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Forschung & Entwicklung für eine bedarfsgerechte und umweltschonende Pflanzenernährung
Recherche & développement pour une nutrition des plantes adaptée aux besoins et respectueuse de l'environnement

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Vorträge / Exposés

Hinweis :
Beiträge in ausschliesslicher wissenschaftlicher Verantwortung der jeweiligen Autoren.
Les auteurs portent la responsabilité scientifique de leur contribution.

Posters

V-1 STRATÉGIES DE NUTRITION DES CULTURES DANS LE CADRE DE L'INTENSIFICATION ÉCOLOGIQUE

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Le défi majeur de l'agriculture de demain est de nourrir une population mondiale beaucoup plus élevée de façon durable, en utilisant en particulier les ressources naturelles d'une manière plus efficace. L'intensification écologique de la production végétale pourrait contribuer à atteindre ce but. Pour Bommarco et al. (2013) l'intensification écologique est une gestion des services écosystémiques de régulation et de support permettant de remplacer des apports anthropogènes et/ou améliorer la productivité des cultures. De façon spécifique pour van Noordwijk and Brussaard (2014), l'intensification écologique doit à la fois permettre de combler l'écart existant entre les rendements observés en milieu paysan et les rendements pouvant être « facilement » atteints (surtout dans les pays en voie de développement), et d'augmenter l'efficacité d'utilisation de l'eau et des éléments nutritifs pour diminuer les effets négatifs sur l'environnement (ce qui concerne toutes les agricultures). Selon Doré et al (2011) l'intensification écologique nécessite la mise en œuvre de toutes les découvertes scientifiques dans le domaine du végétal et du sol, une profonde connaissance du fonctionnement des systèmes naturels (qui sont par définition durables) et une véritable prise en compte des savoirs locaux.
Cette présentation va discuter des options permettant d'assurer la nutrition des cultures dans le cadre de l'intensification écologique de la production végétale depuis le niveau parcellaire jusqu'au niveau régional. Au niveau parcellaire le choix du cultivar va affecter l'acquisition et l'utilisation des éléments que ce soit en culture pure ou en mélanges. De même la microflore du sol et l'apport de nouveaux microorganismes peuvent améliorer la disponibilité et la capture des éléments par les cultures. Les variations spatiales souvent fortes des propriétés de sol au niveau parcellaire vont fortement influencer la disponibilité des éléments et leur capture par la plante. Les techniques d'agriculture de précision peuvent permettre d'adapter les apports au plus près des besoins. Dans un deuxième temps l'effet du système de culture dans son ensemble sur l'efficacité d'utilisation des éléments par les cultures sera discuté. Enfin les possibilités de recyclage local du N et du P sous forme de struvite ou/et de produits issus de cendres de boues d'épuration des milieux urbains vers les systèmes de déchets seront abordés.

Bommarco R, Kleijn D, Potts SG: Ecological intensification: harnessing ecosystem services for food security. Trends Ecol. Evol., 2013, 28,230-238
Doré T, Makowski D, Malézieux E, Munier-Jolain N, Tchamitchian M, Tittonell P: Facing up to the paradigm of ecological intensification in agronomy: revisiting methods, concepts and knowledge. Eur. J. Agron., 2011, 34, 197-210.
van Noordwijk M, Brussaard L: Minimizing the ecological footprint of food: closing yield and efficiency gaps simultaneously? Curr. Opin. Environ. Sustain., 2014, 8, 62–70.

V-5 CAN INOCULATION WITH PSEUDOMONAS PROTEGENS CHA0 ENHANCE THE MOBILIZATION OF PHOSPHORUS FROM SOIL AND SEWAGE SLUDGE ASH?

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Phosphorus availability to plants in calcareous soil is often limited due to fixation of P in soil solution with calcium. To increase the P use efficiency in the field, fostering microbial P mobilization holds promises to increase the P availability to plants from non-soluble P forms in soil by mineralization of organic P and solubilization of inorganic P. Especially microorganisms which showing high P solubilizing activities holds promising to be added to soil-plant systems as bio-inoculants.

We studied the effect of a P solubilizing bacteria with plant growth promoting abilities, the trains Pseudomonas protegens CHA0, on the availability of P from soil and thermos-chemical treated sewage sludge ash (SSA) in an incubation and plant growth study with Lolium multiflorum. We expected that due to acidification and chelation of Ca^{2+} with gluconic acid produced by P. protegens CHA0 that the inoculant would increase the availability of P from otherwise non soluble P forms and thus, increase the P uptake by Lolium multiflorum from soil and SSA P. The strain CHA0 was able to solubilize P from SSA under controlled conditions in liquid media, but did not enhance P mobilization in soil or from P contained in SSA. In presence of the inoculant organic P mineralization was reduced as soil respiration decreased supposing inhibition of inherent microbial activity. However, any inorganic P solubilized by the inoculant might have been offset by less basal organic P mineralization. Lolium multiflorum took up more P in the first cut when inoculated with CHA0. This increased P uptake we assigned to reduced pathogenic pressure in the rhizosphere and not due to increased P availability from soil or SSA. Total P uptake of Lolium multiflorum of three harvests was not affected by the inoculant CHA0 and is in line with reduced microbial P mineralization rates measured in the incubation study. Low survival rate of the inoculant was measured as no culturable CHA0 cells were detectable on roots of Lolium multiflorum after the third harvest and in the incubated soil 60 days after inoculation. Inoculating a microbial active calcareous soil with the P solubilizing bacteria P. protegens CHA0 did not increase P availability to Lolium multiflorum and further attempts are needed to identify constraints for P solubilization by bio-inoculants in soil, e.g., under reduced microbial activity by using sterilized soil and testing other host plants than Lolium multiflorum.

V-7 NUTRIENT ACCUMULATION BY COVER CROPS WITH DIFFERENT ROOT AND SHOOT CHARACTERISTICS

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Cover crops protect the soil between two main crops and can provide many agrosystemic services including soil fertility improvement. Cover crops play a crucial role in the cycle of nutrients. They are able to accumulate large amounts of nutrients and therefore prevent their loss. The major part of the nutrients accumulated by cover crops is then available for the subsequent crop through the decomposition of the biomass and the mineralization of the residues. However, uptake capacity differs widely among cover crop species, and a characterization of the plant traits involved in nutrient accumulation is required. Thus, the objectives of the current study are to characterize nutrient uptake capacity of a wide range of cover crop species and to determine how root and shoot traits influence this uptake. A field experiment was conducted in non-limiting fertility conditions to describe 20 species from different botanical families. Several leaf traits, such as specific leaf area, were measured. Shoot biomass production was assessed before winter, at 85 days after sowing. To characterize cover crop root system, soil cores were taken from each plot up to a depth of 50 cm. After root washing, image analysis using WinRhizo was performed to determine root length, area and mean diameter. To investigate the relationship between plant characteristics and nutrient uptake, a redundancy analysis (RDA) was performed. The scores of the two first axis of the RDA were used in a cluster analysis in order to delineate groups of species with similar characteristics.

Large differences in nutrient uptake were evidenced. Substantial amounts of nutrients, about 120 kg ha^{-1} of N, 30 kg ha^{-1} of P and 190 kg ha^{-1} of K, were accumulated by phacelia, sunflower, niger, daikon radish and faba bean in three months. These species showed either high shoot biomass or high nutrient concentration. Contrasting root systems were observed. Some species exhibited a big taproot with high root mass, while others were characterized by a fibrous root system with high root length. We observed that high shoot biomass was linked to high root mass and dense root tissues, whereas high P, K and Ca concentrations were related to large root length density and root area. Five nutrient acquisition strategies could be individualized by the cluster analysis. Among these strategies, three groups showed comparable high accumulation of all nutrients, despite different plant traits and nutrient concentrations. In non-limiting fertility conditions, species such as sunflower or faba bean, producing high root and shoot biomass, or phacelia, which was characterized by high nutrient concentrations and high root length density, would be recommended.

V-8 MYKORRHIZA-GESTÜTZTE PFLANZENERNÄHRUNG – NICHT OHNE UNSER ZUTUN!

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In der Anwendung werden die grundsätzlich in jedem Boden natürlich vorkommenden arbuskulären Mykorrhizapilze vorab als nutzbringende Nährstoffversorger von Kultur- und Wildpflanzen gesehen. Aber sind sie das auch wirklich per se im Kontext einer Produktionslandwirtschaft? Anhand von Gewächshausversuchen mit Modellpflanzen konnten wir zeigen, dass die Gesamt-, sowie Mykorrhizapilz-vermittelte Stickstoff- und Phosphataufnahme durch Zugabe von Phosphatdünger oder Freisetzung von Nährstoffen nach Bodensterilisation bedeutend gesteigert werden können, dies sich aber nicht zwingend in höheren Biomasseerträgen niederschlägt. Auf einer tieferen quantitativen Ebene steigerte auch Vermischen eines sandigen und organischen Bodens das Pflanzenwachstum. Die totale und Mykorrhizapilz-vermittelte Pflanzenernährung stieg nach Bodenvermischung ebenfalls. Die natürlich vorkommenden Mykorrhizapilze des sandigen Bodens begünstigten sowohl das Pflanzenwachstum als auch die Phosphataufnahme der Pflanzen, hielten aber längerfristig auch sehr viel Phosphat- und Stickstoff in den kolonisierten Wurzeln zurück. Der organische Boden musste entweder sterilisiert oder mit sandigem Boden vermischt werden damit mit Verzögerung Pflanzenwachstum und Phosphataufnahme zunahmen. Wir folgern, dass arbuskuläre Mykorrhizapilze die pflanzliche Phosphat- und möglicherweise auch Stickstoffaufnahme nur fördern können, wenn diese Nährstoffe für sie verfügbar gemacht werden - sei es durch Düngung oder physikochemische und biologische Bodenstörung. Die Bodenmatrix, das übrige Bodenleben, wie auch die Mykorrhizapilze selber, sind eine grosse nicht zu vernachlässigende die Pflanzenernährung konkurrierende Nährstoffsenke. – Kurz, die allgegenwärtigen arbuskulären Mykorrhizapilze brauchen unsere Unterstützung, um für eine nachhaltige Pflanzenproduktion nützlich zu werden - welche Massnahmen die besten sind, ist jedoch immer noch eine unbeantwortete Frage, da unser biologisch-ökologisches Verständnis der Funktionsweise des Boden-Mikroben-Pflanzensystems noch sehr mangelhaft ist. Vermutlich sollten in der Pflanzenzüchtung für eine verbesserte Nährstoffaufnahme gezielt auch Wurzel-Mikroben-Wechselwirkungen optimiert werden.

V-9 THE FATE OF CADMIUM IN SWISS AGRICULTURAL SYSTEMS

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The application of P-fertilizer leads to an unintended input of Cadmium (Cd) into agricultural systems where it can be immobilized by the soil, washed into the ground water or taken up by plants. Cadmium is toxic for plants and humans and it can reach a biological half life time of up to 10 years in human bodies. Consequently, relatively small contents of Cd in edible parts of crops can pose a risk for human health due to its accumulative characteristics. Long term observations conducted by Swiss Soil Monitoring Network (NABO) revealed that Cd concentrations in Swiss agricultural soils have not changed in the last decades despite the fact that 45% of the P-fertilizers used in Switzerland exceeded the Swiss ChemRRV limit of Cd (FitzGerald & Roth 2015). The goal of this study was to gain information about the fate of Cd in Swiss soil-fertilizer-plant systems under controlled conditions and further integrate these data into Cd-budgets compiled on agricultural scale conducted by the soil science group of the University of Berne.

The use of isotopes as tracers enables to quantify contributions of different sources (e.g. soil, fertilizer) to the sink if interest (e.g. plant parts). For that purpose, a P-fertilizer was labelled with a Cd radioisotope (109Cd) and introduced into three soils from the NABO long term study sites varying in soil pH and texture. Straw and grains of wheat (*Triticum aestivum L., cv. "Fiorina"*) was harvested at full maturity and analyzed for Cd concentrations and 109Cd was traced using gamma-ray spectroscopy.

The results showed that Cd concentrations in shoots (0.06 to 0.2 mg/kg dry matter) were significantly higher than in grains (0.023 to 0.1), consequently more Cd accumulated in the straw (0.3 to 1.2Âµg Cd/kg of dry soil) compared to the grains (0.25 to 1). Gamma ray measurements revealed that 8% to 17% of the Cd in the shoot and 4% to 11% of the Cd in the grain derived from the fertilizer. Additionally, the fertilizer recovery was calculated and revealed that only a small fraction of the Cd introduced is taken up by the plant (0.5% to 2%) implying that most Cd introduced fertilizer remains in the soil (98% to 99.5%).

The different Cd concentrations and Cd quantities in straw and grain show that Cd is retained in the shoot. The ranges of concentrations and quantities of Cd between the different soils are a consequence of different pH values in the soils which determines the plant avail.

V-10 L'ART DE FRACTIONNER L'AZOTE POUR OPTIMISER LE RENDEMENT ET LA QUALITÉ DU BLÉ

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Afin d'améliorer la teneur en protéines des récoltes, l'interprofession des céréales a instauré depuis 2015 un système de paiement à la protéine sur les récoltes de blés de la classe Top. Agroscope a mis en place des essais pour étudier l'impact du fractionnement de la fumure azotée sur le rendement et la qualité du blé.
Les objectifs de l'étude étaient :

- de tester différentes possibilités d'augmenter la quantité de gluten humide et de protéines,
- de voir à quel point ce critère influence les critères rhéologiques et la qualité boulangère,
- de déterminer la conduite qui mènera à un optimum entre rendement en grain et qualité,
- et finalement de vérifier quelles stratégies sont les plus efficaces en termes de valorisation de l'azote.

Six variétés de diverses classes de qualité de blé d'automne ont été testées en deux lieux pendant trois ans (récoltes 2011 à 2013). Huit procédés de fumure azotée (sous forme de nitrate d'ammoniaque) ont été comparés: trois niveaux de fumure 0,140 et 200 kg N/ha combinés avec différentes variantes de fractionnement. Le premier apport a été donné à la reprise de la végétation, le 2e au stade redressement (épi à 1 cm) et le 3e (procédés P3 à P8) au moment de l'apparition de la dernière feuille (DF) ou à la floraison (FLO). L'efficacité de l'apport azoté a pu être assurée par une irrigation post-application à Changins, mais pas à Goumoëns. Une fumure azotée est nécessaire pour atteindre un niveau de rendement en grains et une teneur en protéines convenables. Parmi les procédés à 140 kg N/ha répartis en 3 apports, le procédé P5 permet de concilier le mieux teneur en protéines et rendement. Ce fractionnement est préconisé pour les agriculteurs souhaitant cultiver des variétés de classes Top. Les producteurs désireux de produire des grains à haute teneur en protéines peuvent être tentés de choisir les variétés les plus riches en protéines et de les conduire de façon très intensive avec un 3^{e} apport important au moment de la floraison. Toutefois, cette stratégie présente un risque très élevé de non assimilation de l'azote par la plante et de perte de rendement en grains.
Les variétés étudiées varient fortement quant à leur efficacité d'utilisation des apports d'azote. CH Combin, par exemple, utilise beaucoup mieux la fumure azotée que Runal. La répartition de la fumure azotée influence également le CAU (Coefficient Apparent de l'Utilisation de l'azote) dans les grains. Dans nos essais, le procédé P5 a été le plus efficace, les grains ayant valorisé environ la moitié de la quantité d'azote apportée. Les 60 kg N/ha supplémentaires apportés dans les deux procédés les plus intensifs (P7 et P8) ont été relativement mal valorisés (CAU plus faibles).

Du point de vue économique, la variante P2, avec seulement deux apports, est la plus intéressante, suivie de près par le procédé P5. Les apports au stade floraison sont peu rentables quelle que soit la dose appliquée.

Le fractionnement en trois apports d'azote au lieu de deux augmente significativement la teneur en gluten humide ainsi que la qualité des protéines (indice de Zeleny, volume des pains issus des trois tests de panification). Ainsi, pour produire des blés de la qualité Top, la pratique d'un fractionnement en trois apports (20-40-80 kg N/ha, avec un dernier apport au moment de l'apparition de la dernière feuille) est vivement recommandée. L'augmentation de la teneur en protéines obtenue dans certains procédés azotés intensifs ne s'accompagne pas d'une amélioration de la qualité du gluten: l'indice de Zeleny, la force de la pâte, l'index de gluten et le volume du pain en pousse froide stagnent, voire diminuent avec l'intensification de la fumure azotée. Ce résultat peut s'expliquer par une stagnation de la proportion des gluténines, ainsi que par une diminution significative des gliadines au profit des albumines et des globulines.

Le choix variétal reste le facteur le plus facile à maîtriser pour améliorer la teneur en protéines. 05 10 15 20 25 30 35 40 Gluténines HPM Gluténines FPM Gliadines Albumines & Globulines %.

P-1 GENOTYPE X ENVIRONMENT INTERACTIONS UNDERLINE THE NEED FOR MULTI-LOCATION TRIALS FOR FUSARIUM HEAD BLIGHT RESISTANCE ASSESSMENT

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Fusarium head blight (FHB) is a major disease of wheat worldwide. Fusarium graminearum (FG), the most prominent FHB pathogen, causes yield losses but also deoxynivalenol (DON) mycotoxin accumulation in the grains. Fungicide application has proven to be unreliable to control the disease. FHB control is usually based on cultural methods such as crop rotation and deep ploughing. Choosing a resistant variety is an easy way for the farmer to limit damages to the crop by FHB. In spite of the progress in marker assisted selection, resistance trials remain essential in assessing the resistance of new candidate cultivars. In order to assess the need for multi-location trials, visual symptoms of FHB on 11 Swiss varieties inoculated with FG have been rated at 2 locations and for 4 years. DON contamination has been measured on 8 varieties and for 3 years. Highly significant GxE interactions have been detected. For one cultivar, visual disease symptoms were much stronger in one of the locations. GxE interaction effects on DON production were even more striking. Some cultivars accumulated relatively small amounts of DON in one location while accumulating important amounts of DON in the other location. Overall, the present results emphasize the need for multi-location assessment trials.

P-2 MONITORING DES MUTTERKORN-BESATZES IM ROGGENSAATGUT

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Offene Ährchen vor allem von Roggen werden während der Blüte durch Ascosporen des Mutterkornpilzes Clavisceps purpurea infiziert. Anstelle der Körner bilden sich dunkelviolette, hornförmige Mutterkornsklerotien. Diese enthalten Alkaloide wie Ergotamin, die für Mensch und Tier giftig sind. Im Mittelalter trat Ergotismus (sog. Antoniusfeuer oder Kribbelkrankheit) nach dem Verzehr von kontaminiertem Brotgetreide meistens in feuchten Jahren auf. Für die Pharmaindustrie wurden in der Schweiz Mitte der 50-iger Jahre 950 Hektaren Roggen künstlich infiziert.

In den Übernahmebedingungen von Brotgetreide sind maximal 0,05% Gewichtsprozente im Schwarzbesatz toleriert. In der Saatgutqualitätsprüfung ist im Basissaatgut der verschiedenen Getreidearten maximal ein Mutterkornsklerotium in den untersuchten 500 g erlaubt. Im zertifizierten Saatgut der 1. und 2. Vermehrung sind es drei Mutterkornsklerotien in 500 g. Bei Hybridroggen und Hybridgerste sind wegen der Fremdbefruchtung und der damit verlängerten Blühzeit vier Mutterkornsklerotien im Gebrauchssaatgut der 1. Vermehrung toleriert.

Unsere Auswertung der Reinheitsanalysen von Roggen Saatgutposten der Kampagnen 2003 bis 2015 zeigte, dass in ungereinigten Einsendemustern vereinzelt ein sehr hoher Mutterkornbesatz (> 100 Sklerotien) beobachtet werden kann. Extrem trockene Witterung wie im 2003 oder niederschlagsreiche Witterung wie im 2010 und 2012 begünstigen die Infektion. Mit der Saatgutreinigung wird der Besatz sehr deutlich reduziert. Ab der Kampagne 2007 mussten wir keine Saatgutposten wegen zu hohem Besatz mit Mutterkorn aberkennen.

Neue Hybridroggensorten mit verbesserter Infektionsresistenz gegenüber Clavisceps purpurea in Kombination mit der PollenPlus®-Technologie haben sich in der Praxis durchgesetzt. Diese Technologie bewirkt eine grössere Pollenproduktion und damit einen schnelleren Spelzenschluss. Die Hybridroggensorte Palazzo ist seit der Kampagne 2010 in der Vermehrung und ist aktuell unsere Hauptsorte. Mit Farbauslesern können Mutterkörner aus stark belasteten Posten in der Saatgutaufbereitung als auch beim Brotgetreide gezielt eliminiert werden. Wirksame Hygienemassnahmen wie die Verbrennung des Schwarzbesatzes sowie das Abmähen der Gräser am Feldrand vermindern den Infektionsdruck.

Die Saatgutkontrolle unterstützt mit ihrer Qualitätssicherung die Produktion von zertifiziertem Saatgut und sichert bezüglich Mutterkornbesatz das gesunde Brot- und Futtergetreide für Mensch und Tier.

P-3 IMPACT OF FUSARIUM INFECTIONS ON BETA-GLUCANS IN BARLEY GRAINS

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Barley grains can provide elevated quantities of ÃŸ- glucans, a soluble fibre recognized to provide benefits for human health. Barley products containing enhanced contents of ÃŸ-glucans are now receiving an increasing interest from consumers. Barley plants are also hosts for Fusarium pathogens, causing Fusarium head blight and accumulating mycotoxins in grains. As these Fusarium pathogens affect properties of the grains, this study aims at investigating modifications of ÃŸ- glucan content in grains in case of infections. For that, six winter barley varieties were artificially infected in field trials with a DON producing strains of Fusarium graminearum, in three sites across Switzerland. Success of infection was controlled by Fusarium Head Blight symptoms on spikes. After harvest, Thousand Kernel Weight (TKW) were compared between infected and non-infected grains to evaluate changes in morphological properties of grains due to the infections. DON accumulation was measured as well as ÃŸ- glucan content in both infected and non-infected grains. Our results indicate that ÃŸ- glucan content decreased with infection and this in all varieties. The decrease was correlated with the loss of TKW in infected samples and stronger in susceptible varieties. Surprisingly, in varieties with elevated ÃŸ-glucan content, we detected lower concentrations of the mycotoxin DON. To further study a possible role of ÃŸ- glucan in DON accumulation, additional barley varieties with a broad range of ÃŸ- glucan content will be tested in the same experimental display.

P-4 THE RYEGRASS MICROBIOME - HIDDEN LIFE IN AND ON LEAVES

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Ryegrasses (*Lolium spp.*) are important components of pastures and meadows and have great impact on grassland-based agriculture. They are vulnerable to various bacterial and fungal pathogens including *Xanthomonas translucens pv. graminis* or *Puccinia coronata*. Great efforts have been made to study the pathogen-*Lolium* interaction and to identify host-resistance and pathogen-virulence. However, apart from fungal endophytes, little attention has been paid to interactions of *Lolium* spp. with symbiotic or commensal microbes. The plant microbiome, i.e. the entity of plant associated microorganisms, has been shown to substantially influence plant performance and resistance against pathogens. While considerable effort has been made to describe the root microbiome of various plants, little information is available on the leaf microbiome of grassland species.

The overall aim of this project is to gain a better understanding of the diversity of bacterial phyllosphere communities associated with *Lolium spp.* in grassland. In a first step, we aimed at separating epiphytic from endophytic communities and adapting a sequencing approach based on the 16S ribosomal RNA gene.

Plant leaves were washed in a phosphate buffer combined with a sonication treatment. The adhesion of bacteria to plant surfaces was analysed. Repeated washing distinctly reduced the amount of bacteria detected in the buffer solution. However, ribosomal intergenic spacer analysis (RISA) revealed no apparent changes in bacterial community composition.

In order to enable massive parallel sequencing of bacterial communities from whole plant tissue, universal 16S rRNA gene primers were applied. The PCR was supplemented with specifically designed peptide nucleid acid (PNA) probes to reduce the amplification of plant organelles. PNAs are designed to bind to mitochondria (mPNA) or chloroplast (pPNA) DNA and function as sequence specific PCR blockers. The amplicons were sequenced on the Illumina MiSeq platform.

First results indicate a successful reduction of amplicons from plant organelles by adding PNAs to the PCR reaction. An eightfold increase of bacterial reads could be achieved in samples where PNAs were added. In total, 247 bacterial operational taxonomic units (OTU) were derived from 12’280 bacterial reads, including known phyllosphere genera such as *Pseudomonas*, *Sphingomonas*, *Methylobacterium* and *Agrobacterium*.

Furthermore, no loss of OTUs could be observed due to PNA addition. Thus, PNAs offer a powerful tool to decrease organelle reads in plant samples and therefore allow to detect microbial communities in and on leaf material. This opens the way for detailed investigations of the *Lolium* leaf microbiome in different environments and on different genotypes.

P-5 GWAS OF THE DYNAMIC RESPONSES OF CANOPY COVER AND PLANT HEIGHT TO TEMPERATURE

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Breeding for future crop varieties requires better understanding on the dynamic responses of crop growth to temperature and climate change, which is increasingly bringing about extreme climate phenomena and often results in reductions in crop productivity and grain quality. Understanding and further uncovering the underlying genetics of the responses will allow for the identification of preferred crop traits and trait combinations that meet the requirements for crop improvements. With the aid of a novel Field Phenotyping Platform (FIP) we are currently able to monitor the dynamics of winter wheat canopy cover and plant height over growing seasons, using the FIP-onboard NIR camera and laser scanner respectively. A two-year field experiment comprising of more than 300 wheat genotypes were conducted in two growing seasons with varied replications. Growth rates based on canopy cover and plant height were calculated, and their responses to the temperature determined. Results showed that canopy cover and plant height based growth rates were affected by temperature change, and they generally increased as a result of temperature increase. Heritability of the response to temperature was around 0.50 for both of the canopy cover and plant height, whereas it was 0.90 for a subset of 30 Swiss cultivars. Genome-wide association studies (GWAS) analysis showed that the marker-trait-associations (MTAs) were pronounced in different linkage groups for canopy cover and plant height, suggesting the potential for simultaneously identifying the traits combination and associated marks combination for elite line selections. As a whole, these results demonstrated that our methods for canopy cover and plant height measurements enable the high throughput phenotyping of crop traits dynamics and combinations, which will facilitate the GWAS on crop improvement for future breeding. The low heritability and differed MTAs reveal the complexity of environmental effects and multiple factors that affect crop traits, which also brings us new insights into modifications of modern cultivars for global change mitigation.

P-6 A NEW PHENOTYPING APPROACH TO SUPPORT THE "BREEDER'S EYE"

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For breeders it's getting more and more important to speed up the breeding process and to get more efficient in breeding to cope with the faster changing climate conditions. The aim of this study is to investigate the potential of modern phenotyping technologies (FIP, UAV's etc.) to support the "breeder's eye" and to develop a database for further phenotyping activities.

The study was conducted from spring to autumn 2015 at the ETH plant research station in Eschikon. The maize trial comprised 15 different maize hybrids from different registration years with three replicates and was conducted in a randomized block design.

On this poster two ground truth parameters (early vigor and yield) were correlated to parameters derived from FIP images (canopy cover and ENDVI) and to spectral indices calculated from ASD field spectrometer measurements and to other ground truth measurements (LAI, SPAD, height etc.).

The analysis of correlations showed that the early vigor has a very strong relationship to canopy cover measured with the FIP and to some spectral indices measured with the field spectrometer ($|r| > 0.8$). Medium correlations ($0.4 < |r| < 0.6$) were found for corn yield with ENDVI.

Automated phenotyping methods have great potential to support the breeding process in the future. The accuracy of parameter determination has to be improved in future research with optimized experimental conditions and fully automated data analysis.

P-7 PHENOTYPING OF SOYBEAN WITH NON-DESTRUCTIVE METHODS AS APPLICABLE FOR BREEDING AND PRECISION FARMING

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There is potential to speed up the breeding process and reduce farm inputs by means of remote-sensing. In the following study data derived from the Field Phenotyping Platform (FIP) and spectral indices (SI) measured with the ASD Fieldspectrometer were compared to breeding relevant parameters such as height, early vigour and senescence ratings. The statistical analysis computed the highest coefficient of correlation for the early vigour with the canopy cover derived by the FIP ($r = 921$, $p < 0.01$). The SI NDWI2130 a plant water indicator ($r = .890$, $p < 0.01$) could be used to explain the senescence progress most accurately. For the above-mentioned parameters high significant genotype and block effects were observed. The maturity groups explained a part of variability in the data. It seems that the remote sensing methods such the FIP device and SI can be used to measure breeding relevant parameters automatically. For the practical application the image segmentation and analysis need to be further automatized. Further research is needed to get more knowledge on the effects of factors like soil and sunlight on the optical properties of measured plants.

P-8 PHENOTYPE OF THE MAIZE ROOT SYSTEMS UNDER NITROGEN LIMITATION IS STRONGEST INFLUENCED BY GENOTYPE AND ENVIRONMENT

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Due to the need for sustainable intensification of agriculture in coming decades, excessive application of nitrogen (N) is not justifiable from ecological and economic perspectives. One opportunity to reduce application rates without major losses in yield is breeding for nutrient efficient crops. One key parameter that influences nutrient uptake efficiency is the root system architecture (RSA). To explore the impact of N availability on RSA and to investigate the impact of the growing environment, a diverse set of 36 inbred dent maize lines crossed to the inbred flint line UH007 as a tester was evaluated for N-response over two years in three environments. RSA was investigated by excavating and imaging of the root stocks followed by image analysis with REST software (Colombi et al, 2015). Despite strong site and year effects, the heritability was generally high. Root traits showing the highest heritability (> 0.7) were the width of the root system, indicative of the horizontal expansion, and the fill factor, a measure of the density of the root system. Heritabilities were in a similar range under high or low N application. Under N deficiency the root system size decreased, angles became steeper and the root system less dense. However, there was little differential response of the genotypes to low N application, making it difficult to select for specific adaptation to low N. By contrast, strong differences were observed for ‘stay green’ and silage yield, indicating that these highly heritable shoot traits are better indicators for responsiveness to low N.

P-9 FUSARIEN UND MYKOTOXINE IN GERSTE UND HAFER - WELCHE ANBAUFAKTOREN BEEINFLUSSEN DEN BEFALL?

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Getreideerzeugnisse bilden bei der schweizerischen Bevölkerung einen grossen Anteil der Kalorienzufuhr und tragen zu einer ausgewogenen Ernährung bei. Besonders weniger häufig angebaute Getreidearten, wie Gerste und Hafer können für den Menschen gesundheitsfördernde Stoffe enthalten.

Jedoch muss Getreide nicht nur gesund, sondern auch sicher sein und daher frei von gesundheitsschädlichen Substanzen. Die gefährlichsten pilzlichen Erreger von Getreidekrankheiten gehören zur Gattung Fusarium. Fusarien-Infektionen führen bei Getreide zur partiellen Taubährigkeit, die durch verschiedene Fusarienarten ausgelöst werden kann, wobei Fusarium graminearum (SCHWABE) die weltweit dominanteste ist. Die Getreidearten unterscheiden sich in ihrer Anfälligkeit gegenüber den verschiedenen Fusarien und zusätzlich haben Anbaufaktoren, wie Bodenbearbeitung und Vorfrüchte, sowie das Wetter einen grossen Einfluss auf den Fusarien-Befall. Neben den Ertragsverlusten stellt die Bildung verschiedener Pilzgifte (Mykotoxine) ein wesentlich gefährlicheres Risiko für Menschen und Tiere dar, da sie z.B. zur Schädigung von Organen führen können.

Um das Artenspektrum und die Mykotoxinbelastung in Gerste- und Hafer beurteilen zu können, wurden zunächst Ernteproben aus der gesamten Schweiz gesammelt und analysiert. Zudem wurden verschiedene Anbaufaktoren erhoben, um deren Einfluss auf den Befall zu eruieren. Dabei wurden in den Jahren 2013-2015 in Gerste F. graminearum und in Hafer F. poae als vorherrschende Fusarienarten festgestellt. Die Analyse der Mykotoxine zeigte in Gerste vor allem eine Kontamination mit Deoxynivalenol (DON), welches durch F. graminearum (FG) gebildet wird und in Hafer mit T-2/HT-2, welche durch F. langsethiae (dritthäufigste Art) gebildet werden. Die Untersuchung der Anbaufaktoren haben gezeigt, dass die Kombination aus Vorfrucht Mais und reduzierter Bodenbearbeitung das Risiko einer Infektion mit FG und einer DON-Belastung in Gerste erhöht. Bei Hafer wiesen Winterhafersorten eine stärkere Infektion mit F. poae und F. langsethiae auf, sowie eine höhere T-2/HT-2 Belastung. Weiterhin erhöht sich das Risiko einer T-2/HT-2 Kontamination durch den Anbau von kleinkörnigen Getreiden (z.B. Gerste, Weizen) vor Hafer.

In einem weiteren Schritt werden die aus dem Gerste- und Hafermonitoring erhaltenen Daten zusammen mit Ergebnissen aus epidemiologischen Studien genutzt, um das Prognosemodell „FusaProg“ für Weizen und DON auf Gerste und Hafer sowie deren Mykotoxine zu erweitern.