SUGAR BEET AT EXTENDED GROWING PERIOD

ABSTRACT

Autumn sown sugar beets (winter beets) are expected to yield markedly higher than spring sown beets. This requires a continuous growth during an extended growing period. The objective of this study was therefore to analyse yield formation and sugar storage of sugar beet plants during an extended growing period. Pot experiments were carried out in the greenhouse with 11 sowing dates spread over the years with sequential harvests. The oldest plants were grown for 859 days. Root fresh matter yield continuously increased till the latest harvest, whereas the sugar concentration reached an optimum value and then decreased with time. The results provided some evidence that the sugar concentration of the storage root is limited by the sink capacity, which in turn controls the source activity by a feedback regulation of photosynthesis and leaf formation. The dry matter composition of the storage root changed towards lower sugar concentration, but higher concentration of cell wall compounds (marc). The sugar yield still increased beyond a time period at which winter beets will probably be harvested in practice. Hence, the theoretical yield increase of autumn sown sugar beets can be realized, provided that the plants show sufficient winter hardiness and bolting resistance.

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POTENTIAL OF SUGAR BEET IN THE DANUBE REGION

ABSTRACT

In the Danube Region Austria, Bulgaria, Czech Republic, Germany (Bayern), Croatia, Hungary, Romania, Slovenia, Slovakia, Moldavia and Serbia have produced sugar beet. But due to EU Sugar Reform the production had stopped in Bulgaria and Slovenia and reduced in the other EU countries. Currently in total 350.000 ha sugar beet are cultivated in Danube Region with average 56 t/ha root yield. But the potential of sugar beet area could be 1 million ha and the yields are increasing continuously.

In the last few years sugar beet is also considered as base material of bio-fuels. In these countries sugar beet yields average about twice the amount of bioethanol per hectare than corn and three times than wheat. In 2012 Germany produced 321,3 million litre and Czech repuplik 110,4 million litre agrar–ethanol. In addition to ethanol production, other components of the sugar beet plant (marc, top, tail) can be used advantageously for biogas production.

In this paper the possibilities of sugar and energy beet production in Danube Region are discussed.

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POSSIBILITY OF SUGAR BEET YIELD INCREASE BY EARLIER SOWING IN BELGIUM

ABSTRACT

Since the 2010s and when weather conditions permit, the IRBAB establishes each year one sugar beet yield trial where different sowing dates (2 or 3 dates) are combined with different harvesting dates (2 or 3 dates). Different growing periods are thus obtained. They generally range between 150 and 250 growing days. Due to global warming and the variety improvement, 250 growing days is currently a maximum that can be achieved in practice in Belgium (sowing on March 10 and harvesting on November 15). These trials combine different varieties and/or different population levels per hectare. Depending on the year, evolution in the average yield according to the growing period evolves asymptotically or linearly.

POSSIBILITÉ D'AUGMENTATION DU RENDEMENT EN BETTERAVE SUCRIÈRE PAR DES SEMIS PLUS HÂTIFS EN BELGIQUE.

RESUME

Depuis les années 2010 et lorsque les conditions météorologiques le permettent, l'IRBAB veille à mettre en place chaque année un essai de rendement betteravier où différentes dates de semis (2 ou 3 dates) sont combinées avec différentes dates de récolte (2 ou 3 dates). Différentes durées de végétation sont ainsi obtenues. Elles s'échelonnent généralement entre 150 et 250 jours de végétation. Suite au réchauffement climatique et à l'évolution des variétés, une durée de végétation de 250 jours est actuellement un maximum qui peut être réalisé en pratique en Belgique (semis au 10 mars et récolte au 15 novembre). Ces essais combinent différentes variétés et/ou différents niveaux de population par hectare. Selon les années, l'évolution du rendement moyen selon la durée de végétation évolue de façon asymptotique ou linéaire.

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EFFECT OF AN APPLICATION OF ORGANIC MANURE, COMBINED WITH A COVER CROP CONTAINING LEGUMINEOUS PLANTS ON THE NITROGEN FERTILIZATION OF THE SUGAR BEET. FIRST TRIAL YEAR

ABSTRACT

The legislation in the Walloon Region (Belgium) permits the spreading of organic matter (cattle manure, cattle slurry, poultry manure, compost, ...) in summer, usually after a cereal crop, provided that this application is followed by the drilling of a nitrate trap crop. This practice is to cover the ground during the winter to limit the winter nitrate leaching. Since 2014, a mixture of species containing up to 50% legumineous (by weight of seeds) can be used as green manure in this case. Tests combinations thereof have been carried out in 2014/2015 (combination manure or slurry with green manure legumineous-based or other) to evaluate the effect of this combination on the additional mineral nitrogen fertilization to be given to the sugar beet. Mustard cover crop tolerant to the beet cyst nematode have also been used in these tests, in nematode contaminated fields, to compare the effect of these cover crop combinations on the populations of the beet cyst nematode. This project has received funding from the Ministry of the Agriculture of the Walloon Region. The experiment will be repeated in 2015/2016.

EFFET D'UN APPORT DE MATIÈRES ORGANIQUES COMBINÉ AVEC UN SEMIS D'ENGRAIS VERTS À BASE DE LÉGUMINEUSES SUR LA FUMURE AZOTÉE DE LA BETTERAVE. PREMIÈRE ANNÉE D'ESSAIS.

RESUME

La législation en Région Wallonne (Belgique) autorise l'épandage de matières organiques (fumier, lisier, fientes, compost, …) en été, généralement après une récolte d'une céréale, pour autant que cet épandage soit suivi par le semis d'une culture piège à nitrate. Cette pratique est destinée à couvrir le sol en hiver pour limiter le lessivage hivernal des nitrates. Depuis 2014, un mélange d'espèces contenant jusqu'à 50% de légumineuses (en poids de graines) peut être utilisé comme engrais vert dans ce cas. Des essais combinant ces différents éléments ont été mis en place en 2014/2015 (combinaison apports de fumier ou de lisier avec engrais verts à base de légumineuses ou autres) pour étudier l'effet de cette combinaison sur le complément de fumure azotée minérale a apporter pour la betterave sucrière. Des engrais verts à base de moutarde résistante au nématode à kyste de la betterave ont été également utilisés dans ces essais, dans des terres nématodées, pour comparer l'effet de ces combinaisons d'engrais verts sur les populations de nématode à kyste de la betterave. Ce projet a reçu un financement de la part de Ministère de l'Agriculture de la Région Wallonne. L'expérimentation sera reconduite en 2015/2016.

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DIVIDED N FERTILIZER USE DURING THE GROWING SEASON

ABSTRACT

Nitrogen is the most important nutrient for optimum sugar beet growth. It has effect on plant early growth and full canopy closure. Large capony allows plants to utilize the sunlight's energy more efficiently. Excess N at the end of growing season reduces sugar beet quality by increasing amino-nitrogen concentration of beet roots. Since last couple years some of the sugar beet areas in Finland are turning yellow very early during the growing season. This has raised the question about the N fertilization rates. The maximum N rate 140 kg/ha for sugar beet is determined by The Finnish Agri-Environmental Program, however the average use rate by the farmers at the moment by the statistics is between 90 to 100 kg/ha.

The aim of the study was to fiund out how the divided N fertilizer use could increase the sugar beet yields in Finland. The application levels of control fertilization were 90, 110, 140 kg N/ha. Divided treatments were drilled 25 kg N/ ha less than controls. The 25 kg N/ha was added by surface application during the growing season, no later than beginning of July. The trial was carried out in the two trial sites with clay and loam soils for three years. The root yield and quality was determined with different nitrogen levels.

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WHAT IS THE RIGHT LEVEL OF N FERTILIZATION FOR SUGAR BEET IN FINLAND

ABSTRACT

Nitrogen is the most important nutrient for optimum sugar beet growth. It has effect on plant early growth and full canopy closure. Large capony allows plants to utilize the sunlight's energy more efficiently. Excess N at the end of growing season reduces sugar beet quality by increasing amino-nitrogen concentration of beet roots. Since last couple of years some of the sugar beet areas in Finland are turning yellow very early during the growing season. This has raised the question about the N fertilization rates. The maximum N rate 140 kg/ha for sugar beet is determined by The Finnish Agri-Environmental Program, however the average use rate by the farmers at the moment by the statistics is between 90 to 100 kg/ha.

The aim of the study was to indicate actual crop need for N in Finland. The application levels of N were 90, 110, 140, 160, 200 and 220 kg/ha. The trial was fertilized by the common system used in Finland. NPK-fertilizer was placed during the drilling into the separate row. Extra N was also replaced during the drilling. The trial was carried out in the two trial sites with clay and loam soils for three years. The root yield and quality were determined with different nitrogen levels.

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EFFECT OF STARTER APPLICATION OF PHOSPHORUS ON YIELD

ABSTRACT

The sugar beet drilling in Finland is usually done in conditions where the soil contains sufficient amount of moisture, however the soil temperature is usually very low. In these northern growing conditions the total growing period is short, approximately 160 days so everything that can be done to improve sugar beet growth should be adopted to farming practise. Finland is also very regulated with the use of phosphorous so it is crucial that the fertilizers that are used are used properly.

Aim of this study was to improve yields with starter application of phosphorous.The studies were done on years 2012-2015 on soils with different P-levels. One with <23 mg P l^{-1} and other with >23mg P l^{-1}. On this study liquid fertilizer were used with three different doses: 0 kg P ha^{-1}, 5 kg P ha^{-1} and 10 kg P ha^{-1}.

It was shown that with these starter applicatios of phosphorous it is possible to increase root and sugar yield.

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DRONE BASED REMOTE SENSING OF SUGAR BEET WATER-USE EFFICIENCY

ABSTRACT

In the context of global change incidences and duration of temporal drought will increase in many regions worldwide and may cause severe yield losses of economically significant crops like sugar beet (*Beta vulgaris* L.). Minimizing drought induced yield losses should be a major concern among agronomists, and this emphasizes traits such as water-use efficiency (WUE). Generally, WUE relates a plant's carbon balance to its water consumption. At the canopy level, WUE is expressed as the ratio of net ecosystem CO_2 exchange (NEE) to evapotranspiration (ET). However, WUE is most commonly accessed on the basis of single leaves. Single leaf measurements are easy to perform but only poorly scale up to WUE of complex agroecosystems. Non-destructive multi-sensing approaches, such as infrared- and NDVI-screening, are excellent tools to study transpiration, leaf area development and biomass production of entire crop canopies. Recently the use of unmanned aerial vehicles (drones) for remote sensing has become popular in applied agricultural science which allows fast spectral screening of crop stands.

In our study we compare labor-intensive direct chamber-based measurements to a drone-based estimation of WUE in sugar beet stands. The trial was carried out at Cunnersdorf, Germany. The experimental site was established 25 years ago with four levels of potassium input within a 4-year crop rotation. Canopy-WUE was determined by a mobile non-steady state chamber system. A high-end quadrocopter was developed for agricultural NDVI mapping and thermal imaging.

Estimated WUE from drone-based spectral data proofed to be well and significantly correlated with chamber-based measurements. We therefore conclude that drone-based spectral remote sensing has the potential for estimating WUE of entire crop stands. Possible future applications include the screening for drought tolerant and nutrient efficient varieties, early detection of plant stress and the development of sustainable low-input fertilizer strategies. However, general algorithms have to be developed in order to make this technique applicable to a broad range of users.

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ADAPTATION OF POTASSIUM FERTILIZATION IN CALCIUM (LIME) DEFICIENT SOILS – EXPERIMENTAL AND STATISTICAL EVALUATION

ABSTRACT

The application of lime to soils is obligatory when either the soil calcium content or the pH value is low. But liming is known to affect nutrient extractability from the soil and nutrient availability to plants. Such effects are not yet considered in current fertilizer recommendation systems. Therefore, the influence of lime on the extractability/availability of potassium (K) was investigated with field trials in 62 lime deficient and equal environments in Germany. 24 weeks after the application of 3 and 12 t CaO ha^{-1} the soil nutrient content was analyzed using electro-ultrafiltration. Subsequently, sugar beet was grown in 10 of the 62 environments with a varied K fertilization. The yield of beets and tops was measured and quality parameters and nutrient contents were determined. A principle component and a cluster analysis was applied to soil analysis data of the 62 environments before trial establishment in order to compact data and to identify groups of environments. The statistical evaluation resulted in two groups of clusters. The first group (G1236) comprised environments with low calcium contents, the second group (G45) contained lime deficient environments with higher calcium contents. In G1236 the soil K content increased 24 weeks after the application of lime by 1.8 mg $(100\ g)^{-1}$ whereas in G45 the soil K content remained unchanged after liming. The K content of sugar beet was not influenced due to liming neither in tops nor in beets. However, in G45 the K uptake decreased after liming without a compensatory K fertilization. Over all, the differention of equal environments was achieved and enables the improvement of the fertilizer recommendation.

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REPEATED TESTING OF SOIL FACTORS AFTER LIMING OF 52 DIFFERENT SOIL TYPES IN THE SOUTH OF SWEDEN 2009-2014

ABSTRACT

The background of this research project was a previous investigation in the sugar beet growing area showing that many soils are suboptimal in pH, resulting in reduced growth and yield. The aim of this new research project was to improve the nutritional status of the soils and develop specific liming recommendations for different soil types.

During 2009-2011, 52 different soil types in the south of Sweden were limed with factory lime or lime stone meal. The soils were limed in the autumn before sugar beets. In the following three years, a soil sample was collected every spring in the plots. The soil samples were analysed for pH and soluble nutrients Ca, Mg, P and K by extraction with ammonium lactate.

The yearly changes in soil factors will be presented for the different soil types. Implications for new liming recommendations will be discussed.

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IDENTIFYING ROOTING TRAITS FOR OPTIMAL NUTRIENT UPTAKE

ABSTRACT

The importance of early canopy closure to maximize sugar beet yield is well understood. Early root growth and nutrient uptake are therefore important to allow rapid canopy expansion. Stevanato *et al*. (2010) found positive relationships between root elongation rate, nutrient uptake and root yield. Our current work is evaluating the diversity in rooting traits in UK and European germplasm and exploring relationships between rooting traits, nutrient uptake and ultimately yield. The aim of the work is to enable nutrient uptake efficiency to be selected for within sugar beet breeding programmes: either using a seedling screen or molecular markers.

Sugar beet varieties were grown for two weeks within hydroponic growth pouches in controlled environment rooms and image analysis was used to gain root phenotype data including root length, area and branching. The same varieties were grown for eight weeks in a controlled glasshouse; root length and area was measured along with leaf area, nitrogen content and dry weight.

The hydroponic study found differences between varieties in total root length at 14 days ($P<0.001$). In the glasshouse experiment, there were differences between the varieties in leaf area and leaf and root dry weight ($P<0.05$), with similar ranking of the varieties for the three parameters. Positive relationships were found between early rooting traits (root length, root diameter, total root weight) and leaf nitrogen content ($P<0.001$) and there was also a positive relationship between lateral root number in the hydroponic study, and N uptake in the glasshouse ($P<0.05$).

Working with breeders, this work has now been extended to a wider range of breeding lines. The next step will be to establish field experiments to determine whether the differences in early growth and nutrient uptake are also seen in the field and, if so, whether these translate to yield.

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EFFECT OF DIFFERENT COVER CROP CULTIVATION SYSTEMS FOR WEED SUPPRESSION IN SUGAR BEETS

ABSTRACT

In our study we tried to evaluate the effects of cover crops and cover crop mixtures in sugar beet. Two field studies were conducted at the University of Hohenheim and at Renningen in 2014 and 2015. We tried to investigate the weed suppression ability of cover crops planted in autumn and the resulting mulches during sugar beet vegetation in spring. 6 different treatments were used, containing: one untreated control, 3 cover crops in mono-cultivation and 2 cover crop mixtures (CCM). Sugar beets were sown at the beginning of April into the 6 treatments, only at the 2015 vegetation period. We wanted to see, if (i) single and mixture cultivation of cover crops resulted in similar weed control efficacy in autumn and in spring during the sugar beet growing season; and (ii) if CCMs lead to higher biomass (in autumn) and mulch (in spring) compared to mono-cultivation. Weed densities in the field experiments ranged from 20 to 300 plants m^{-2}. Mustard (*Sinapis alba* L.), fodder radish (*Raphanus sativus* var. *niger* J. Kern), spring vetch (*Vicia sativa* L.) and the different CCMs resulted in weed suppression of up to 80% compared to the untreated control. Highest biomass yields were observed in the mustard mono-cultivation. In spring, before planting of sugar beets, mustard provided the highest soil coverage (60%) and reached the highest plant biomass and residues. Measurements prior to the first crop`s herbicide application, showed that cover crop mulches reduced weed density by 60% and 55% in mono- and mixture cultivation, respectively. In all treatments white sugar yield was significant higher compared to the untreated control. This study has proven a potential of cover crops and cover crop mulches as weed suppressors in different cover crop - sugar beet systems.

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ROBOTIC INTRA-ROW WEED HOEING IN SUGAR BEET

ABSTRACT

Vision-based and GNSS-based row guidance systems for inter-row hoeing have been developed for maize, soybean, sugar beet and other crops with wide row spacing. Selective intra-row weeding, however, has not yet been realized for many arable crops. Weeds within crop rows and close to the crop are difficult to remove without damaging the crop. Intra-row weeding can be carried out in several different ways. We developed a prototype intra-row hoe for robotic weeding in sugar beet. A bi-spectral camera and image analysis algorithms were developed to automatically identify weed species in sugar beet based on shape features. A step-wise classifier was developed for automatic weed/crop classification.

Positions of crops and weeds were recorded in the classification results. Thresholds were set to decide when the speed of the finger weeder was increased. Electric motors were rotating the finger weeder with a fluctuating speed. At driving speed (2 km/h), the finger weeder worked selectively and did not damage the crops. At 8 km/h, the finger weeder removed all plants in the row. An encoder was mounted in the axis of a non-driven wheel running over the ground providing information concerning distance. After calibration, the distance between two images and between classified plants in the image and the finger weeder were known. A micro-controller gathered the information from the encoder, and the classification program, triggered the camera and the finger weeder.

If weeds were close to crops or if no weeds were identified, the speed of the finger weeder was not increased.

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IPM IN SUGAR BEETS – A JOINT PROJECT OF LOCAL FARMERS ASSOCIATIONS DLS AND OEL, NORDIC SUGAR, NBR, AARHUS UNIVERSITY, COPENHAGEN UNIVERSITY AND SEGES

ABSTRACT

The aim of the project is create a common description and set of tools in applying renewed IPM in beet growing including sugar beets, fodder beets and energy beets. The activities comprise common description of the IPM tools, input and strategies, development data form trials in weed control, phytopathology and plant growth challenging the intended IPM tools. One activity addresses development of early warnings tools by QPCR in combination of weather data and trial data. To secure awareness and knowledge transfer demonstration on five “demonstration farms” are applied during the season towards groups of farmers, especially sugar beet growers. The weather data are collected from weather stations located on the demonstration farms and uploaded on the web with the intention to serve as a future tool in a local warning system.

5.2 CHRISTIAN SCHLATTER
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A NEW BROAD-SPECTRUM FUNGICIDE SUGAR BEET SEED TREATMENT

ABSTRACT

Soil-borne diseases such as *Rhizoctonia solani* and *Pythium ultimum*, and seed/air-borne diseases such as *Phoma betae*, are widespread in sugar beet growing areas worldwide, and are known to have a severe negative impact on sugar beet plant establishment, ground coverage and, ultimately, sugar yield.

The new sugar beet seed treatment solution combines three active ingredients with different modes of actions, and provides broad-spectrum disease control targeting most key seed/soil-borne diseases in sugar beet. It contains a new active ingredient from the succinate-dehydrogenase inhibitor (SDHI) fungicide class that has been developed exclusively for seed treatment use.

The new solution was developed specifically for sugar beet seed treatment, and contains 15 g/l Sedaxane, 22.5 g/l Fludioxonil, 15 g/l Metalaxyl-m. Laboratory, greenhouse and field data demonstrate that the combination of the three active ingredients delivers broad spectrum of activity, with superior control of *Rhizoctonia*, *Pythium* and *Phoma* compared to the existing solutions.

A particular benefit of this highly effective protection are the stronger and healthier roots in the early crop stages, ensuring vigorous sugar beet development and hence better performance under a broad range of conditions. A specific methodology was developed to measure and demonstrate enhanced sugar beet root development. More quality roots, particularly unhindered growth of tap and side roots, are the foundations for high yield. Data and conclusions from an extensive field programme conducted in 2015 in Europe and USA will also be provided.

5.3 ANNE-CATHERINE RENNER[1], RUDOLF APFELBECK[2], JOHANN MAIER[3], MICHAEL ZELLNER[1]

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MONITORING *RHIZOCTONIA SOLANI* AG2-2 INOCULUM LEVELS IN SUGAR BEET FIELD SOILS

ABSTRACT

Rhizoctonia solani (Kühn) is an important soilborne pathogen causing root and crown rot in sugar beets. A high soil inoculum potential of *R. solani* is the main prerequisite for the development of sugar beet root rot. To quantify *R. solani* AG 2-2 densities in soil, a specific molecular quantification assay, called quinoa-qPCR-assay, was developed. In addition to its efficient use in greenhouse and in field trials with artificially infested soils, the assay was now evaluated for its suitability to monitor the *R. solani* concentration level in naturally infested soil.

A total of fifty sugar beet fields in Bavaria were categorized into high and low risk fields using the factors pre-crop (high-risk: maize, low-risk: winter wheat) and risk-area (high-risk: region with high incidence of root rot, low-risk: region with low incidence of root rot). Sampling was repeated two times at intervals of two months and infection rates of sugar beet were recorded as percent surface area affected.

There was a good agreement between infection rates and inoculum amounts observed with the quinoa-qPCR-Assay. As expected, the *R. solani* concentration level was significantly higher at locations where maize was grown as a pre-crop. Furthermore, when wheat was grown as a pre-crop, the inoculum amount in high-risk areas was twice as high as in low-risk areas. The results demonstrate that the quinoa-qPCR assay is a highly sensitive method to efficiently estimate the inoculum potentials of *R. solani* AG 2-2 in naturally infested soils.

5.4 SASCHA SCHULZE, HEINZ-JOSEF KOCH
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IMPACT OF PHYSICAL SOIL PROPERTIES ON THE OCCURRENCE OF RHIZOCTONIA ROOT AND CROWN ROT IN SUGAR BEET (*BETA VULGARIS* SSP. *VULGARIS*)

ABSTRACT

The soil borne pathogen *Rhizoctonia solani* (*R. solani* AG2-2IIIB) is the causal agent of the late crown and root rot in sugar beet, which became an increasing problem in European sugar beet growing in the past decades. Conditions causing Rhizoctonia disease outbreak are not yet understood. However, physical soil characteristics are assumed to have a strong influence on Rhizoctonia inoculum potential in the soil and Rhizoctonia infestation of sugar beet. We present results from multi-factorial split-plot field experiments (pre-crop / inoculation as main plot, tillage, sugar beet variety and harvest time as sub-plots) with four replicates conducted at Haardorf (Lower Bavaria). This region is the main infestation area for Rhizoctonia root and crown rot in Germany. The soils were inoculated with a barley inoculum and maize was grown as a susceptible pre-crop to create a high and uniform infestation potential in the soil. Maize straw was left (grain maize) or removed (silage maize) from the field, and the soil structure of the topsoil (0-15 cm) was differentiated by a variation of soil tillage and additional soil compaction in autumn (tillage: plow 25 cm, cultivator 10-12 cm, cultivator 5 cm plus additional load).

Undisturbed soil samples were taken to determine physical soil characteristics (field capacity, bulk density, air capacity, pore volume) probably affecting Rhizoctonia infestation. In addition, soil moisture, soil temperature and the electrical conductivity was continuously recorded by data loggers in the field during the growing season. The Rhizoctonia infestation level of sugar beet was evaluated by a crop scoring system at different harvest dates. Correlations between soil structural properties and the occurrence of Rhizoctonia infestation in the field will be presented.

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PREVENTATIVE EFFECTS OF BCA-COATED INTERCROP SEEDS AGAINST *RHIZOCTONIA SOLANI*

ABSTRACT

Rhizoctonia solani (AG 2-2IIIB) causes Rhizoctonia root and crown rot, a major problem in sugar beet production worldwide. Recent investigations showed differences in the susceptibility of some major intercrop species against the soilborne pathogen. Furthermore preventative effects of Biological Control Agents (BCA) against *R. solani* could be realized in vivo by "seed coating", even on Phacelia, a well-known host plant. The consideration of the present study was to investigate effects of intercrops as well as BCAs – used as "seed coating" – on a following sugar beet - maize crop rotation in vivo.

For this approach, three different intercrop species were coated with a *Trichoderma* genus by a newly established technique. Intercrops were grown in pots in a multifactorial-design (intercrop x coating x artificial inoculation). The residues of intercrops were mixed into the soil. These substrates were the basis of further sugar beet and maize growing.

Tested intercrop species didn´t differentiate in Rhizoctonia-symptoms on sugar beet, they significantly increased their yield. Applied BCAs reduced root rot and constrictions on a susceptible sugar beet cultivar up to 20%. Furthermore, results figured out that protective effects of BCAs could be extended on roots of maize, which was grown after sugar beet. Results showed this approach as an appropriate method to assemble an antagonistic potential in soil to form a microbial controlled atmosphere for a sugar beet - maize crop rotation against soilborne pathogens.

5.6 VERA STOJŠIN[1], DRAGANA BUDAKOV[1], FERENC BAGI[1], A. KONJEVIĆ[1], Ž. ĆURČIĆ[2], D. LATKOVIĆ[1], J. CRNOBARAC[1]

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INFLUENCE OF THE LONG-TERM MINERAL FERTILIZATION AND CULTIVAR ON SUGAR BEET ROOT ROT

ABSTRACT

Sugar beet production in Serbia is a challenging task since it is grown without irrigation, which leads to uneven supply of water during vegetation. Since rainfalls have irregular distribution and, more than often, cultivation procedures which have a task to preserve soil moisture are avoided, sugar beet plants suffer from drought especially during the second part of the vegetative period. This mostly applies to plants which develop exuberant leaves as in soils which are supplied with high doses of mineral fertilizers. Such plants are more susceptible to fungi causing root rot in extreme environmental conditions. Economically most important pathogens in Serbian production area are *Macrophomina phaseolina* (charcoal root rot), *Fusarium* species (Fusarium root rot) and only in some years and on individual parcels *Rhizoctonia solani* (Rhizoctonia root rot). The aim of this trial was to evaluate the effect of long-term mineral nutrition on root rot in 8 sugar beet cultivars. The trial was set up in 4 replications of 20 NPK combinations (1. Without fertilization to 20. 150 kg/ha of pure N, P and K each) and 8 commercial sugar beet cultivars (C1-C8). Results showed that both cultivar and the level of fertilization affected severity of root rot. Significant differences were notable between cultivars which implied that they have different level of susceptibility to root rot. At the same time, severe root rot appeared in plots with high mineral fertilization, whereas lowest intensity of root rot was present in plots with low level fertilization, especially with phosphorus and potassium excluding nitrogen.

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SPOREID – INNOVATIVE DISEASE MONITORING AND DIAGNOSTICS FOR IMPROVED EFFICIENCY OF CROP PRODUCTION

ABSTRACT

SporeID is a new project designed to minimise the impact of powdery mildew, rust and other potential foliar disease threats on the yield of the UK sugar beet crop. Foliar diseases have the potential to reduce yield by 12, 20 or 50% for rust, mildew or cercospora respectively and, whilst current practices prevent losses of this magnitude, it is estimated that up to 10% of yield in the UK is lost each season to foliar diseases. Climate change may lead to increasing pressure, both from existing and 'new' emerging diseases, which will require increased crop protection. Improved knowledge and decision making will optimise chemical input and offer environmental benefits through improved resistance management in future climates.

The project is bringing together novel diagnostic tools, crop disease modelling and yield forecasting to underpin grower decision making, and will investigate the potential impact of emerging disease on the crop. The three-year project is led by the BBRO; it also involves British Sugar plc, AB Sugar, the University of Nottingham, Rothamsted Research, Burkard Manufacturing Company Ltd and Crop Performance Ltd. This poster will highlight the latest developments from this collaborative project to date.

5.8 GIOVANNI CAMPAGNA[1], FRANCO CIONI[2]
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INTEGRATED STRATEGIES FOR CERCOSPORA LEAF SPOT (CLS) CONTROL

ABSTRACT

CLS is the most important leaf disease for the Italian sugar beet crop. Crop protection strategies reached a new balance in Italy after the uprising of CLS strain resistant to strobilurins (QoI inhibitors) and the decrease of efficacy of the triazoles (DMI), though the recovery of active ingredients not used for long time as Clortalonil, Thyophanate Methyl, Mancozeb (Manganese Ethylenebis Dithiocarbamate) and the optimization of the use of new compounds based on copper and sulfur.

Without the introduction of new active ingredients against CLS, a valid alternative would be improving the defense mechanisms versus fungal pathologies stimulating the natural self defenses of the plant or otherwise improving the fitness of the crop using specific products in foliar nutrition. Among these products, Phosphites showed an improving of the yield although no reduction of the Affected Leaf Area has been reported, but only a vegetative state in better condition. Results obtained in 2 years of experimentation with these products give rise to points of reflection on the use of such substances.

5.9 JULIANE SCHMITT[1], BENNO KLEINHENZ[1], JOHANN MAIER[2], PETER RISSER[2], CHRISTIAN LANG[3], PAOLO RACCA[1]

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CERCBET 3 PLUS – A NEW ACTION THRESHOLD AGAINST *CECOSPORA BETICOLA* (SACC.) IN SUGAR BEET BASED ON WHITE SUGAR YIELD AND INFECTION PRESSURE

ABSTRACT

The aim of this work was to determine a correlation between the epidemiological progress of *C. beticola* and losses in white sugar yield (WSY). A new threshold system was developed to predict the need and optimal timing for consecutive fungicide treatment from an economic perspective.

For modeling, the data of five years of fungicide trials carried out by Südzucker AG were used. By discriminant analysis a function was determined describing the decreasing WSY with increasing infection pressure index (IPI). The IPI is a daily calculated parameter, representing the epidemiology for *C. beticola* within a period, caused by weather conditions. The new IPI based action threshold is established to the equivalent of a WSY loss of 1%.

With exceeding the threshold after 15th August, the amount of the additional loss in WSY is calculated for the remaining period until 15th September (standard deadline for fungicide treatments).

A first evaluation showed a correct classification of WSY loss in over 90% of all cases. An independent validation will be done with the data of field trials carried out in 2015 and planned for 2016.

5.10 PASCAL KREMER[1,2], JAN SCHLÜTER[1,2], HANS-JOACHIM FUCHS[1], CHRISTIAN LANG[2]

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POSSIBLE IMPACT OF CLIMATE CHANGE ON THE OCCURRENCE AND THE EPIDEMIC DEVELOPMENT OF CERCOSPORA LEAF SPOT DISEASE IN SOUTHWEST GERMANY

ABSTRACT

The possible impact of climate change on the occurrence and the epidemic development of Cercospora leaf spot disease (CLS) in sugar beets was analyzed using the forecasting models CERCBET1. In practical use, CERCBET1 projects the day of the year when 1% (T1), 50% (T50) and 100% (T100) of the fields in a region are potentially infested by CLS. If CERCBET1 projects the attainment of T50, the fungicidal strategy is being simulated and recommended by CERCBET3 on the basis of three-day weather forecast data of the German Weather Service.

In this study CERCBET1 was used as a model on the impact of climate change driven by REMO (REgional MOdel) climate projection data as input. The possible impact of climate change on the occurrence of CLS was studied in three time windows: a baseline period 'B' (1971-2000), a medium-term period 'K' (2021-2050) and a long-term period 'L' (2071-2100). Moreover, the ontogenesis of the sugar beet plants was simulated with the aid of a leaf-growth model simulating the leaf formation in early growth stages. The simulation results were compared in order to draw conclusions on whether CLS would potentially occur in a different leaf stage. The date of completion of the 20- and 40-leaf stage (B20 and B40) was examined.

The comparison of the time windows B and K indicates that T1 has an earlier occurrence of 4 days, T50 of 5.7 days, and T100 of 7 days. In period L, T1 is reached 20.9 days, T50 23.9 days, and T100 27.5 days earlier than in period B. The leaf-growth-stages shift slightly less forward than the CLS occurrence. For period L, B20 is projected 9.5 days and B40 14 days earlier than in period B. An increasing number of fungicide applications could be one consequence.

5.11 DRAGANA BUDAKOV[1], VERA STOJŠIN[1], FERENC BAGI[1], Ž. ĆURČIĆ[2], M. GRAHOVAC[1], N. ĐURAGIN[1]

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EFFICACY OF CLOROTHALONIL FUNGICIDE COMBINATIONS IN CONTROL OF CERCOSPORA LEAF SPOT

ABSTRACT

Sugar beet leaf spot, caused by *Cercospora beticola* Sacc., is the most important foliar disease of sugar beet in warm and humid environmental conditions, which regularly occurs during summer months in sugar beet growing regions in Serbia. In the absence of control measures in areas with high disease incidence, severe epidemics of Cercospora leaf spot (CLS) results in a significant reduction of root yield, recoverable sugar, sucrose concentration and in an increase of impurities leading to higher processing costs. CLS is primarily controlled by application of fungicides, most of which have a site-specific mode of action and posses a high risk for resistance development in target organisms. Since resistance is the most important limiting factor of CLS chemical control, the main aim of this work was to evaluate efficacy of chlorothalonil in combination with systemic and local systemic fungicides. Tetraconazole, carbendazim and azoxystrobin, representing each chemical group of systemic fungicides that is used for CLS control in Serbia, were tested alone and in combination with chlorothalonil. Results showed that each fungicide in combination with chlorothalonil was more effective in CLS control than corresponding single fungicide. Being multi-site protective fungicide, chlorothalonil proved to increase efficacy of tested fungicides and in perspective, it could postpone the emergence of fungicide resistance in *C. beticola*.

5.12 DRAGANA BUDAKOV[1], VERA STOJŠIN[1], NEVENA NAGL[2], G. POGANČEV[1], FERENC BAGI[1], M. GRAHOVAC[1], K. TAŠKI AJDUKOVIĆ[2], OLIVER T. NEHER[3]

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SENSITIVITY OF *CERCOSPORA BETICOLA* ISOLATES IN 2015 IN SERBIA

ABSTRACT

Cercospora leaf spot (CLS) caused by the hemibiotrophic fungus *Cercospora beticola*, is sugar beet disease primarily controlled with fungicides. However, an exclusive use of fungicides which belong to the same class of fungicides with site-specific mode of action creates a pressure under which resistant isolates within a population become predominant. The aim of this research was to determine the sensitivity level of *C. beticola* isolates from the site on which CLS was controlled solely by strobilurin fungicides (azoxystrobin or trifloxystrobin) in combination with triazoles (mostly cyproconazole) during the previous 5 years. Qualitative sensitivity of *C. beticola* isolates was tested by measuring mycelial growth on media amended with discriminative concentrations of carbendazim (benzimidazole), azoxystrobin (strobilurin) and tetraconazole (triazole). Concentrations that were used are: 5 µg/ml of carbendazim, 0.1 µg/ml of azoxystrobin + 1mM salicylhydrooxamic acid (SHAM) and 0.6 µg/ml of tetraconazole and were established based on testing wild type populations of *C. beticola* obtained from typical symptoms of CLS on chard and beet from organic production. Results showed that decrease of sensitivity of *C. beticola* to tetraconazole and azoxystrobin exists in populations, whereas only a small proportion of isolates showed resistance to carbendazim from the benzimidazole group.

5.13 JÁNOS KIMMEL[1], LÁSZLÓ POTYONDI[1], FERENC CSIMA[2], ÉVA KULCSÁRNÉ TAKÁCS[2]

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PROTECTION AGAINST FUNGICIDE RESISTANT CERCOSPORA STRAINS IN HUNGARY

ABSTRACT

Among the fungal diseases of sugar beet Cercospora leaf spot is the most important in Hungary. The control of this disease is more and more difficult, because the rising resistance level against the commonly used active ingredient groups.

At present triazols, strobilurins, morfolins and combinations of them, as well as coppers are used against Cercospora. Until now they were effective against the disease.

Four years ago most authorized systemic fungicides were just perfectly effective in our field trials. In 2013 the mostly used Juvel and Tango Star gave weak defending effect but Sfera (not widespread in Hungary) was effective (AGRANA trial 2013).

In 2014 the efficiency of Sfera alone was extremely weak, but with copper showed proper effect (AGRANA trial 2014).

In 2015 the effects of the above-mentioned fungicides were practically vanishing. The contact fungicides (with copper) were the most effective against Cercospora in the trials.

The field trials were artificially infected with the mixture of Cercospora isolates from different growing regions of sugar beet in Hungary. Probably several local strains are not resistant to these fungicides but every year new information about ineffectiveness is received from the farmers.

The resistance level of different isolates are continuously examined in the Hungarian sugar beet research institute, and farmers are recommended for the suitable control.

5.14 LARS PERSSON, ÅSA OLSSON
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VERTICILLIUM WILT IN SUGAR BEETS IN SWEDEN

ABSTRACT

Sugar beet leaves with yellow chlorosis and wilt typically on one side of the leaf is commonly found in fields in Sweden. The cause of these symptoms has previously not been investigated in Sweden. Wilt in sugar beets was studied during 2012-2014. Plants, soil and fungal isolates from 152 sugar beets fields were analyzed using molecular tools and traditional technique. Analyses on root samples from biotests and wilted leaves from beet fields using PCR indicated that 13% of the fields were infected with *Verticillium* spp.. Analyses on isolates from infected leaves and stems of sugar beet and also oil seed rape indicated that *V. dahliae* dominated. Wilted sugar beet leaves from crop rotations with both sugar beet and potato had highest presence of *Verticillium* spp./*V. dahlia*.

5.15 BRAM HANSE[1], JOYCE H.C. WOUDENBERG[2], ELLEN VAN OORSCHOT[1]
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Diagnostics of *Stemphylium beticola* nom. prov. in sugar beet

ABSTRACT

Since 2007 yellow leaf spots appear on the leaves of sugar beet on fields in the Netherlands. The causal fungus was identified as *Stemphylium beticola* nom. prov. and cause sugar yield losses up to 40% in Dutch sugar beet production (Hanse, 2013, Hanse and Raaijmakers, 2014, Hanse *et al*., 2015). The first infestation appears in June-August on the leaves of sugar beet and is characterised by small, irregular, yellow spots. Subsequently, the yellow spots necrotise from inside out into a brownish tissue. The spots spread over the leaves and *Stemphylium beticola* nom. prov. infest the whole plant. Heavily infested leaves die and on the newly formed leaves new yellow spots appear. Due to the loss of leaves the canopy falls open and in case of a severe infestation the soil becomes visible in August-September. Due to the damage caused by this fungal infestation, the damage threshold is at the appearance of the first spots. It is important to distinguish yellow spots caused by *Stemphylium beticola* nom. prov. from all other yellow spots, caused by other pests, diseases and nutrient deficiency. This poster is aimed to facilitate the diagnostics of *Stemphylium beticola* nom. prov. in sugar beet in the field and laboratory.

5.16 BRAM HANSE
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STEMPHYLIUM IN SUGAR BEET – FACTORS INFLUENCING INFECTION

ABSTRACT

Since 2007 the yellow leaf spots identified as *Stemphylium beticola* nom. prov. cause sugar yield losses up to 40% in Dutch sugar beet production every year (Hanse, 2013, Hanse and Raaijmakers, 2014, Hanse *et al.*, 2015). The infestation appears in June-August on the leaves of sugar beet. From infested sugar beet leaves several isolates were obtained. Those isolates were used in climate room experiments to investigate the variability in tolerance of sugar beet varieties. Also experiments on the required circumstances for successful infection of sugar beet leaves by *Stemphylium beticola* nom. prov. are presented.

5.17 BRAM HANSE, ELMA RAAIJMAKERS
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RHIZOMANIA: SPREAD OF AND RESEARCH ON RESISTANCE BREAKING BNYVV TETRAD TYPES IN THE NETHERLANDS

ABSTRACT

Since 2004 rhizomania symptoms caused by BNYVV infection are observed in Rz1 (Holly) resistant sugar beet varieties on fields with the BNYVV A-type in the Netherlands. Since then, the number of fields increased gradually, monitored by the Diagnostic Service of the IRS (Institute of Sugar beet Research). All those fields had in common that rhizomania symptoms were found in Rz1 resistant sugar beet varieties. The resistance breaking of the most dominant P25 67-70 amino-acid tetrad variant was confirmed a few years later (Bornemann *et al.*, 2015). This AYPR tetrad of the BNYVV A-type is the most abundant tetrad among the samples in the Diagnostic Service. The degrees of infestation of those fields vary from a small spot to severe infestation of the whole field. Therefore field trials were conducted on fields with infestation of the AYPR variant, from 2011 to 2015, to compare yield levels of varieties with different levels of rhizomania-resistance. Besides the field trials a resistance test in the climate rooms was developed.

The spread of AYPR and other BNYVV A-type tetrads in the Netherlands together with results of field trials on infested fields and the resistance test are presented.

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OCCURRENCE OF VARIOUS TYPES OF BNYVV IN AUSTRIAN SOILS

ABSTRACT

Rhizomania of sugar beet is one of the most serious diseases in sugar beet occurring worldwide. The plant pathogen BNYVV can cause a considerable yield damage in heavily infested fields. The only effective mean to control the virus is the cultivation of resistant cultivars. Since several years, *Rz1* resistance breaking types of BNYVV were detected in different soils in USA and Europe. A monitoring of regions with intensive sugar beet cultivation accompanied by the occurrence of Rhizomania is therefore indispensable to identify potential sources of *Rz1* resistance breaking pathotypes. Here, we analysed soil samples taken from regions in the Eastern part of Austria where plants with *Rz1* resistance gene showed severe Rhizomania symptoms. In a greenhouse test BNYVV susceptible genotypes and genotypes with resistance genes *Rz1* and *Rz1+Rzx*, respectively, were grown in BNYVV infested soils and subsequently ELISA and pathotype analysis were performed. Analysis of the p25 tetrad combination revealed a broad spectrum of different types of the virus and can be allocated to different regions in Austria. Additionally, the presence of RNA 5 was tested. ELISA results demonstrated that lateral roots of susceptible plants clearly contained higher virus titres compared to the resistant genotypes and displayed variation in virus content depending on the region of the field sample. The knowledge of the distribution of the various types of BNYVV in Eastern Austrian soils will contribute to a better understanding of the spread of the various types of virus and may improve management of sugar beet cultivation.

5.19 MARK STEVENS
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A NOVEL PRE-BREEDING STRATEGY TO REDUCE DEPENDENCE ON INSECTICIDES FOR VIRUS YELLOWS CONTROL IN SUGAR BEET

ABSTRACT

Virus yellows remain a key problem for the UK because the maritime climate favours the survival of the aphid vector. The UK beet industry invests up to £7M annually on insecticides for aphid control, without which virus yellows could cause losses of up to 50% of the national crop each year.

Recent EU restrictions on neonicotinoid use, as well as the development of insecticide resistance in aphids elsewhere in Europe, threatens to increase the incidence of virus yellows in UK-grown sugar beet. Consequently, development of sugar beet varieties which are resistant or tolerant to virus yellow is a critical component of future control strategies.

The project team (BBRO, ADAS, SES Vanderhave and Syngenta) has identified several wild beet species that show resistance or tolerance to the effects of virus yellows. The project aims to develop these heritable resistance and tolerance traits further, by crossing such lines with modern commercial breeding lines. These new varieties will be tested rigorously for virus yellows resistance or tolerance, plant vigour and sugar yield. This five year pre-breeding project will accelerate production of new sugar beet varieties that provide host protection against virus yellows.

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INFLUENCE OF MINERAL NUTRITION AND CULTIVAR ON SUGAR BEET INFESTATION WITH THE ROOT APHID *PEMPHIGUS FUSCICORNIS* KOCH

ABSTRACT

Pemphigus fuscicornis (Koch, 1857) (Homoptera, Pemphigidae) is a pest of warm and dry regions worldwide. It is known as an important pest of sugar beet in Eastern Europe, mostly associated with fibrous roots, rather than the main one. Beside the outer symptoms of root aphid infestation, as wilting and yellowing of leaves, this pest causes looses in root weight together with reduction of sugar content. This study was conducted to determine the level of sugar beet root infestation caused by the root aphid, *P. fuscicornis*, in different cultivars of sugar beet, including different amounts of NPK fertilizers. Colonies of nymphs were monitored in plots with randomly chosen cultivars (1-8) and fertilization combinations (1. Without fertilization, 2. N_2, 3. P_2, 4. K_2, 5. N_2P_2, 6. N_2K_2, 7. P_2K_2, 8. $N_1P_1K_1$, 9. $N_1P_2K_1$, 10. $N_1P_2K_2$, 11. $N_2P_1K_1$, 12. $N_2P_2K_1$, 13. $N_2P_2K_2$, 14. $N_2P_3K_1$, 15. $N_2P_3K_3$, 16. $N_3P_1K_1$, 17. $N_3P_2K_1$, 18. $N_3P_2K_2$, 19. $N_3P_3K_2$, 20. $N_3P_3K_3$, where 1 stands for 50 kg/ha, 2 for 100 kg/ha and 3 for 150 kg/ha of pure element. Sugar beet roots attacked by root aphid were ranked from 0 (no attack) to 4 (high aphid population density). In general, most plants (more than 55%) were attacked by root aphid. At the same time, the infestation level was low, with most plants colonized with aphids only on individual root hairs (rank level 1). The lowest intensity of root aphid infestation was in nutrition containing only potassium, while the highest infestation was with nutrition which included higher dosages of all three essential elements.

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DYNAMICS OF NEMATODE POPULATIONS BY GROWING SUSCEPTIBLE, TOLERANT AND RESISTANT SUGAR BEET VARIETIES – RESULTS OF A NATIONWIDE SYSTEMATIC FIELD TRIAL IN GERMANY AND AUSTRIA 2012-2014

ABSTRACT

The beet cyst nematode *Heterodera schachtii* is the most important pest in sugar beet growing regions of Central Europe. Quantification of nematode populations in the soil requires elaborate methods of sampling. The widespread of different climatic conditions and soil types in the growing regions necessitates a large number of trial sites to get a well-balanced data-set to assess the effect of varieties on population dynamics of the nematode.

Differences in the dynamics of the nematode population were studied by growing a susceptible, a resistant and three tolerant sugar beet varieties in a systematic field trial. The nematode infestation levels were measured in two soil layers. Soil samples from topsoil (0-30 cm) and subsoil (30-60 cm) were analyzed to determine the number of eggs and larvae per 100 g of soil dry weight.

Results of about 50 sites in typical sugar beet growing areas over three trial years are shown describing effects of the different variety types on final nematode populations shortly after harvest.

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INTEGRATED CONTROL OF BEET CYST NEMATODES BY CATCH CROP CULTIVATION AND SUGAR BEET VARIETY CHOICE

ABSTRACT

Nematodes (*Heterodera schachtii*) are among the most severe pests in sugar beets in Northern Germany. 40 to 50% of all fields are estimated to be infested with *H. schachtii*. This estimation was confirmed by a monitoring program (12,000 soil samples analyzed). So far, the main measures to secure a high yield on nematode infested fields are growing (i) nematode resistant catch crops and (ii) nematode tolerant sugar beet varieties. Growing resistant sugar beet varieties is not yet very common due to the substantially lower yield of such varieties as derived from the German coordinated variety trials. The potential of each of the two measures (catch crop cultivation, sugar beet variety choice) separately and in combination for reducing the nematode infestation level has not been evaluated on field scale so far. Thus, in a series of field trials three variants (without catch crop, nematode resistant white mustard, catch crop mixture) were grown after cereal pre-crop followed by the cultivation of a susceptible, tolerant and resistant sugar beet variety each under different *H. schachtii* infestation levels. Nematode infestation was investigated before and after catch crop and sugar beet cultivation, respectively, and sugar beet yield was measured. Catch crop mixtures came up recently in Germany as growers may use them to fulfill the EU greening obligations.

The main results of the field trials were:

- The higher the nematode infestation the higher the yield loss was. In the susceptible variety yield loss was higher than in the tolerant and the resistant variety.
- Differently from the results of the German coordinated variety trials the resistant sugar beet variety performed as good as the tolerant variety!
- If the catch crop was not established well (e. g. sown late) the effect of both reducing nematodes and increasing sugar yield was very low or even not existing.
- Recommendations derived from these results are:
- Growers must know whether their fields are nematode infested or not, and how high the infestation level is.
- Resistant catch crops must be sown as early as possible in order to establish a good stand securing high nematode reduction and providing a positive yield effect in the subsequent sugar beet crop.
- In case of having a high nematode infestation level growing a resistant sugar beet variety is a suitable alternative to the tolerant varieties existing.
- The German coordinated variety trials (3-row-plots) do not properly establish the yield of varieties with decreased canopy growth such as the nematode resistant variety.

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ARE NEMATODE TOLERANT SUGAR BEET VARIETIES RESISTANT OR SUSCEPTIBLE TO THE BEET CYST NEMATODE *HETERODERA SCHACHTII*?

ABSTRACT

Heterodera schachtii is an important parasite compromising yield of sugar beet in many sugar beet growing areas of the world. To prevent reduction in yield next to standard nematode susceptible sugar beet varieties, there are resistant varieties, which can reduce initial infestation level but show no high yield potential. With the introduction of numerous so-called tolerant sugar beet varieties, there is now an option to earn high yield in nematode infested fields. Theoretically, this group of variety can react as susceptible or as resistant to nematodes. Therefore, in 15 locations of three years of field trials the nematode propagation factor pf/pi of five tolerant varieties was investigated. Our results demonstrate that the size of pf/pi of all tested tolerant varieties is between the nematode propagating susceptible reference variety and the nematode reducing resistant reference variety.

The varieties were classified as moderately or highly level susceptible (S1, S2, respectively) or as moderately or highly resistant (R1, R2, respectively). The triannual field trials show that tolerant varieties tend to respond moderately resistant rather than susceptible or highly resistant.

5.24 JONAS FISCHER[1,2], PASCAL KREMER[1,2], MARIE REUTHER[2], HANS-JOACHIM FUCHS[1], CHRISTIAN LANG[2]

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TEMPERATURE DEPENDENT DEVELOPMENT OF *HETERODERA SCHACHTII* IN A CHANGING CLIMATE IN SOUTHWEST GERMANY

ABSTRACT

The lifecycle duration of the beet cyst nematode (*Heterodera schachtii* sacc. Schmidt) notably depends on the soil temperature. According to Kochs (2014) respectively Curi & Zmoray (1965) 450-465°Cd to a base temperature of 8°C are required to complete one generation. The potential number of completed lifecycles per year was analyzed for the timeframe 2010-2015 and put in relation with the reproduction rate of *Heterodera schachtii* in related field trails. Therefore data of the daily mean temperature in 20 cm soil depth were taken from agrometeorological stations in the study area. All temperatures above 8°C were summed up and divided by 450. The result is that 2011-2015 potentially 4 generations could be completed per year.

The possible impact of climate change on the potential number of lifecycles of *Heterodera schachtii* was estimated by using REMO (REgional MOdel) climate projection data. For the impact assessment between the 1st of March and the 31th of October the daily mean temperature above 8°C was summed up annually. The following three time windows were compared: a baseline period 'B' (1971-2000), a medium-term period 'K' (2021-2050) and a long-term period 'L' (2071-2100). The results show an increase of the potential number of lifecycles of *Heterodera schachtii* due to the projected warming with obvious regional differences. On average in period B 3,3, in period K 3,7 and in period L 4,8 lifecycles could be completed potentially during one vegetation period. Due to that the regional importance of an appropriate nematode management will become more important in future.

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YIELD DEVELOPMENT IN ASSESSMENT TRIALS WITH NEMATODE TOLERANT VARIETIES

ABSTRACT

Value for Cultivation and Use (VCU) trials are carried out annually by the Austrian Agency for Health and Food Safety (AGES), Vienna. One of the main targets of these investigations is to characterize the incoming material on its tolerance against Cercospora, nematodes and Rhizomania. The occurrence of nematodes in Eastern Austria is described for well-known areas. Breeding for nematode tolerance achieved progress in root and sugar yield. Better results with new sugar beet genotypes as well as differentiation in the appearance of Rhizomania symptoms signalized changes, either in the virus concentration itself, or in its aggressiveness.

Results of the official assessment trials are summarized in a report, including the last three test years (2012-2015). An additional variety screening carried out in 2015 by AGRANA Research & Innovation Center, Tulln, focused on variety performance on heavily Rhizomania infested sites. Special attention was paid to the interaction between tolerance against Rhizomania and nematodes.

Compared to a standard variety, one genotype with extended tolerance against Rhizomania and two nematode tolerant cultivars were analyzed. Without pest and disease pressure, these genotypes exceeded the standard in sugar yield by 2% to 3%. Nematode infested sites showed an advantage for nematode tolerant cultivars of approximately 15 to 20%. Increase in sugar yield in a similar range can be achieved by extended tolerance against Rhizomania on heavily infested sites, free of nematodes. This yield progress allowed to close up to a usual yield level or even to exceed it. Severe occurrence of nematodes in heavily Rhizomania infested sites limited the performance of varieties only tolerant against one of the restricting factors, although sugar yield exceeded the standard by about 20%.Only one of the genotypes allowed to overcome the restrictions of both limiting factors, increasing yield by nearly 40%.

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ANTINEMATODE EFFECT (*HETERODERA SCHACHTII*) AND YIELDS OF SELECTED WHITE MUSTARD LINES AND VARIETIES CULTIVATED AS STUBBLE CATCH CROP ON BLACK EARTH IN POLAND

ABSTRACT

The aim of the investigation performed in 2013 and 2014 was to evaluate the antinematode effect and yields of double low white mustard lines, derived from the national breeding programme. Mustard lines were cultivated as a stubble catch crop, which is broadly exploited in crop rotation with root crops as green manure, antinematode factor and mulch. Four breeding lines of white mustard: PN1 (847/12), PN2 (518/12), PN3 (554/12), PN4 (563/12) and three cultivars: Nakielska, Sirola and Warta were included in the testing procedure. The field experiment was performed in a randomized complete block design, with four replications, on black earth with high beet cyst nematode density (1300-2400 eggs and larvae in 100 g of soil). White mustard was sown (20 kg seeds per ha) in the first week of August and harvested during the last week of October. On experimental site pre-sowing fertilization was applied in the following doses: 50 kg N per ha and 70 kg K per ha. Before plant sowing and during harvest soil samples were collected in order to determine the number of eggs and larvae of *Heterodera schachtii*.

The analysis of the average results from two years showed that in the white mustard lines group the line PN1 produced the highest fresh and dry matter yield of shoots and roots. The yields mentioned were similar to the yields of white mustard cultivar Warta, however smaller than the yields of cultivars Nakielska and Sirola. The population of beet cyst nematode in soil was most efficiently reduced by white mustard line PN4.

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NEMATODE SITUATION AND VARIETY TRIALS IN FINLAND

ABSTRACT

Many historical and structural facts on sugar beet farms have been limiting the crop rotation of those farms for years in Finland. And same time missing the good crop rotation has been increasing the nematode problems during the years in Finland. Nematodes were first recognized in Finland on 1960's and after that there have been many indications and studies that the populations are increasing.

In this short introduction to the nematode situation in Finland, we describe the nematode levels in different growing areas, the impact to the yield, and the use and yield levels of the nematode varieties in Finnish sugar beet growing conditions.

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CHEMICAL AND NONCHEMICAL STRATEGIES FOR SUSTAINABLE SUGAR BEET CYST NEMATODE MANAGEMENT IN IDAHO, USA

ABSTRACT

Sugar beet cyst nematode (SBCN), *Heterodera schachtii*, on sugar beet is the most serious pests on sugar beet in Idaho, USA. Chemical and non chemical strategies have been developed to manage the nematodes below the economic thresh old level. Most of the combination practices are commercially adapted by the growers which are environmentally safe and some of them are economically viable which include chemical treatments, new compounds and chemistries, trap crops, crop rotation, use of resistant varieties and seed coat treatment with biological nematicide. New tolerance varieties have been tested in field and greenhouse trials and have proven effective in increasing beet yield and reducing nematode populations. Low rate fumigation of Telone II has been tested in repeated field trials and has proven effective in reducing nematode populations and increasing sugar beet yield. Field trials that combined tolerant varieties and low rate fumigation of Telone II added an increased benefit to both management techniques. Several new products have been tried with the expectation of being effective at managing sugar beet cyst nematodes. Through a number of field efficacy trials we have determined that several new products such as BCS-AR83685, Movento and Nimitz have proven effective at reducing nematode populations. However, phytotoxicity complications in some products have negated the effects of the reduction of populations. New experiments have been proposed and are currently underway to address these concerns. Biological seed treatments in combination with tolerant variety field efficacy trials have also proven effective in sugar beet nematode management. Multiyear trap crops field and greenhouse experiments have also produced positive results with an increase in sugar beet yield and a decrease in nematode populations depending on the variety of trap crops chosen.

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CLARIVA™ SEED TREATMENT NEMATICIDE, A BREAKTHROUGH FOR SUGAR BEET PRODUCTION

ABSTRACT

Heterodera schachtii, the sugar beet nematode, is a persistent soil-borne pest which can cause serious stand and reduce root yields by up to 60% and build up over time to render fields unusable for sugar beet and some other crops. Lower levels of infection, which may present little or no visible symptoms can cause up to 10% root loss and begin a build-up in the soil which will cause problems in later years. The recent increased incidence of the problem is thought to be caused by the concentration of the beet growing area, a trend to closer rotations and increases in soil temperature. So far there is now no permitted active ingredient controlling for beet cyst nematodes.

Clariva™ contains the biological active ingredient Pasteuria nishizawae, a natural obligate bacterial parasite of nematodes. The product delivers long lasting activity via a unique mode of action causing immediate infection upon contact and resulting in reduced reproduction and death of the sugar beet cyst nematodes.

In addition, Clariva™ offers sugar beet growers the following key benefits:

- Clariva™ is a great fit to enhance the performance of sugar beet cyst tolerant varieties aiming to increase sugar yield
- Clariva™ may provide long-lasting activity, has an excellent safety and environmental profile, and is combined best in class insecticide and fungicide seed treatment package
- It works under a range of environmental conditions and is independent of soil pH, temperature and moisture conditions
- Through reduced nematode attacks to the root system, Clariva™ may provide an indirect yield effect by reducing interactions of fungal pathogens such as *Pythium* and *Rhizoctonia.*
- Clariva™ adds a key component to supplement current beet cyst nematode management practices such as crop rotation and the use of nematode tolerant varieties

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THE EFFECT OF THE E-TOLL ON THE SUGAR BEET LOGISTICS

ABSTRACT

The toll system which was introduced in 2013 has had a significant impact on the logistics process of the sugar beet in the production area of Magyar Cukor Zrt. since then. The e-toll increased the logistics costs of the road transport by 8% in average. The calculations have shown that the burden of the toll could be higher than the average, in some cases even by 30%. In case of sugar beet road transport option for the return load is minimal, and according to the regulation the toll has to be paid not only in case of loaded vehicles but for empty vehicles too, and this results in a further significant increase in the cost of the raw material logistics.

6.10 AGHAEI, M.[1], M. HONARVAR[1]*, M. MIZANI[1], AND M. BAZRAFSHAN[2]
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CHANGES IN TECHNOLOGICAL QUALITY OF SUGAR BEET (*BETA VULGARIS* L.) DURING ITS HARVEST AND LONG-TERM STORAGE IN FARS, IRAN

ABSTRACT

In Iran, sugar beet is purchased based on sugar content and fresh root weight. Due to the low capacities of sugar factories in Iran, and the farmers' rush to plant wheat, the harvested roots are kept in the farm silos nearby. Root storage near the farms under dry and semi-dry climate conditions would further dry the roots, and causes errors in the polarimetric method. The aim of this study, the effect of storage time (at harvest time, and at four subsequent one week intervals) and two sugar cultivars (Rosire from Florimond Desprez and Isella from KWS) was studied using factorial experiment with randomized complete block design. The results obtained showed that storage time had a significant effect on sugar content (SC), dry matter (DM), sodium (Na), potassium (K), amino-N (N), white sugar content (WSC), and molasses sugar (MS) for two cultivars. With increase in the period of root storage up to two weeks, SC, DM, WSC, Na, K, and N increased significantly due to moisture loss and dehydration. However, storage periods of up to three and four weeks decreased these variables due to decrease in temperature, rainfall occurrence, and increase in the relative humidity, and thus increase in the amount of moisture in roots. In general, sugar beet storage causes dehydration of their roots, and reduces their technological quality. Therefore, it is necessary to harvest sugar beet according to a scheduled program, and the carrying capacity of the factory.

6.11 SAMIR KHAYAMIM
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SUGAR BEET PROTEIN PATTERN UNDER SALINITY STRESS AT ESTABLISHMENT AND HARVEST TIME

ABSTRACT

Increase saline land in most regions of world and also in Iran cause to pay attention about research related to salt stress and produce tolerant varieties. Proteomics is suitable method for study molecular mechanism of proteins which include in crop acclimation to stress and nutrition deficiency. This study was conducted in order to evaluate sugar beet protein pattern as well as some physiological parameters under salinity stress to find out these parameters relationship in establishment (green-house) and harvest time of sugar beet in the field. Two sugar beet genotypes: Bp Karaj as tolerant and 452 as sensitive genotype which was selected among other genotypes in physiological studies, were studied at two electrical conductivity (1 and 16 dS/m) with factorial (greenhouse) and split pot designs (field) respectively. Samplings were taken at establishment growth stage for green house and maturity (harvest time) for the field trial. Protein extraction was preformed by TCA Acetone method. Extracted proteins were analyzed by two-dimensional gel electrophoresis (2-DE) with IPG gel (pH=4-7) at first dimension and Polyacrylamide gel 12.5% (SDS-PAGE) for second dimension. Silver Stain method was used to stain the gels and protein spots were compared by Melanie software. Bp Karaj and 452 had maximum and minimum root, white sugar yields and sugar content percentage among other genotypes respectively. More over physiological and biochemical parameters of these genotypes grouped them in salt tolerant and sensitive genotypes. Protein pattern showed that among 307 and 218 protein spots detected at establishment and maturity growth stages, 195 and 100 protein spots had significant and repeated changes in two genotypes under salt stress. Protein pattern of sensitive 452 geno-type changed more than tolerant one under salinity in the way, 167 and 98 protein spot in sensitive genotype, and 165 and 77 spots in tolerant genotype were detected during establishment and maturity stages.13 protein spots responded to salt stress at both growth stages. Down regulated proteins were more observed at establishment than harvest time. More over most physiological parameters were affected by salinity at establishment growth stage. So down regulated proteins may have relations with these physiological parameters? It can be concluded that sugar beet growth stage has very important role in protein pattern. Salt tolerant genotypes could be selected by planting in greenhouse and measure suitable parameters during establishment and also by genetic manipulating of physiological and biochemical parameters related to salt tolerance at this growth stage.

6.12 RYAD BENDOULA[1], ALEXIA GOBRECHT[1], ARNAUD DUCANCHEZ[2], ANA HERRERO-LANGERO[1], PABLO GUERRERO-CASTRO[1], JEAN-MICHEL ROGER[1]
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THE POTENTIAL OF AN INVASIVE BUT NON-DESTRUCTIVE FIBER-OPTIC PROBE FOR SOLUBLE SOLIDS CONTENT IN WHOLE SUGAR BEETS

ABSTRACT

Sugar beet is the second biggest world contributor to sugar production and the only one grown in Europe. Great efforts are currently being made to preserve and enhance its competitiveness. Within this context, one of the main bottlenecks identified is the lack of effective tools for assessing sugar content in unprocessed sugar beet roots. In the sugar industry, Near Infrared Spectroscopy (NIRS) is an approved method that has long been used to control product quality on sugar processing lines in both sugar beet and cane industrial processes. In sugar beet, the main work has been performed on beet brei samples although some authors studied the feasibility of predicting sucrose content of intact and sliced beets. Even though the results are relatively good, the beet peel is still a real problem to acquire signals of sufficient quality. Within the framework of AKER project, the objective of this work was to evaluate the use of a self-designed fiber-optic probe for the estimation of Soluble Solid Content (SSC) in intact sugar beets. Two geometries were tested: a single-fiber probe and a multiple-fiber probe. Total reflectance over the 400 – 2500 nm spectral range of 180 sugar beet samples were measured with both probes geometries. Immediately after spectrum acquisition, SSC measurements were achieved for each sample. Partial Least Square (PLS) algorithm was used to calibrate the SSC estimation of the sugar beets. Whereas the results with the single-fiber probes were not satisfactory, PLS regression models showed good performance in the estimation of SSC with the multiple-fiber probes. Results demonstrated good correlation between SSC and reflectance spectra for intact sugar beets with R2 values higher than 0.9 and a RPD higher than 3.30 Hence, these first results are very promising but further improvements are needed in order to achieve a satisfactory accuracy.

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TEREOS COMMUNICATE WITH HIS FARMERS ON THE YIELD CONSERVATION DURING THE BEET STORAGE

ABSTRACT

The cooperative Tereos led storage trials since 2003, in order to prepare the campaign lengthening. The summary of these 26 trials showed that rot is responsable of the main cause of losses during the storage, and that a 2% sugar loss is 'inevitable' The most determining factors have been identified and they have become the base of Tereos communication :

- Storage duration management according to the 250°C rule. The result of this is a recommanded harvest date according to loading date, weather forecast and mutiannual average temperature
- Injury limitation necessity during the harvest, those are responsable of rot developement.

Tradionnal well known factors:

- Root deases managment in the field
- Protection against frost

Tereos communicates regularly trough different media: AgroInfos (paper), Extranet (website), individual advices (oral).

TEREOS COMMUNIQUE AVEC SES PLANTEURS SUR LA CONSERVATION DU RENDEMENT PENDANT LE STOCKAGE

RESUME

La coopérative Tereos conduit des essais stockage depuis 2003 pour préparer l'allongement des campagnes. La synthèse de ces 26 essais a permis de démontrer que la pourriture est la principale cause de pertes en silo durant le stockage, et qu'une perte de 2% en sucre est « inévitable ». Les principaux déterminants ont été identifiés et sont devenus la base de la communication de Tereos :

- Gestion de la durée du stockage selon la règle des 250°C. Il en découle une date d'arrachage préconisée selon la date d'enlèvement, la météo prévisionnelle et la température moyenne pluriannuelle
- Nécessité de limiter les blessures lors de l'arrachage et de la mise en silo, celles-ci étant à l'origine du développement de pourritures.

Facteurs traditionnels bien connus :

- Gestion des maladies des racines au champ.
- Protection contre le gel.

Tereos communique régulièrement à travers plusieurs supports : AgroInfos (papier), site Extranet (web), reunions et conseil individual (oral).

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CHOPPED STRAW TO PROTECT BEET CLAMPS AGAINST FROST: TEREOS METHODS AND EXPERIENCES

ABSTRACT

Using chopped straw assures a sufficient protection against frost in northern France conditions. The straw application and its removal are mecanized. This technique is a good compromise between frost protection and workload.

Trials led by the Tereos agronomical team since 2009 showed advantages and inconveniences of each protecting techniques (black tarpaulin, toptex, straw), and defined the conditions for and efficient straw protection.

- Straw protection is adapted to all clamps forms, but the use of a beet cleaner is required.
- Straw protection has to be done by adapted machines (straw blower or silage harvester) to apply chopped straw (strand < 5 cm).
- A regular straw thickness (10 cm) has to be applied, i.e. between 700 and 800 kg straw for 100 tons of beets.
- The straw protection is efficient against frost and does not cause over-heating : temperature mesured just under the straw and in the heart of the clamp are similar to a toptex protected clamp.
- The sugar losses during a long term storage are equal for a straw and toptex protected clamp.

Since 2011, 3 million tonnes of beets were protected with straw by Tereos in France and Czech Republic, of which 1.3 million during the last campaign (2014) in France.

LA PAILLE HACHÉE PROTÈGE LES SILOS DE BETTERAVES CONTRE LE GEL : MÉTHODES ET EXPÉRIENCES DE TEREOS

RESUME

Le paillage en brins cours assure une protection suffisante contre le gel dans les conditions du nord de la France. La pose de la paille et son élimination sont mécanisées. Cette technique est un bon compromis protection contre le gel / charge de travail.

- Les essais réalisés par le service agronomique de Tereos depuis 2009 ont permis de montrer les avantages et inconvénients de chaque technique de protection (bâche noire, bâche toptex, paille), et de définir les conditions pour un paillage efficace.
- Le paillage s'adapte à toutes formes de silo, et à toutes formes de chargement à condition que le silo soit déterré.

- Le paillage doit être réalisé avec des machines adaptées (pailleuses ou ensileuses) afin de projeter sur le silo de la paille hachées en brins courts (<5 cm).
- Une épaisseur régulière de 10cm de paille de bonne qualité doit être appliquée, soit entre 700 et 800 kg de paille pour 100T de betteraves.
- Le paillage protège efficacement contre le gel et ne provoque pas d'échauffement : les variations de températures mesurées juste sous la paille et au cœur du silo sont similaires à celles mesurées dans un silo bâché « toptex ».
- Les pertes en sucre au cours d'un stockage long pour un silo paillé sont égales à celles d'un silo bâché « toptex ».

Depuis 2011, 3 millions de tonnes de betteraves ont été paillées par Tereos en France et en République Tchèque, dont 1.3 millions de tonnes au cours de la campagne 2014 en France.

6.4 ALEXIS TORDEUR, JEAN MICHEL CHASSINE, ADRIEN GOSSET
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THE 'NON COMMERCIAL BEET' (NCB) RATE: A MAJOR AGRONOMICAL INDICATOR

ABSTRACT

The simplified beet reception tested in 2013 and developped in each Tereos French refinery in 2014 is accompanied by the mesure of the 'Non Commercial Beet' (NCB) rate. The NCB are rotten beets or rotten parts of beets. It can be beets already rotten in the soil (rhizoctonia, ditylenchus nematods…) and non-eliminated during the harvest, or rot developed during storage (e.g. harvest impacts, non adapted storage duration, frost damage). The clamp NCB rate analysis received by Tereos in 2014 was highly instructive.

- We observed a good correlation between the NCB rate and the sum of daily temperatures during the storage. The 250°C rule to not exceed was confirmed.
- The clamps with high NCB rates and with short storage durations highlighted sectors more infected by roots deases.
- The clamps with low NCB rates and with long storage durations showed us agronomical practices contributing to a good beet storability.

The measurement of this new parameter during the beet reception offers an opportunity for a better comprehension of agronomical results of each field, and allows a better knowledge of potential sugar losses during the storage. It also gives the possibility to develop more precise and well adapted agronomical advice.

LE TAUX DE 'BETTERAVES NON COMMERCIALES' (NCB) : UN INDICATEUR AGRONOMIQUE MAJEUR

RESUME

La réception simplifiée des betteraves testées en 2013 puis généralisée à toutes les sucreries Tereos en 2014, s'accompagne de la mesure du taux de Betteraves Non Marchandes (BNM). Les BNM sont des betteraves ou parties de betteraves porteuses de pourritures. Il peut s'agir de pourritures déjà présentes au champ (rhizoctones, ditylenchus, rhizopus…) et non éliminées à l'arrachage ; ou de pourritures développées pendant le stockage (chocs à l'arrachage, durée de stockage inadaptée, défaut de protection contre le gel…). L'analyse du taux de BNM des silos réceptionnés par la coopérative Tereos en 2014 est riche en enseignements agronomiques.

- On observe une bonne corrélation entre taux de BNM et cumul de températures durant le stockage. La règle des 250°C cumulés est ainsi confortée.
- Les silos avec des taux de BNM élevés et des durées de stockage courtes permettent de caractériser des secteurs géographiques plus touchés par les maladies racinaires.

- Les silos avec des taux de BNM faibles mais des durées de stockages longs permettent la mise en avant de pratiques agronomiques favorisant la bonne conservation des betteraves.

La mesure de ce nouveau paramètre lors de la réception des betteraves permet une meilleure compréhension des résultats agronomiques de chaque parcelle et une meilleure appréhension des pertes potentielles en sucre au cours du stockage. Ceci favorise la mise en place de conseils agronomiques plus adaptés et plus précis.

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ABILITY OF SUGAR BEET VARIETIES TO THE LONG-TERM STORAGE: IMPROVEMENT OF THE IRBAB METHODOLOGY

ABSTRACT

The sugar beet long-term storage trials achieved by the IRBAB during these recent years have demonstrated that commercial sugar beet varieties sampled on the Belgian market have acceptable sugar yield losses during long-term storage provided they were kept for a period equivalent to 300 degree days (± 2 months at 5°C) and provided they were harvested with minimal root damage. An improvement of the IRBAB methodology was tested in 2015 to evaluate the varieties after a storage period equivalent to 450 degree days (± 3 months at 5°C), and according to different harvesting conditions.

APTITUDE DE VARIÉTÉS DE BETTERAVE SUCRIÈRE À LA CONSERVATION À LONG TERME : AMÉLIORATION DE LA MÉTHODOLOGIE DE L'IRBAB.

RESUME

Les essais de conservation à long terme de betteraves sucrière réalisés par l'IRBAB depuis ces dernières années ont observé que les variétés commerciales de betteraves échantillonnées récemment sur le marché belge présentent des pertes de poids sucre jugées acceptables pendant la conservation à long terme, pour autant qu'elles aient été conservées pendant une période équivalente à 300 degrés jours (± 2 mois à 5°C) et qu'elles aient été arrachées avec un minimum de dégâts aux racines. Une amélioration de la méthodologie de l'IRBAB a été expérimentée en 2015 pour évaluer les variétés après une période de conservation équivalente à 450 degrés jours (± 3 mois à 5°C), et selon différentes modalités d'arrachage.

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IMPACT OF HARVEST TECHNOLOGY ON STORAGE ROT FORMATION AND INVERT SUGAR ACCUMULATION DURING LONG-TERM STORAGE OF SUGAR BEET

ABSTRACT

During storage in field clamps, the processing quality of sugar beets is significantly reduced due to storage rot formation and invert sugar accumulation. As wounds represent entry sites for pathogens and saprophytic microorganisms, harvesting technology might pose a significant influence on the development of storage rot and white sugar yield losses. To detect possible effects of eight different selfpropelled harvesters on these parameters, sugar beets were sampled from a harvester demonstration field trial in Poland. Storage at 8°C was conducted in climate containers for 5 and 12 weeks. The results indicated a significant influence of the harvester technique on storage rot formation and invert sugar content. Further trials in a randomized design with field repetitions need to be performed to support these findings.

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CAMPAIGN LENGTH AND SUGAR CONTENT OF ROTTEN BEETS

ABSTRACT

The extension of the campaign length and the question of increasing of rotten beets is a real subject, a subject that is going to be expanding in the future. This subject has led us to consider the sugar content of these rotten beets. The current rule in France is to remove the rotten beets or rotten parts of beets in the tare house. That means, rotten beets are considered to have no commercial value and a sugar content equal to 0° S. ARTB conducted trials in 2013-14 and 2014-15 in order to measure the sugar content in rotten beets or beets parts by polarimetry, and to compare with the chemical content of sucrose measured by HPLC. Results will be presented.

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THE KINETICS OF CHANGES IN THE QUALITY OF FROST DAMAGED SUGAR BEET

ABSTRACT

The aim of this study was to determine the kinetics of changes in the technical quality of frost damaged sugar beet with particular emphasis on the content of dextran, glucose, fructose, acetic acid and lactic acid. The frozen and no frozen sugar beets were stored at constant temperatures: 4°C, 12°C and 20°C during 100 days.

In our research the greatest deterioration in the quality of sugar beet occurred in frost damaged beets. These changes always increased with increasing storage temperature. In the case of beets damaged by frost, cell juice is flowing out and it creates favorable conditions for the growth of microorganisms and formation of harmfull metabolites such as dextran or organic acids.

The studies carried out show a significant deterioration in the quality of sugar beets as a result of damage of the beets caused by frost. Hence, it is of particular importance to take care to preserve the good conditions during storage to prevent the formation of large amounts of dextran.

The present work shows that frost and thawing of beets have a great impact on their quality. As a result of defrosting during storage, there is a significant increase of undesirable compounds which adversely affect the technological process. In frost damaged beets changes occur more intensely compared to normal healthy beets. Apart from the length of the storage, the temperature value in the prism has a major influence on the formation of undesirable substances such as dextran and lactic and acetic acids.

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SUGAR BEET ROOT YIELD ESTIMATION BY REMOTE SENSING DATA

ABSTRACT

Estimating the potential crop yields greatly benefits strategic planning for developed and developing countries. Remote sensing could successfully be used for yield estimation. The objective of this investigation was to develop a robust technique to forecast sugar beet root yield (RY). This study evaluated capabilities of the Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Index 250-m 16 day composite (MOD13Q1) and MODIS surface reflectance 250-m 8 day composite (MOD09Q1) to track and retrieve information over sugar beet fields at Eqlid county, Fars province, Iran. Vegetation indices (VIs) were calculated from remotely sensed data. VI time series were obtained from several single day and temporal cumulative values. Correlation and regression analyses were performed using VI values as the independent variables and field level RY as the dependent variable. Results demonstrated that power regression models best described the relationship between RY and VIs from MOD13Q1. The best yield estimation equations were found based on temporal cumulative VI values on 241 day of year (late August). MOD13Q1 can be successfully used to forecast sugar beet RY with good accuracy. The best time for making RY forecasting was 30 to 50 days before harvest. It can be concluded that VIs derived from remote sensing data can be an effective tool for sugar beet RY estimation before harvesting time.

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SYPPRE PROJECT: DEVELOPMENT AND TEST OF INNOVATIVE CROP SYSTEMS IN FIELD CROPS AREAS

ABSTRACT

Syppre is a new and huge project shared by three technical institutes in France, Arvalis-Institut du Végétal (cereals, potato), Terres-Inovia (oil seeds, protein crops), and ITB for sugar beet. The objective is to make our institutes work together at crop system scale, first to get knowledge of today systems and evaluate them, and secondly to imagine new systems involving new cultivation techniques, with the aim of combining productivity, economical sustainability, and environment respect. Innovative systems will be tested in large long term field trials and leaded by technical institutes. Two experimental platforms, among five, integrate sugar beet, in Picardie and in Champagne regions. The first step was the construction of innovative crops systems, which was achieved with regional agriculture actors. For the selection of the most promising ones, systems were evaluated through Systerre® tool implementation. Field experimental device are set up and first measurements being obtained.

The whole project intends to be a place for knowledge acquisition, for communication and exchange with farmers, development technicians and agriculture and agro industry actors. It will be a place for demonstrations of new cultivation techniques. The ambition is also to welcome scientific projects on an original long term experimental site. The project is intended to run for at least 15 years.