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Physiological enhancement for alleviation of low temperature stress in canola (*Brassica napus*) using abscisic acid

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Low temperature stress severely influences canola (*Brassica napus L.*) cultivation as an important worldwide biofuel and oily plant. Seed priming is an approach for improving germination characteristics under stress. Plant hormones like abscisic acid (ABA) have significant potential as priming materials. The present study was conducted to enhance low temperature tolerance in *Brassica napus* by seed priming with ABA. In this study, the effect of seed priming with three concentrations of ABA (50, 100 and 150 µM) was investigated on germination of *Brassica napus* cv. *Zarafm* under low temperature stress (3° C). ABA-priming, especially with 50 µM concentration increased germination percentage and vigor index and decreased mean germination time. Higher concentrations of ABA were not as effective as low concentration. Protein content was affected and reduced by ABA treatment. The highest and the lowest level of soluble proteins was located in the embryo axis (245.2 mg/ml), and seed coat (67.3 mg/ml), respectively. ABA-priming promoted superoxide dismutase and peroxidase activity for detoxification of superoxide and hydrogen peroxide radical, respectively. However, polyphenol oxidase was not affected. Seed coat exhibited the highest activity for the antioxidant enzymes.

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Overexpression of annexin, *AnnBj2* confers salinity and ABA tolerance on mustard plants at germination and early seedling growth

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Background: Annexins belong to a multigene and multifunctional group of proteins, which can bind the plasma and endo membranes in a calcium dependant manner. Gene expression studies of these proteins carried out by different groups revealed their differential expression pattern in different tissue and developmental stages of the plants. Their expression pattern significantly changes in response to different stress (biotic and abiotic) conditions and signalling molecules. Overexpression of some annexins conferred abiotic stress tolerance to the transgenic plants. In mustard, *Brassica juncea*, six annexins (*AnnBj1, AnnBj2, AnnBj3, AnnBj4, AnnBj6* and *AnnBj7*) were reported to exhibit differential expression pattern in response to salinity, oxidative stress, wounding and signalling molecules (Jami et al. 2009). Among these, *AnnBj2* showed strong upregulation at transcript level to all the four signalling molecules (abscisic acid, methyl jasmonate, ethephon and salicylic acid). This member of the annexin family may play an important role in plant signalling in response to stress condition.

Objectives: To study the function of *AnnBj2*, we planned to overexpress it in the native system under the control of a constitutive promoter and generate several overexpression lines. These transgenic lines will be analysed under different abiotic stress conditions and compared to the wild type.

Methods: To study the function of *AnnBj2* gene, it was overexpressed under the control of CaMv35S constitutive promoter. Overexpression lines of this gene were generated in *Brassica juncea* through Agrobacterium mediated transformation using cotyledonary petiole as explant. The green shoots generated in the presence of 15mg/l kanamycin as selective agent were transferred to the rooting media. The plantlets were shifted to green house and allowed to self-pollinate. The seeds of stabilized lines in T3 generation were used for germination assays. For germination assay, seeds were sterilised and placed on ½ MS media supplemented with 0, 100, 200 and 300 mM NaCl. To check the ABA sensitivity seeds were placed on ½ MS media supplemented with 0, 4 and 8 µM ABA. Emergence of radicle was used as a scorable marker for the germination. After six days of incubation, germination percentage, fresh weight, root and shoot length and proline contents were measured.

Results: Putative transgenic mustard plants were characterized for the constitutive expression of *AnnBj2* and lines overexpressing *AnnBj2* were selected for further analysis. *AnnBj2* overexpression lines showed significantly higher germination percentage than the wild type (control) seeds under different concentrations of NaCl and ABA. In response to NaCl and ABA stress, *AnnBj2* overexpression lines showed enhanced growth in terms of fresh weight, longer root and shoot length and increased proline content than the wild type genotype.

Conclusion: As the *AnnBj2* overexpression lines were more tolerant to NaCl and comparatively less sensitive to ABA than the wild type genotype at germination stage, it could be a good candidate gene for genetically modifying the crop to perform better under saline conditions.

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The impact of sulfate restriction on seed yield, oil and meal quality of winter oilseed rape depends on the ability to remobilize sulfate from vegetative tissues to reproductive organs

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Background: Compared with other crops such as cereals, oilseed rape is particularly sensitive to S deficiency because this crop is characterized by a high demand for sulfate. Nevertheless, our knowledge about the stages of development the more sensitive to S limitation or the physiological processes that are involved in S management by oilseed rape subjected to sulfate restriction remains largely unknown.

Objectives: Our goal is to investigate the response to S restriction applied at two crucial growth stages (bolting or early flowering) on (i) the S management (uptake vs remobilisation) and (ii) the seed yield, oil and meal quality in winter oilseed rape (cv Capitol).

Methods: Sulfate limitation was applied at bolting or early flowering stages under controlled conditions. A pulse-chase 34SO42- labelling method was carried out in order to study the S fluxes from uptake and remobilization at the whole plant level. The contribution of tonoplastic SULTR4-type transporters in the efflux of sulfate from the vacuole of source leaves was studied at the transcriptional level. Seed quality was carried out by NIRS analysis for oil composition and two dimensional gel for seed proteome.

Results: When S limitation was applied at bolting or early flowering stages, the leaves are the most important source organs for S remobilization during reproductive stages. By combining 34S-tracer with biochemical fractionation in order to separate sulfate from other S-compounds, it appeared that sulfate was the main form of S remobilized in source leaves. Tonoplastic SULTR4-type transporters were specifically involved in the sulfate remobilisation from leaves in case of S limitation. The seed yield and quality from S-limited plants were dramatically reduced compared to control, suggesting that the increase of both S remobilization from source leaves and root proliferation in order to maximize sulfate uptake capacities, were not sufficient to maintain the seed yield and quality. When S limitation occurred at the early flowering stage, oilseed rape can optimize the mobilization of sulfate reserves from vegetative organs (leaves and stem) to satisfy the demand of seeds and maintain the seed yield and quality as far as possible. Results also indicated that the stem may act as a transient storage organ for remobilized S coming from source leaves before its utilization by seeds. Proteomics approaches in mature seeds have revealed that the protein quality of seeds was reduced depending on the severity of S limitation and was associated with a reduction in S-rich seed storage protein accumulation (such as Cruciferin Cru4) which favoured S-poor seed storage protein (such as Cruciferin BnC1).

Conclusions: The impact of sulfate restriction on seed yield and quality of oilseed rape depends on the ability (i) to remobilize sulfate from vegetative tissues to reproductive organs and (ii) to maximize the sulfate uptake. Consequently, these physiological traits such as S remobilization, root proliferation, or transient S storage in stem, could be used in breeding programs to select genotypes with high S use efficiency and elevated seed yield and seed quality.

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Effect of seeding date on oil and protein content in winter rapeseed cultivars

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Background: According to the total production of major oilseeds in the world, rapeseed takes the second place just after soybean (USDA 2014). It is primarily grown because of high quality oil and proteins that are used as animal feed (Vujaković et al. 2014). The seed contains 40-48% oil and 18-25% proteins. Seeding date is an important management factor in rapeseed farming as the proper seeding time allows sufficient crop growth and development to reach satisfactory yield and yield components.

Objectives: The aim of this study was to determine the effect of seeding date on oil and protein content in four winter rapeseed cultivars during two cropping seasons. In Southeast Europe such studies are scarce.

Methods: The field trial was conducted to study the response of oil and protein content of four rapeseed cultivars (Banaćanka, Slavica, Express, and Valeska) to six seeding dates (SD1-21 August, SD2-31 August, SD3-10 September, SD4-21 September, SD5-1 October, SD6-9 October). The two-year trial was carried out from 2009 to 2011 at Rimski Šančevi, near Novi Sad (Serbia) as randomized complete block design (RCBD) with four replications on 6 m2 plots. Row spacing was 25 cm between rows and 5 cm within rows. Oil content (NMR method) and total proteins content (Kjeldahl method) were determined after harvest. Analysis of variance (ANOVA) via GenStat (trial version) was used for statistical analysis.

Results: Oil content ranged between 41.19% (cv. Valeska) and 42.69% (cv. Express). Significantly lowest oil content across seeding dates was found in SD6 (40.67%), and highest in SD4 (41.86%). Valeska showed significantly highest mean protein content (21.54%). Protein content was highest in SD6 (20.18%). Between years there were highly significant differences in both traits. Increased oil content in the second year (2010/2011) was related to weather conditions which were favorable for rapeseed. However, protein content was significantly higher in the first year (2009/2010). The three-way ANOVA for both traits indicated that all main effects (year, cultivar, sowing date) and first order interaction (year × sowing date) were highly significant. The cultivar gave the highest contribution to oil content (50.7%). The contribution of year to oil content was also high (34.4%), and to seeding date 4.2%. Protein content was primarily affected by year (70.5%), while cultivar contributed 9.7% and seeding date 5.3%.

Conclusion: Seeding date significantly affected rapeseed oil and protein content. Oil content decreased with delayed seeding. Study results may be helpful in recommending optimal rapeseed seeding date in this region.

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Ecosystem carbon balance of field-scale canola and barley in central Alberta

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Background: Canola acreage is close to 8 million ha and 90% of the production is exported. This is a large environmental footprint nationally and globally. Sustainability is a market issue that impacts canola market accessibility. Central Alberta is known as a region of intensive canola and barley production, resulting in relatively high grain and seed yields. The deep, black Chernozem cropland, originally broken from grassland, with a high soil organic matter content, may lose a quantity soil carbon each year until equilibrium is attained (Malhi et al. 2010; National Inventory Report 2011). The eddy covariance system is micro-meteorological method for studying within year ecosystem carbon (C) dynamics as well as annual ecosystem C-flux which includes soil and crop organic-C sources and sinks.

Objectives: To compare the ecosystem carbon balance for hybrid canola and barley crops grown intensively at a field scale using input levels typical of the Central Alberta region.

Methods: Hybrid canola and spring barley were planted on approximately May 16 and harvested using farm-scale equipment over four years in 20 ha fields from 2011 until 2014 at Lacombe, AB. Each field was equipped with an eddy covariance system. Instrumentation and measurement were similar to Skinner (2008). Net ecosystem-C flux (NEE) was determined (365 d yr-1) on a daily, seasonal and annual basis. Grain, residue and root dry matter (DM) yields were determined and converted to C (kg ha-1) to investigate organic-C inputs and outputs. Thus biome-C change could be determined.

Results: Canola was an NEE-C sink in all years, while barley was a sink in 3 of 4 years. Contribution of residue and roots to the NEE-C pool averaged 3.3 and 4.4 Mg C ha-1 yr-1 for barley and canola, respectively. However, harvested grain and seed yield were high, averaging 4.3 and 3.3 Mg DM ha-1 yr-1 for barley and canola, respectively. At the biome-C level, after removal of grain and seed-C from NEE-C, both barley and canola crops were sources in 3 of 4 years averaging 0.3 and 0.5 Mg C ha-1 yr-1, respectively.

Conclusion: Both barley and canola managed intensively were capable of balancing NEE-C annually, however neither species balance the system-C pool after harvested grain or seed was accounted for. However, the Century model estimates that cropland recently broken from grassland, with a high organic matter content as used in this research, loses approximately 0.5 Mg C ha-1 yr-1 (National Inventory Report 2011) due to respiration of organic matter. Thus this intensive farming practice should be considered sustainable.

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Fertilization of winter oilseed rape with urea with inhibitors

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Background: Fertilization with urea without inhibitors may in some cases be less effective (Watson et al., 1990). Due to hydrolysis grow losses of nitrogen to the atmosphere, which may be 5 to 20 %, in extreme conditions of up to 50 % (Harrison and Webb, 2001). For the stabilization of urea is used nitrification inhibitors - Dicyandiamide (DCD) (e.g. fertilizers Alzon®46 and Ensin) and urease - N- (n-butyl) thiophosphoric triamide (NBPT) (e.g. fertilizer UREAstabil). Urea with nitrification inhibitors or urease inhibitors has a high assumption for the application in oilseed rape nutrition. This will increase the effectiveness of nitrogen fertilization and also limit the pollution of groundwater and air (Šimka et al., 2010).

Objectives: The aim of the experiment was to determine the effect of urea with nitrification inhibitor (Alzon) and urease inhibitor (UREAstabil) after autumn and spring nitrogen fertilization in relation to yield, oil content and TSW.

Methods: Field experiments were established in the years 2009/10 - 2011/12 on Research Station of Czech University of Life Sciences Prague in the locality Cerveny Ujezd (GPS 50.0718794N, 14.1701372E, altitude 398 m asl). The average annual air temperature is 7.7 °C and an average total annual precipitation is 549 mm. Autumn dose of nitrogen was 45 kg N/ha and was applied in fertilizers: Alzon, UREAstabil and urea. At the spring fertilization we applied fertilizer Alzon and UREAstabil only twice (90 + 65 kg N/ha) in spring, while the control LAV fertilizer (ammonium nitrate with limestone) four times (40 + 35 + 50 + 30 kg N/ha). Fertilizers Alzon and UREAstabil contain 46 % of nitrogen, same as urea. Fertilizer LAV has 27 % of nitrogen.

Results: Autumn application of urea with inhibitors increased the yield by 1 – 2 % compared to unstabilized urea (Alzon - 3.65 t/ha, UREAstabil - 3.70 t/ha and urea - 3.62 t/ha). Ureas with inhibitors decreased slightly oiliness (by 0.2 to 0.5 %) and increased TSW (0.5 – 0.7 %). Spring combined application of urea with inhibitors decreased slightly yield (by 1 – 4 %) compared to the standard LAV (Alzon - 3.46 t/ha, UREAstabil - 3.55 t/ha, LAV - 3.60 t/ha). But the advantage is saving of two applications of urea with inhibitors compared to the standard LAV (four spring applications). Fertilizer Alzon increased oiliness by 0.7 % and TSW by 1.7 %. Fertilizer UREAstabil increased only TSW by 0.4 %.

Conclusions: Oilseed rape nitrogen nutrition using urea with inhibitors proved very useful. In autumn application is evident increase of yield. Due to the gradual release of nitrogen, it is possible to combine doses in spring and thus save the number of passes over the field.

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Brassica carinata germplasm development as an industrial oilseed

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Brassica carinata is a blackleg resistant, stress tolerant oilseed brassica that has compared favorably with other brassica species in tough conditions such as the historically hot, dry, and windy southernmost regions of the Prairies and extending into the Northern Great Plains of the United States. Very good shatter and lodging resistant characteristics are native to this species. Carinata produces an oil that has been found to be highly suited as a feedstock in the manufacture of Bio Jet fuel and biodiesel. The meal component, obtained after the oil has been extracted, is protein rich and has potential to serve as an excellent animal feed additive. Agrisoma Biosciences Inc., in partnership with Agriculture and Agri-Food Canada, have commercialized adapted varieties of *B. carinata* as a sustainable source of industrial oil feedstock. In response to increased demand and interest from new markets, Agrisoma has established a carinata breeding program seeking to develop high yield potential, high oil content, and earlier maturing varieties. As part of this development process, Agrisoma Biosciences has collected and evaluated a large number of *Brassica carinata* accessions and lines from various world collections. Germplasm evaluation has been focused on agronomic adaptation to geographies with potential for commercial acreage, seed quality characteristics, and genetic relationships among the germplasm collection. This work has required a number of partnerships and collaboration of effort. For example, headed by a progressive University of Florida extension team in Northern Florida, suitable carinata backgrounds and agronomic practices are being evaluated for its use as a winter crop option in the Southeast United States. Further, working in close partnership with Agriculture and Agri-Food Canada, germplasm has been evaluated on a molecular basis using GBS methodology, to estimate genetic distance among the various original accessions and breeding lines. The information generated in these studies have been useful in understanding the plasticity and genetic diversity available in this species.

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New oil seed crops for new French cropping systems

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Background: A review was made in 2013 on different seed oil species including *Brassica carinata* and *Camelina sativa*. The objective was to describe for each species the agronomic requirements and to focus on the production of molecules which could have some interest for industrial uses. This work showed that the most interesting species at both agronomic and quality point of view was *B. carinata* and camelina, because of their short cycles and composition of their seeds.

Objectives: A research program called ANOI* aims to study new oil seed crops with short crop cycle which can produce molecules that can have interest for industrial targets to introduce them in French cropping systems, in particular to develop crop rotations with 3 crops in 2 years. The objective of the project is to collect information on phenology, accumulation of reserves during seed filling and on yield potential.

Methods: Two oil seed crops (*B. carinata* and *Camelina*) were tested by CETIOM in 2014 in experimental field plots in comparison to spring rapeseed in two experimental trials located in the north of France: the first one to explore the variability of nitrogen supplies and the second one to analyze the genetic variability of camelina. Another trial was sown in the south of France, in order to study the behavior of the three species in limiting water availability situation. An experiment was also conducted in glasshouse in 2014. In all these experiments, development stages and composition of the seeds (oil, fatty acids and protein concentration) of the three species was measured.

Results: The first results indicate that the total length of the cycle for *B. carinata* and camelina exceeds 100 days with the varieties tested. *B. carinata*, such as spring rapeseed, is very sensitive to insect attacks (especially blossom beetle *Meligethes aenus*) which affect greatly yield while *C. sativa* reaches more promising yields under French northern conditions. At a quality level, *B. carinata* can be a source of erucic acid and *C. sativa* can provide high levels of alpha-linolenic acid, complementary to fatty acids found in rapeseed oil.

Conclusions: The field and glasshouse experiments indicate that the length of the cycle is too long to make 3 crops in 2 years. It will be useful to have earlier varieties. Experiments will be renewed in 2015, in which genetic variability of camelina will be extend in order to identify behavior of specific lines for yield or composition of the seed.

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PERISCOPE : A new phenotyping experimental device for individual root and shoot investigations in reconstructed canopy until harvest, under field-like conditions

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Background: Cultivars with improved Nitrogen Use Efficiency (NUE) are central to face economic competitiveness and environmental sustainability of rapeseed. Under low N input, a higher NUE can be achieved by increasing N uptake efficiency (NUpE) and/or by improving N reserve use. NUpE results from root development and specific nitrogen uptake. Exploring the GxN variability of this efficiency remains challenging, as a reliable quantification of fine root fraction and N uptake remains difficult in the field, and as alternative systems such as rhizotrons are not suitable to manage rapeseed plants until harvest under field-like conditions.

Objectives: Our aim was to design and test a new semi-controlled culture system for growing rapeseed plants, able to fit the following requirements: i) quantitatively access to each plant fraction, including fine roots, ii) be relevant until harvest to estimate final yield components, iii) generate individual plants in a reconstructed canopy, with phenotype and yield similar to those of field grown plants, and iv) combine measurements at plant and crop scales.

Methods: The PERISCOPE system consisted of individual columns of 1m high and 0,16m diameter, grouped by 24 into boxes of 1m3, placed outside and therefore submitted to field climate. Each column was filled with substrate and regularly supplied with nutrient solution. In boxes, the space between columns was filled with soil, in order to ensure the thermal insulation of root parts and the implantation of two rows of border plants around the columns and thus to mimic environmental conditions of the field. Six seeds were sown on each column. After thinning out, a single plant was kept per column, leading to an homogeneous canopy of 35 plants/m2, which was grown for the whole crop cycle until harvest. Various combinations of substrates and N treatments were experienced in 2 locations. Plants were harvested at 7 sampling dates during the crop cycle and divided into tuberized roots, fine roots, leaves, stems, pods and seeds. Biomass and N content of the different plant fractions were measured and the leaf area index (LAI) was assessed.

Results: This new system was successful at collecting plant fractions, including fine roots, until harvest under field-like conditions. In addition, the canopies generated were similar to those obtained in the field, showing equivalent aerial DM, N content and harvest index. Results showed a good repeatability between plants and revealed a significant contribution of fine roots to total plant biomass (up to 23 %). The PERISCOPE system was also adequate to discriminate substrate and nutrient effects on plant traits.

Conclusions: This new experimental device proved to be effective to characterize the phenotypic responses of rapeseed to N limitation and should be helpful to screen large genotypic variability for NUE traits, including contribution of fine roots to NUpE. A comparison of 8 contrasted genotypes is currently under progress using the PERISCOPE system. This device could also be useful to study root interactions in associated cropping combining several species whose location can be modulated by columns positioning.

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Canola establishment – How important is seed size?

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Background: 'Moisture seeking' seed is a common practice in some regions in Australia. It involves the placing of seed into soil moisture below dry topsoil, often at depths below what is generally optimal for a particular variety or crop. The main aim of this is to ensure a crop is planted and germinates within the optimum planting window, with producers often prepared to accept a reduced emergence to ensure timely crop establishment.

Objective: The aim of this research was to evaluate the seed characteristics (seed size and variety type; hybrid or open-pollinated) that improve crop emergence, especially in challenging soil conditions, such as when planted relatively deep.

Methods: Six canola varieties were planted at three seeding depths (25, 50 and 75 mm) in five plot experiments over the 2012 and 2013 seasons in central-west New South Wales (NSW), Australia. Emergence data were collected for each sowing depth and plots were harvested for grain yield. The varieties included three hybrids and three open-pollinated (OP) varieties, with one triazine tolerant (TT) variety and two non-TT varieties within the hybrid and OP groups. Seed of the hybrid varieties was generally larger than seed of the OP varieties.

A pot study was also conducted where seed of each variety was graded into two separate size classes; large (2.0-2.4 mm) and small (1.0-1.4 mm), and planted at 25, 50 and 75 mm to determine the relative importance of seed size and hybridity on observed emergence differences

Results: In all five small plot experiments deeper sowing reduced canola emergence, however emergence of the hybrid varieties was significantly better than emergence of the open-pollinated varieties at all seeding depths. Grain yield was reduced by deep sowing to a lesser degree than plant emergence, with the hybrid varieties being higher yielding at all seeding depths.

In the pot study, there were only small treatment effects at the 25 mm sowing depth. As seeding depth increased from 25 to 75 mm canola emergence was reduced, however the effect was greatest for the small seeded OP varieties (94% reduction) and least for the large seeded hybrid varieties (18% reduction). Planting large seed improved canola emergence within both the hybrid and OP varietal groups.

Conclusions: This research has shown that planting relatively large canola seed will improve canola emergence, especially when conditions at planting are challenging. Growers can capitalise on these findings by either purchasing large commercial seed or by grading their own retained OP seed for larger seed size.

SuMoToRI, a model to simulate growth and sulfur content in rapeseed *(Brassica napus L.)* until the onset of pod formation

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Background: There is an increasing demand for oilseed rape to meet worldwide needs for the food and biofuel industries. Its high sulfur (S) requirements during the vegetative phase can drastically impact yield and oil quality. In a context of S oligotrophy, S fertilization management before the onset of pod formation has become a major issue. Modelling S requirements and allocation within the main plant compartments could be a helpful approach to correct deficiencies occurring during these early stages.

Objectives: In this study we developed a predictive model of plant growth until the onset of pod formation in relation to S availability (*SuMoToRI*, Sulfur Model Towards Rapeseed Improvement).

Methods: *SuMoToRI* is a compartment model that distinguishes green leaves, fallen leaves and the rest of the plant. Effective organ growth is calculated by taking into account air temperature, photosynthetically active radiation and S availability. The model works with a daily time increment and at the plant level. *SuMoToRI* was calibrated and evaluated with independent datasets from greenhouse experiments in ample and limiting S supply conditions until the onset of pod formation.

Results: *SuMoToRI* predicts the dynamics of the leaf area, the distribution of both dry biomass and the amount of S within the plant compartments. It can also simulate the fractions of S that is used for growth defined as structural and metabolic functions (S organic compounds) and of S that is stored as sulfate (major mineral form) within these compartments. Key processes were introduced with a mechanistic approach: (i) the growth S demands for the green leaves and the rest of the plant match the critical demands required for organ expansion and are estimated by construction of the critical S dilution curves; (ii) the daily S offer was estimated as the sum of daily S uptake and a pool of mobile S shared by all organs, which is enriched by S remobilized from senescing leaves. *SuMoToRI* is run with few parameters. The model gave satisfying predictions of growth dynamics and took into account an S-organic pool required for growth and an S-mobile pool used for remobilization towards growing sinks. The parameter values were not dependent on S uptake except for variables underlying carbon (C)-related processes, that is, radiation use efficiency, specific leaf area and C leaf allocation, which required specific calibration in severe S limitation. These results suggested that S restriction might affect C assimilation and that the imbalance in the nitrogen to sulfur (N:S) ratio might also affect photosynthesis.

Conclusions: The results also bear out the crosstalk between N, S and C metabolisms that deserves to be further underpinned. *SuMoToRI* introduces novel features compared to other mineral-driven crop models because it considers the specificities of S nutrition in a crop that undergoes leaf senescence during the vegetative phase. It can be a relevant framework not only to analyse early deficiencies in oilseed rape but also to model the responses to S nutrition of other crops.

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POSTERS THEME D

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Pod shatter resistance in WOSR hybrids improves yield reliability and can bring additional benefits in the rotation

Pod shatter (a seed dispersal strategy inherited from the wild ancestors of *Brassica napus*) has long been regarded as a problem in cultivated varieties of Winter Oilseed Rape. Adverse weather conditions at maturity, delayed harvest and diseases which can affect the pods such as Phoma, Sclerotinia, Verticillium and Alternaria all have the potential to increase seed loss, as can pre-harvest and harvest operations themselves. Historically, many techniques have been used to try to reduce (or compensate for) these losses; including Chemical 'stickers', Insurance against bad weather, slow combine speeds and special headers. If reduction is unsuccessful then specific volunteer management strategies may be required. All of these things give rise to additional expense and trouble for the grower.

In 2011 at the International Rapeseed Congress in Prague we presented the first results of breeding for seed pod shattering resistance in WOSR hybrids. These hybrids were developed from inherited resistance linked to the Ogura restorer segment.

In this poster we will show supportive data on the effectiveness of this resistance and examine the breadth of information relating to the value and use of the pod shatter resistance trait from first commercialisation to the present day. Data is included from laboratory tests, field trials and experiences with commercial crops, and demonstrates how this trait is adding to the future sustainability of the crop.

In addition to the direct yield benefit for the grower, we will examine the impact on reduced inputs, increased harvest flexibility, lower slug populations throughout the rotation, better control of plant populations due to lower volunteer numbers and the specific management advantages when using Clearfieldtm varieties.

The effect of variety, fertilization and sowing date on overwintering of oilseed rape

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Background: Diversifying cereal monoculture (maize, wheat), main cropping system in Serbia, can provide numerous agronomic and environmental benefits, particularly with winter crop, like oilseed rape. Despite the advantages of autumn-seeded oilseed rape, winter survival present a big constraint in our continental climate with cold winter. Leaf number and plant development before winter may be a limiting factor for overwintering of winter rapeseed (Waalen et al. 2013). Cessation of growth and sufficient levels of photosynthates are necessary for the cold acclimation and freezing tolerance during the. Beside above plant characteristics also some extreme soil and weather conditions have large influence on it, and this is reason why is winter survival a very complex trait (Rapacz et al. 2014).

Objectives: There are many laboratory procedures in research work for measuring freezing tolerance: plant tissue water content; ion leakage from plant cells after a freezing stress or meristem regrowth after plants are subjected to freezing temperatures. But, in commercial production field survival is the only one and final decision method concerning winter survival and freezing tolerance of oil seed rape. So, we decided to investigate multiyear influence of some of cropping practices (sowing date, fertilization and varieties) on winter survival of oilseed rape.

Methods: The field trials with four replication were conducted at Institute of field and vegetable crops, 45o19′ N, 19 o 49′ E, altitude 70 m, on a chernozem soil. It present four year data, from two trials: planting date with (20.VIII, 01.IX and 10.IX) and autumn fertilization (0, 20 and 40 kg ha -1, equal amount of each N ,P2O5 and K2O)

Both experiments were a split-plot design with sowing date or fertilizations as the main plot and four varieties (Jet Neuf, Banacanka, Samuraj and Falcon) as the sub-plot (4m *1.7m).

According to numbers of plants per row in the beginning of November, after plant growth had ceased, and in the beginning of March, when growth had resumed, was calculated percentage of winter survival. Data processed by ANOVA, using software MSTATC, Model 20, combined over year. The effect of each treatment /interaction was assessed by its partitioning in their total sum of squares.

Results: According to F-test in both trials significant effect ($p<0.01$) on winter survival had year and variety and interaction year*variety. Their partitioning in total sum squares was 47, 10 and 30% respectively in fertilization trial and 27, 21 and 37% in planting date trial. Planting date, fertilizatiion and all other interaction had no significant effect. Overall average survival was 83.7 and 85,2% respectively for fertilization and date trial. The lowest was in 2002/03 around 73.0% and the highest in 2005/06 93.7% and 91.0% respectively. The lowest winter survival had variety Samuraj 76.4 and 74.3% and the highest variety Falcon 87.2 and 89.3% respectively.

Conclusions: Field winter survival of oilseed rape mainly depended of weather fluctuation and crop variety, while cropping practice had no significant influence on it.

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POSTERS THEME D

Screening of germplasm with resistance to pod shattering in rapeseed

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Background: Shattering resistance is an important trait for rapeseed varieties suitable for mechanical harvesting, therefore screening of germplasm with pod shattering resistance is the basic work for the breeding of shattering resistance. Although there is some genetic variation in *B.napus*, the degree of resistance is considered inadequate to reduce loss of shattering in harvest management. However, Wen et al screened two lines (Chinese origin) with shatter resistant, which could potentially be used as parents to develop new varieties for improved this trait.

Objectives: To screen available germplasm with good resistance to pod shattering among semi-winter accessions from China in *B.napus.*

Methods: In the present paper, we employed two methods, including random impact test (RIT) and shattering percentage test in the field, to evaluate pod shattering resistance of 75 accessions of *B. napus* in three years.

Results: These accessions tested displayed wide variation in shattering resistance index (SRI) and shattering percentage (SP) in the field, which ranged from 0.01 to 0.70 with the variance coefficient (CV) of 70.70% for SRI, and from 1.58% to 55.51% with CV of 62.53% for SP in the field. The simple correlation analysis showed there was no correlation between pod SRI and SP in the field when all accessions included. However, for the accessions with strong or weak shattering resistance, there was no different between two methods, except for the accessions with the shattering resistance between strong and weak ones. The SP and the wall thickness of pod had significantly negative correrlation (r =–0.429), pod SRI and the wall thickness of pod had significantly positive correlation (r = 0.687). Thus, the pod wall thickness can be used as an auxiliary index to screen shatter resistant germplasm.

Conclusions: A germplasm, Ny with high pod shattering resistance was identified in this study. Ny has thicker wall and smoother surface of pod. The shattering percentage of Ny was 7.74% under adverse condition (two weeks after the maturity), and 1.58% under normal condition (one week after maturity). The pod SRI of Ny was 0.70 in 2011 and 0.48 in 2013, higher than that of rest accessions. Ny will be a valuable resource for rapeseed breeding for pod shattering resistance in the future.

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POSTERS THEME D

Organic winter oilseed rape response to N fertilisation and preceding agroecosystem

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Background: Increased knowledge on how to use organic amendments will increase crop productivity in organic farming and reduce nutrient losses to the environment. In order to obtain better estimates of the optimum nitrogen (N) fertilisation rate (OptN) in spring to organic winter oilseed rape (WOR), the yield response to organic fertilisers as affected by different previous crops and sites need to be determined.

Objectives: The overall objective of this work was to contribute to a better synchronisation of spring N fertilisation to soil N supply and crop N requirements in order to improve yield level and N use efficiency in organic WOR. The specific objectives were to a) determine the effect of autumn and spring application of organic fertilisers on yield of organic WOR grown after various preceding crops; and b) investigate whether OptN in spring can be determined by various factors.

Methods: The effect of autumn and spring application of organic fertilisers on the yield of organic WOR with various preceding crops was studied at eight organic farm sites in southern Sweden in 2008/2009 and 2009/2010, in a two-factor experiment. Autumn N fertilisation (F1) comprised Biofer (meat meal pellets), applied at 0 and 50 kgNha−1, and spring N fertilisation (F2) comprised increasing rates of Vinasse (liquid by-product from yeast industry): 0, 50, 100, 150, 200 kg N ha−1. How soil mineral N, N uptake in late autumn and early spring, plant available soil N during spring and summer (SoilNplant) and yield level was associated with OptN in spring was investigated.

Results: At three of the eight field sites, autumn N fertilisation resulted in significantly higher yield than no fertilisation in autumn (140, 320 and 400 kg ha−1 yield increase). At OptN in spring, yield increased significantly at five of the eight sites, by on average 780 kg ha−1. The greatest yield increase was 1393 kg ha−1 at OptN= 190 kg Nha−1, at a site with grass ley (14-years old) as preceding crop. The lowest yield increase, 240 and 390 kg ha−1 at OptN=41 and 61 kg N ha−1, respectively, was obtained at two sites with white clover and red clover as preceding crop.

Conclusions: Autumn N application of Biofer cannot be recommended after white and red clover as preceding crops since it had no impact on yield. Autumn N application can be justified and small yield increases can be expected after previous crops such as grass leys. Late sowing and autumn fertilisation in this study resulted in high levels of soil mineral N in late autumn and thus an increased risk of N losses. Spring N fertilisation with Vinasse can be recommended when the preceding crop is grass ley, since the yield increase and N use efficiency were the highest. Spring N fertilisation does not increase yield after a leguminous preceding crop, as pasture or clover. Regression analysis showed that soil mineral N, N uptake in late autumn, SoilNplant and yield level must be considered when estimating spring N fertilisation.

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Examining the feasibility of several oilseed crops for production in the Inland PNW

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Background: The USA remains highly dependent on fossil fuel imports and interest in producing bio-jet fuel from vegetable oils has increased. *Brassicaceae* oilseed crops have high oil content that make them suitable for biofuel production. In addition, *Brassicaceae* crops have shown rotational benefits when grown with small grain cereals that predominate in the dry land Pacific Northwest (PNW). However, few studies have examined species adaptability to PNW growing conditions, the physiological growth pattern, basic plant morphology, reaction to biotic and abiotic stresses, or rotational effects.

Objectives: In this study we examined yield and oil content of three fall-planted *Brassicaceae* species (*Brassica napus, B. rapa,* and *Camelina sativa*) and six spring-planted species (*B. napus, Sinapis alba, B. juncea, B. carinata, B. rapa,* and *C. sativa*) to evaluate the adaptability of these oilseed crops in our region.

Methods: Field trials were grown at two locations in Idaho, in 2013 and 2014. Winter and spring planted trials were grown adjacent, although they were not inter-randomized. Weeds and pests were controlled throughout by application of appropriate herbicides and insecticides. At maturity, crops were swathed (winter only) and combine harvested and a subsample was taken from each plot for oil content analysis. After harvesting the oilseed crops, the complete trial area was planted to winter wheat to determine the rotational effect of the previous oilseed crop.

Results: Highest seed yield was obtained from the two winter canola (*B. napus*) cultivars ('Wichita' 4,491 kg ha-1 and 'Amanda' 4,186 kg ha-1). Winter industrial rapeseed cultivars, 'Durola' and 'Dwarf Essex', also produced high seed yields of 3,780 kg ha-1 and 2,732 kg ha-1, respectively. Yields of spring cultivars and species were significantly lower than the winter ones. The highest yielding spring cultivar was DKL 30-42 1,954 kg ha-1 (*B. napus*) followed by 'Oasis' 1,632 kg ha-1 (*B. juncea*). The highest oil yield was produced by Wichita, 2,142 L ha-1, Amanda, 2020 L ha-1, and Durola 1983 L ha-1; all winter *B. napus* cultivars. Oil yield of spring crops was markedly lower, particularly from the low oil content mustard species (*S. alba* 346 and 336 L ha-1) and camelina (*C. sativa* 467 L ha-1). Estimating simple farm returns at harvest 2014 prices showed highest returns from winter canola or rapeseed at $2273 ha-1 ($906 acre-1). Farm returns from spring canola or rapeseed was $842 L ha-1 ($341 acre-1). Farm returns on mustard were equal to spring canola due to traditionally higher seed value for condiment spices. Over all cultivars and species there was no significant difference in following winter wheat yield potential.

Conclusions: Winter canola or winter rapeseed (*B. napus*) cultivars show best potential for producing bio-jet fuel feedstock crop in the PNW. Highest potential spring crops include canola or rapeseed (both *B. napus*), although one *B. carinata* line (AAC-A110) also performed well. Note that the winter crops were planted on fallow ground (common in many PNW areas), and the yield is realized over two years.

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Isolation of MYC2 gene from *Brassica napus* and analysis of its expression in response to salt stress

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Background: The *Arabidopsis* gene *MYC2* encodes a key transcription factor in an abscisic acid dependent pathway in *Arabidopsis* (Nakashima, and Yamaguchi-Sh, 2005). The expression of this transcription factor is induced by salt and drought stress. Moreover, Myc2 has been shown to be involved in various plant responses to biotic stresses (Lorenzo et al., 2004).

Objectives: Isolation of *MYC2* gene from *Brassica napus* (*BnMYC2*) and analysis of its responsiveness to salt stress

Methods: Using the specific primers designed from the exon of *Arabidopsis MYC2 (AtMYC2),* a cDNA fragment of *BnMYC2*, with the size of 962bp, was cloned and sequenced from the rapeseed cultivar SLM046. Using the new primers and RACE technique, the 5′ and 3′ cDNA ends of *BnMYC2* were isolated and then sequenced. Alteration in the expression of *BnMYC2* was monitored upon exposure of Canola to salt stress.

Results: The sequence of the cloned fragment of *BnMYC2* showed great homology to *AtMYC2*. Apllication nof RACE technique helped us to obtain the 5′ end fragment with the length of 574bp and the 3′ end fragment with the length of 687bp. The sequenced fragments were assembled to attain full length cDNA of *BnMYC2* proximate to 2047bp. The coding regions of *BnMYC2* cDNA showed 81% identity to those of in *AtMYC2*. Moreover, bioinformatic analysis revealed that the protein encoded by *BnMYC2* is a hydrophilic protein which contains a bHLH domain. Furthermore, quantitative analysis showed an upregulation in the expression of *BnMYC2* in the leaves and roots of canola under salt stress conditions. In roots, maximum expression of *BnMYC2* was observed after three hours of salt stress, while in leaves, *BnMYC2* expression reached the highest level after six hours of salt stress.

Conclusion: This study provides the first insight into the responsiveness of a *MYC2* transcription factor of canola in stress response of the plant to salt. Here we show that *Myc2* expression would be elevated upon salt stress, and the response could be monitored in the roots as well as shoots. Our results suggest that *MYc2* may play a crucial role in the response of canola to abiotic stresses.

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Calculation of N fertilizer rates in winter oilseed rape in order to maximize farmer incomes and to minimize greenhouse gas emissions

The Decision Support System (DSS) "Réglette azote colza®" provides an estimation of the optimal spring N application rate in winter oilseed rape (WOSR) based on a N balance sheet method. This DSS is used by about one third of farmers cultivating WOSR in France. The parameterization of the DSS was made to achieve an expected yield without accounting for economical nor environmental issues, and did not accurately account for organic fertilizers nor for the effects of legumes in crop rotation. The objective was to develop a new version of this DSS, in order to maximize the farmer incomes, minimize the greenhouse gas emissions, and to better account for organic fertilizers and legumes.

Methods:

The N rates (X) are calculated at the end of winter as follows:

$X = [b \times y + Rf] - (Pi + Ri + M + Mha + Mpro1 + Fleg + Fass)$,

Where b is the amount of N uptaken per unit of grain yield, y is the target yield, Rf and Ri are the mineral N in the soil at harvest and at the end of winter, Pi is the N uptaken by plants at the end of winter, M, Mha and Mpro1 are N mineralization parameters, and Fleg and Fass are the effects of grain legumes respectively as a previous crop or as an intercropped green manure. In soils where the measurement of mineral N is not possible, this equation is adapted.

The users of the DSS must estimate y and Pi, while all other terms of the equation are parameters that were either determined in this study or taken from the previous version of the DSS. Pi is calculated from fresh biomass measurements and from parameters that estimate the amount of N per unit of fresh weight (Cbw and Cew, respectively for the beginning and for the end of winter).

Results and conclusions: For all the French regions, the same median values of b, Cbw and Cew were obtained: respectively 6.45 kgN.(100kg grains)-1, 57.5 and 70.0 kgN.ha-1(kg fresh biomass.m-2)-1, compared to the previous regionalized values that ranged from 6.5 to 7.0 for b and from 65 to 75 for Cbw and Cew. In our study, a great variability of values was observed between experiments. For instance, 10% of values were under 5.30, 46.2 and 55.3, respectively for b, Cbw and Cew, and 10% above 7.37, 73.9 and 93.8. Hence, the use of the median values may over- or underestimate the rate of N fertilizer. Thus, a range of values was tested. The best combination, resulting to the maximum gross margin and to the lower greenhouse gas emission among the combinations that maximized the gross margin, was 7.0, 50 and 65, respectively for b, Cbw and Cew, which corresponded approximately to a 30% risk of underestimation of the N rate.

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Uniform plant stands enhance the synergy of pod formation and seed yield in canola

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Background and Objectives: Canola (*Brassica napus*) productivity is often limited by non-uniform plant establishment, especially in areas with short growing seasons, such as western Canada, where crop plants usually have a limited time span to adapt and compensate for yield losses due to poor plant establishment. It is unknown how the uniformity of canola plant stands would affect pod set and seed yield. This study quantified the impacts of uniformity of canola plant stands on pod formation, seed set, and seed yield.

Methods: Field experiments were conducted at 16 site-years across the different soil-climatic zones of western Canada. At each site-year, a hybrid canola cultivar was seeded at various seed rates to achieve plant densities of 20, 40, 60, 80, and 100 plants per m2, each with uniform stands in comparison with non-uniform stands. To determine the nature of the treatment by site-year interactions in a quantitative manner, we used the Nonmetric Multidimensional Scaling test to group site-years with different treatment effects. As a result, Lacombe 2010, Lacombe 2011, Lacombe 2012, Melfort 2010, and Melfort 2011 were grouped as the "high-yielding sites", and the other 11 site-years were grouped as the "low-yielding sites".

Results: At both high- and low-yielding sites, uniform stands had significantly higher seed yields than non-uniform stands at the same plant density. At low-yielding sites, uniform stands increased seed yield by 32%, 21%, 8% and 7% at the plant densities of 20, 40, 60, and 80 plants m-2, respectively, compared with the corresponding non-uniform stands. At high-yielding sites, the uniform stands increased seed yields by 21% versus the non-uniform stands at plant densities lower than 60 plants m-2. There was a linear relationship between the number of fertile pods per m2 and seed yield, with the uniform stands having a greater intercept (Y = 1329.6 + 0.144X) and higher adjusted R2 (0.74) compared with non-uniform stands (Y = 742.8 + 0.191X, R2 = 0.63). The relationship between fertile pod number and seed yield was altered by plant uniformity. An evenly distributed plant community increased the synergies between pod formation and seed set, and promoted seed development, whereas non-uniform stands increased interplant competition, and reduced the distribution of optical radiation limiting the development of fertile pods.

Conclusions: Across the diverse climate-soil zones on the Canadian prairies, canola stand uniformity has a significant impact on canola productivity, with uniform stands increasing seed yield by up to 32% at the low-yielding sites and by 20% at the high-yielding sites compared to non-uniform stands. Thus, achieving uniform plant stands may serve as a major approach to maximize the yield potential in canola.

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Rapeseed-legumes intercropping: A new strategy to improve *Brassica napus* crop

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Background: *Brassica napus L.* requires high level of Nitrogen (N) fertilization to achieve significant yield. The improvement of agricultural practices is crucial to decrease N inputs and reduce their negative environmental impacts. Intercropping with legumes offers an environmentally sustainable source of N through the process of biological N fixation which can complement or replace N fertilizers (Garg and Geetanjali, 2007). Several studies have shown that cereal-legumes intercropping has a positive impact on cereal yield and grain N content under low N inputs (Malézieux, 2009). However, the management of brassica-legume intercropping requires more studies taking into account different legume species and/or S-fertilization levels.

Objectives: Using additive and substitutive designs, objective of this work consists to test if different legume species (contrasting in their above and belowground architecture) could have benefit effect on rapeseed crops. The aim of this study is to characterize intercropping effects on rapeseed (and legume) dry weight production, N and S nutrition, N soil reserves and N derived from atmosphere in legumes (%Ndfa).

Methods: Rapeseed and three legumes species (*Lupinus albus L., Trifolium incarnatum L., Vicia sativa L.*) were grown in monoculture and in rapeseed/legume intercrops (RL) in a greenhouse under low N conditions. One (M1) or two (M2) rapeseed monoculture were grown to study additive and substitutive designs, respectively. Plants were grown in pots filled with a mixture of soil and sand, watered exclusively with demineralized water. After three months, plants were harvested to determine root and shoot biomass (DW). N, S contents and the δ15N of plants were determined using an IRMS spectrometer linked to a C/N/S analyzer. The %Ndfa of legume was estimated according to Shearer and Kohl (1986).

Results: The DW and N amount of rapeseed were similar between M1, M2 and RL. N amount in soil increased in RL compared to M1 and M2. Moreover, the %Ndfa of legumes was significantly higher in RL than in monoculture legumes (LL). No difference between the S content of rapeseed was observed in M1, M2 and in RL whereas the S content of legumes is significantly lower in RL than in LL.

Conclusions: This study shows that legumes enhance the soil-N pool in RL. In addition, we have shown that the %Ndfa of legumes was significantly increased in RL conditions than in LL while their biomass and S content were lower. These results suggest that in intercropping conditions, soil S resource is preferentially used for rapeseed growth with a negative impact on legume biomass. To verify this hypothesis, effect of different levels of S fertilizer on RL growth will be perform in field conditions.

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Prediction of rapeseed yields is improved by combining several climate variables using linear regression

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Background: Pre-harvest yields predictions are important for development organizations in order to improve the supply chain. At the present time, it is impossible to know the crop yield before the harvesting operations.

Objectives: We plan to build a statistical model to predict the crop yield each year. This model is built at regional scale, based on climatic data.

Methology: Based on monthly climate variables, a statistical model is fitted to the time series of yield and climate from 1976 to 2014 (Michel and Makowski, 2013). The model is used for main French regions of rapeseed production (Burgundy, Lorraine, Centre, Picardy, Poitou-Charentes). Monthly weather data are provided by the French Organisation of Weather Forecast (Météo France). Yields data are provided by the French Ministry of Agriculture (AGRESTE). The accuracy of the yield predictions obtained with the models was then assessed by cross-validation.

Results: Depending on regions, the uncertainly varies from 1.5 to 3.2 q.ha-1. We are going to improve the yield predictions by combing the model results, assessment with field measurements.

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POSTERS THEME D

AZODYN-rapeseed: A biophysical model for decision support in nitrogen fertilization and harvest prediction

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Background: The precise adjustment of nitrogen fertilization is difficult on rapeseed because the crop can absorb high amounts of nitrogen during autumn, a part of plant nitrogen is lost when the leaves fall during winter and the Nitrogen Use Effiency (NUE). The dynamic crop model AZODYN (Jeuffroy and Recous, 1999) rapeseed computes nitrogen dynamic supply in the plant and the soil, but it is necessary to test the model on various conditions in France and improve the model.

Objectives: We develop a methodology to improve the AZODYN model based to the comparison between field observations and simulations. Then, we test the model in various situations of soil (deep or superficial), of climate (Western or Eastern region) and plant growth.

Methods: AZODYN-rapeseed is built up and assessed on twenty situations. AZODYN simulates the aboveground biomass and the yield linked to nitrogen and water dynamic supply in the plant. This model is based on soil nitrogen at sowing, soil type, climate and nitrogen application (date and amount). First, we present the improvements of the model (mineralization in the ground, N plant dynamic…). Second, the model was compared with measurements for biomass, nitrogen amount in the plant and in the soil on eighteen sites situated in different regions of France from 2007 to 2011.

Results: The accuracy of the model AZODYN-rapeseed is 20 % for plant biomass, nitrogen content and nitrogen soil.

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The study of natural variability of winter oilseed rape at vegetative and reproductive stages allows to propose an ideotype adapted to restricted nitrate supply

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Background: Only 50% of N fertilizer is recovered in seeds of winter oilseed rape at harvest, reflecting its low nitrogen (N) use efficiency (NUE). Previous studies based on N balance suggested that NUE at vegetative stage is limited by N utilization efficiency (NUtE), especially N remobilization efficiency (NRE), while N uptake efficiency (NUpE) seems crucial after bolting, when N availability is reduced.

Objectives: Our goal was to identify the limiting component of NUE at vegetative and reproductive stages to propose an ideotype (virtual genotype) adapted to reduced N inputs .

Methods: To define the limiting factors of NUE, a long-term pulse-chase 15N-labelling method was performed to precisely determine (i) the fluxes of N remobilization and N uptake at the whole plant level and (ii) accurate indexes of NUE component. The N fluxes were determined (i) at vegetative stage in 4 genotypes showing contrasted leaf NRE and biomass production in response to a nitrate limitation (Aviso, Oase, Californium and Samouraï; Girondé et al., 2015) and (ii) at reproductive stages (from bolting to mature seeds) in the genotypes Aviso and Oase.

Results: At vegetative stage, the genotype Aviso produced the same leaf biomass in ample and restricted nitrate supply, reflecting its higher NUE compared to Oase, Samouraï and Californium. This higher NUE is associated with a higher leaf NRE, which leads to a reduced N lost by leaf drop, but not to a higher amount of N distributed to the growing leaves. Indeed, the higher leaf biomass production of Aviso is due to a higher NUtE in young leaves (expressed as the fresh matter production by mg of total N distributed to the growing leaves, i.e. from remobilization and uptake). After bolting, the genotype Aviso also presented the highest NUE under restricted nitrate supply. As the monocarpic senescence during the final reproductive stages was efficient, the better seed N filling of Aviso is due to a higher N remobilization from leaves to stem, reducing the N lost by leaf drop and increasing the N availability for seed filling.

Conclusions: These results suggest an ideotype adapted to low N inputs, characterized by a reduced N loss by leaf drop consequently to a higher leaf NRE during all the growing cycle. At vegetative stage, a higher NUtE of the remobilized N in the growing leaves is required to produce a higher biomass before bolting. After bolting, the N from leaves has to be transiently stored in stem during the transition between vegetative and reproductive stage to keep the N from leaves until its remobilization for seed filling during monocarpic senescence.

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POSTERS THEME D

Non-chemical control of volunteers of clearfield oilseed rape

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Background: The introduction of imidazolinone-tolerant oilseed rape/canola varieties (Clearfield system; CL) raises questions of non-chemical control of CL volunteers. These volunteers can be partly or fully tolerant to ALS-inhibiting herbicides, depending on cross-pollination and on the active ingredients. The capacity of seeds to fall dormant and the mode of tillage are crucial for the soil seed bank and volunteer emergence (Gruber et al. 2009, 2010). A comparison of CL-varieties with different levels of dormancy for the capacity to build a soil seed bank under different tillage was not yet performed until now. This information would allow to develop strategies for non-chemical control of CL volunteers.

Objectives: Seed survival and flowering volunteers of two CL oilseed rape varieties with high and low seed dormancy should be determined under different tillage systems.

Methods: Two CL winter oilseed rape varieties were grown with six different modes of tillage from August 2012 – July 2013 in SW Germany. The varieties have been selected for their varietal disposition to low or high seed dormancy, respectively (Weber et al. 2010). Tillage treatments were deep inversion and deep non-inversion tillage, each with or without preceding stubble tillage in the first week after harvest, shallow non-inversion tillage, and no-till. The soil seed bank was determined in February 2014, and volunteers were counted in spring 2014 in winter wheat, the first following crop to oilseed rape. No herbicides were applied at all.

Results: Seed loss at harvest accounted for 1500 seeds m-2 on average. Across tillage treatments, the soil seed bank of the high dormancy variety was significantly larger, comprising 2.4 times as much seeds m-2 (131) as the soil seed bank of the low dormancy variety (54). The soil seed bank across both varieties ranged from 47 _ 200 seeds m-2 (soil inversion without stubble tillage _ deep non-inversion tillage with stubble tillage). The number of flowering volunteers in winter wheat ranged across varieties between < 0.01 plants m-2 (soil inversion without stubble tillage) and 4 plants m-2 (no-till). This number depicts a worst case situation without any herbicides; less volunteers are expected in practical farming with use of herbicides.

Conclusions: Low dormancy varieties seem advantageous in the long run; soil inversion several weeks after harvesting could most efficiently reduce the soil seed bank and volunteers.

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Effect of cattle manure/compost type and application frequency on canola yield and nutrient uptake from an acid soil under greenhouse conditions

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Background: In addition to higher recommended N and P fertilizer rates than cereal crop; canola production also requires S fertilizer input. With increased availability of dried distillers' grain and solubles (DDGS) as feed stuff to replace a portion of barley grain in livestock diets, manure from DDGS diets is generally high in available S content. It is well known that manure releases nutrients slowly for crop uptake. However, manure behaves as a canola nutrient source is not well understood.

Objectives: (1) investigates the effect of cattle manure/compost type and application frequency on canola yield and nutrient uptake under controlled greenhouse conditions and (2) compares the amount of N and P nutrient removed by canola to that of barley

Methods: Two types of manure were collected from the Lethbridge Research Centre feedlot: REG from cattle on a typical finishing diet and DG from cattle fed a diet similar to REG, except with 30% corn DDGS replacing an equal amount of barley grain. The REG and DG manure were used as is, after being stored for 100 days, or after composted for 100 days. Canola was grown and harvested in amended soil for four 7-week cycles. An un-amended CK was included for comparison. Amendments were applied at three frequencies: FRE1 at the start of every cycle at 60 g/kg soil; FRE2 at the start of cycles one and three at 120 g/kg soil with no amendment application for cycles two and four and FRE4 at the start of cycle one at 240 g/kg soil with no application for cycles 2 to 4. The three application frequencies simulate manure/compost applications of 60 Mg/ha every year, 120 Mg/ha every other year and 240 Mg/ha once every four years. Barley was also grown in amended soil, but only with FRE1 application frequency for comparison.

Results: Cumulative canola biomass yield and N and P uptake were generally highest in DG manure, followed by DG compost and REG manure with values from REG compost being the lowest. Canola yield and N and P uptake from manure/compost amended treatments were all higher than un-amended CK. Applying amendments at the start of cycles one and three generated the highest biomass yield and N and P uptake than application at the start of every cycle and only once at the start of cycle one. The higher yield and nutrient uptake associated with DG manure/compost reflects its higher N and P content than REG manure/compost. Compared to barley, canola biomass was 1.7 times, N uptake 1.4 times and P uptake 1.5 times greater under the FRE1 application frequency.

Conclusion: DG cattle manure/compost had higher yield potential than REG manure/compost, while applying once every two cycles (years) could enhance canola yield and N and P uptake. The greater canola N and P uptake than barley suggests feedlot producers should grow canola to increase the nutrient export from soil with excess nutrient accumulation often found in heavily manured soils near the livestock operations.

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POSTERS THEME D

Sustainable canola production increases with cropping system diversity

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Background: Canola (*Brassica napus L.*) production has been steadily increasing in Western Canada. High frequency canola rotations increase canola production risks.

Objectives and Methods: From 2008 to 2013, two direct-seeded experiments were conducted at multiple western Canada locations. In the first experiment, continuous canola and all rotation phases of wheat (*Triticum aestivum L.*) and canola or field pea (*Pisum sativum L.*), barley (*Hordeum vulgare L.*) and canola were studied to determine the effect of canola rotation frequency on canola seed yield, quality and associated pest species. In the second experiment, continuous canola including sequences of different herbicide-resistant canola and two-cultivar mixtures of herbicide-resistant canola from different sources were compared to wheat and field pea rotations with canola. Fertilizers, herbicides, and insecticides were applied as required for optimal production of all crops.

Results and Conclusions: When compared to continuous canola (first experiment), canola yield increases ranged from 7 to 18% in wheat-canola rotations and from 14 to 34% in field pea-barley-canola. For each annual increase in the number of crops between canola, canola yield increased from 0.20 to 0.36 Mg/ha. In the second experiment, rotating herbicide-resistant canola types over years or mixing two cultivars of the same herbicide-resistant type provided no pest management, yield or seed quality advantages compared to planting the same herbicide-resistant cultivar type each year. In both experiments, decreased blackleg [*Leptosphaeria maculans* (Desmaz.) Ces. & De Not.] disease and root maggot (*Delia* spp.) damage were associated with greater canola yields as rotational diversity increased. Long-term sustainable canola production increases with cropping system diversity.

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Isolation and sequence analysis of a BnCSDP3 gene in *Brassica napus L.*

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Background: Rapeseed is one of the most important oil-producing crops in China and worldwide. The yield and quality of rapeseed is frequently threatened by environmental stresses including heat, drought, cold and high salinity. Cold shock domain proteins (CSDPs) are highly evolutionarily conserved nucleic acid-binding proteins, which have large-scale regulatory effects on plants development and stress responses. Although CSDPs are proved to involved in plant cold stress responses in *Arabidopsis* and wheat, little is known about their functions in rapeseed.

Objectives: To understand and study the functional roles of *BnCSDP3* gene in response to cold stress, cold shock domain protein *BnCSDP3* in *Brassica napus* was cloned, and its sequence characteristics as well as biological functions were analyzed and predicted.

Methods: According to the sequences of the *AtCSDP* genes obtained from NCBI, candidate sequences of *BnCSDP* genes were obtained by searching homologous sequences in *Brassica napus* database. Specific primers were designed based on the candidate sequences for reverse transcription-polymerase chain reaction (RT-PCR) to clone the full-length cDNA of *BnCSDP* genes. The bioinformatic methods were used to analyze the sequence characteristics and biological functions of *BnCSDP* genes using online service.

Results: *BnCSDP3,* a novel gene from *Brassica napus* was isolated and characterized. The full-length cDNA was 870bp, containing one complete 870bp open reading frame (ORF), which had no introns and encoded 289 amino acid residues. The predicted molecular weight of *BnCSDP3* gene encoded protein was 28.78 KD with the isoelectric point of 7.42. Any signal peptides were found in amino acid residues of *BnCSDP3,* which indicated that *BnCSDP3* was not a secretory protein. Subcelluar localization prediction showed that *BnCSDP3* might localize in cytoplasm without chloroplast transit and mitochondrial targeting peptides. The sequence alignment demonstrated that N-terminal and C-terminal of deduced *BnCSDP3* exhibited a typical cold shock domain (CSD) and a glycine-rich region interspersed with CCHC-type zinc fingers respectively, which were high similarity with other *CSDP3* from other species. Accordingly, it was named the *BnCSDP3* and might own the function of cold resistance.

Conclusions: The gene *BnCSDP3* was isolated from *Brassica napus* and its sequence characteristics were analyzed in detail. The data presented here will future promote our understanding of the biological functions of *BnCSDP3* and provide a basis for function verification of *BnCSDP3*.

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POSTERS THEME D

Environmental impacts of high intensity oilseed rape cropping systems

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Background: In recent decades the high technology agriculture increases yields due to the application of fertilizers, pesticides, growth regulators and the use of new varieties. However, the requirements to our modern agriculture increased. In addition to meet the food demand of a growing world population, the agriculture should also contribute to the energy demand and concurrently produce in an environmental friendly manner. In Europe environmental policy strategies associated with the use of renewable energy sources and economic benefit for farmers lead to an increase of the oilseed rape (OSR) production area. Especially in Germany the cultivation area of OSR almost doubled from the 1990 and now amounts to approximately 1.5 Mio ha. During the same period the total crop area remained on a constant level (FAO Stat, 2015).

Objective: A field rotation experiment established in 2002 in the Hercynian dry region of central Germany was evaluated with the REPRO software to quantify the environmental impacts in dependency of preceding crop combination before OSR and N-fertilization level.

Methods: The field trial was established at the experimental farm Etzdorf (Saxony-Anhalt, 11° 45.443'E, 51° 26.095'N) of the University Halle. For the evaluated experimental period the precipitation averaged 499 mm per year and the mean air temperature is 9.2 °C (2005-2014). The trial was based on the rotation winter wheat - winter wheat - winter wheat - OSR - OSR - OSR and on an OSR-monoculture. Thus resulting for the first time in the year 2005 in four different preceding crop combinations before OSR: winter wheat - winter wheat (first OSR-crop), winter wheat - OSR (second OSR crop), OSR-OSR (third OSR crop) and the OSR-monoculture. Additional to the preceding crop combination fertilizer treatments with 120 kg N ha-1 and 180 kg N ha-1 were established in the field trial design in the year 2012/2013. An analysis of the environmental impacts of the greenhouse gas emissions, the energy intensity and the N-balance was carried out with the software REPRO.

Results: The results show, that the first OSR has the highest and the OSR-monoculture the lowest yields in most of the years. As a result the greenhouse gas emissions and the energy intensity per kg rapeseed were lowest when OSR followed the winter wheat-winter wheat preceding crop combination. Also the N balance is low in the first OSR-crop. The highest environmental impact was observed, when OSR is cultivated in monoculture. A reduction of the N fertilization level leads to better environmental performance independent of the preceding crop combination.

Conclusions: To achieve high yields and to meet the requirements of an environmental friendly production cropping intervals in OSR cropping systems are crucial. A high OSR proportion in the rotation is not favourable under consideration of greenhouse gas emissions, energy intensity and N-balance. Furthermore the reduction of the N-fertilization level could be an opportunity to mitigate the environmental impacts.

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Are corn, soybeans and canola compatible: Is there a niche for canola in the lower Midwestern US - a case for frost seeding canola

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Background: Cropping systems in the lower Midwestern United States are primarily corn/corn/soybeans, corn/soybeans, or corn/wheat/soybeans. Much research is underway to move canola into this cropping rotation. Breeding of winter survivable canola varieties adapted to the region is progressing. The challenge is, within the region, full season corn and soybean varieties are not harvested in time for optimal winter canola planting. Corn and soybean harvest may not be complete until mid-November, sometimes far later. Optimal winter canola planting time in the region is prior to September 15th. Wheat fits into the corn/soybean system because it should not be planted in parts the region until after early to late October due to concerns with the Hessian fly. There are many potential benefits to including canola in the cropping system, but it must fit the cropping system. Could late winter sowing encourage lower Midwestern farmers to try canola? Frost seeding is commonly used in the region to sow clover seeds into pastures. Might frost seeding work for canola too?

Objectives: The objectives for this study were to determine if frost seeding canola was agronomically viable and if so, when should it be sown in Missouri. A secondary objective was to determine if frost seeded canola yields similarly to fall seeded winter canola.

Methods: Seven canola cultivars were broadcast seeded onto prepared 3m X 3m plots on February 14th and March 9th, 2015. Three winter and four spring canola cultivars were trialed. Each cultivar was broadcast by hand on both dates at the rate of 5.38 kg/ha. Fall weed control was not applied. Fertilizer was applied in the fall and 89.3 kg/ha N as urea was applied on April 13, 2015.

Results: The weather in late winter and early spring 2015 in Missouri was characterized by slightly lower than normal temperatures and limited rainfall. Rainfall in late March and early April was normal. Each of the seven cultivars germinated at both of the planting dates. As of April 10th, there appeared to a slight difference in the growth of canola sown in February versus that sown in March, and between spring and winter cultivars, although all are in stage 2 growth. Spring cultivars appeared to be growing a bit faster than the winter cultivars planted at the same time. As a comparison, winter canola planted as a variety trial in an adjacent plot was in late stage 3 or early stage 4 on April 10th. The secondary objective will be determined at harvest. Weeds were problematic; henbit (*Lamium amplexicaule*) and cereal grasses were the main weedy species, the former a winter annual weed and the latter volunteer seed from a cover crop trial that went to seed. Large weeds were removed by hand between April 14th and 16th.

Conclusions: Objectives 1 and 2 were met. Frost seeding of canola is agronomically viable. It appears from this study that canola can be frost seeded in Missouri between mid-February and early March. It also appears that either spring or winter canola can be established through frost seeding. Broadcast seeding of canola seed may not be the most economical means of seeding high value seed, but for frost seeding it may be the best method. Early morning seeding (before 8 a.m.) may be necessary to ensure that the ground is frozen for seeding and to prevent excessive soil rutting and soil damage from equipment. Thus, commercial producers may have to sow canola seed over several days or even weeks. Freeze thaw cycles seemed to be effective in working the seed into the soil sufficiently to create good seed to soil contact necessary for germination. Fall weed control is necessary to reduce competition on the canola. The application of spring nitrogen fertilizer should favor canola growth over the growth of henbit, but the cereal grasses will remain a concern. Future studies will consider the use of a grain drill for frost seeding compared to broadcasting the seed, and if a fall cover crop of spring oats aids in frost seeded canola establishment. Objective 2 results will be reported on at a later date.

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POSTERS THEME D

Effects of specific organs on seed oil accumulation in *B. napus L.*

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Background: Seed oil content is an important agricultural characteristic in rapeseed breeding. Genetic analysis shows that the mother plant and the embryo play critical roles in regulating seed oil accumulation. However, the overwhelming majority of previous studies have focused on oil synthesis in the developing seed of rapeseed.

Objectives: In this study, to elucidate the roles of reproductive organs on oil accumulation, silique, ovule and embryo from three rapeseed lines with high oil content (zy036, 6F313, and 61616) were cultured in vitro.

Methods and results: The results suggest that zy036 silique wall, 6F313 seed coat, and 61616 embryo have positive impacts on the seed oil accumulation. In zy036, our previous studies show that high photosynthetic activity of the silique wall contributes to seed oil accumulation. Herein, by transcriptome sequencing and sucrose detection, we found that sugar transport in 6F313 seed coat might regulate the efficiency of oil synthesis by controlling sugar concentration in ovules. In 61616 embryos, high oil accumulation efficiency was partly induced by the elevated expression of fatty-acid biosynthesis-related genes.

Conclusions: Our investigations show three organ-specific mechanisms regulating oil synthesis in rapeseed. This study provides new insights into the factors affecting seed oil accumulation in rapeseed and other oil crops.

Yield adjustment to planting date in *Brassica napus L.*: An implication of floral organ genesis

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Background: Canola yield component consists of silique number, seed number per silique, and seed weight. Biologically, silique number depends on effective flower numbers and branches. However, the effective flower number is usually environmental sensitive, i.e. nitrogen supply and planting date. Delayed planting occurs in current rice-canola rotation production system in China due to the global warming and postponing of rice harvesting time, which always results in the reduction of silique numbers and hence yield. However, little information is available on planting date regulates canola flower bud differentiation.

Objectives: 1, to illustrate the process of canola flower bud differentiation; 2, to grasp the dynamics of flower number at main reproductive stages under different planting date.

Methods: a consecutive three-year filed experiment was conducted with a split plot design, where three planting dates (early, optimal, and late) served as main plot and three varieties differing in maturity, 1358 (early), Zhongshuang 11 (middle), and Zheshuang8 (late) employed as sub-plot. Flower bud differentiation process was visualized by stereoscopy. Initiation of flower bud differentiation and dynamic of flower numbers were recorded as well under different planting date.

Results: Delayed planting date reduced seed yield mainly due to the reduction of silique numbers. The process of flower bud differentiation was similar in all planting dates and genotypes. However, initiation of flower bud differentiation and duration were largely varied under different planting dates and among genotypes. Flower numbers among genotypes and planting dates showed increased from budding to middle flowering stage and then decreased to the level of budding stage. Flowers at delayed planting date were significantly lower than that optimal planting date in all genotypes, which averagely reduced by more than 10%. Genotypic variation of flowers was markedly. Zheshuang 8 produced more flowers than other genotypes under all planting dates. The ratio of effective siliques to total flowers ranged from 60 to 70% in gentoypes at all planting dates.

Conclusions: 1, high activity of flower bud differentiation kept from budding stage and ended at end of flowering under all planting dates; 2, flowers at budding stage is a key point to determine the final effective silique numbers; 3, large quality of flowers after budding stage degenerated; 4, insufficient growth under delayed planting date caused reduction of flowers.

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POSTERS THEME D

Characterization of winter oilseed rape response to density and initial conditions

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Background: Plant plasticity is the capacity for a plant to adapt to its environmental constraints (Sultan, 2000). A better understanding of winter oilseed rape plasticity may help to explain plant functioning and to predict plant behaviour in a changing environment.

Objectives: Due to this plasticity, there is a great variability between plants within a crop (Behrens and Diepenbrock, 2006), expressed by different features of architecture, among which the number of leaves and branches. Our objective is to understand how this variability takes place. In this article, we focus on the vegetative part of the crop cycle and simple architectural variables.

Methods: One cultivar (Pollen) have been grown in ten square containers in order to control growth conditions (Grignon, France, 2012-2013). Plants were sowed in buckets and transplanted two weeks later at two densities (49 and 35 pl/m2) with a regular distribution pattern. At the highest density, there was two treatments: homogenous (plants with similar sizes) and heterogeneous (plants were divided into three categories depending on their initial size: Small, Medium, Big). The pattern of distribution of heterogeneous plants was predefined in order to study different types of neighbourhood. At the lowest density, there was only the homogenous treatment.

Once a week from September 2012 to April 2013, the number of leaves by plant was counted and plants were photographed to compute green surface area. Besides, four destructive measurements have been carried out: initial stage, end of winter, end of branch appearance, flowering stage. At each date, all the plants of each container were weighted, organ-by-organ. Results are derived from statistical methods applied to the experimental data (software R 2.15.2).

Results: A great variability in the leaf dynamics was observed even within a pot, whatever the treatment. The number of final leaves ranges from 14 to 32. Considering only the heterogeneous experiment, initial plant size explained 30% of the variability of final leaf number. There is a significant effect of the initial size on phyllochron too. The ranking of plant phyllochrons remained constant over time, meaning the heterogeneity was maintained during the growth, without visible rebalancing effects between plants.

Conclusion: Next step of this work is to study neighbourhood effect between plants using photographies. This study may help to better understand interactions between plants within the crop. These results will be used to validate a functional-structural plant model of WOSR and extend it from individual plant to population of plant level.

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POSTERS THEME D

Branching regulation by red to far-red ratio in *Brassica napus*

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Background: Branching is a key process of plant architecture and yield because it determines the number of inflorescences and pods. Its regulation is highly complex (Jansen et al., 2014) and is part of the so-called shade avoidance answer (Casal, 2012). In the field, the main identified factors that triggers or repress branching are the competition for light and red to far-red ratio (ζ, Chelle et al., 2007).). If many studies can be found on other species, these processes have been scarcely studied on Winter Oilseed rape (WOSR).

Objectives: The objective of the study is to characterize the answer of the plant to a reduction of ζ. Two different devices were used: blue filter and far-red diodes, both reducing ζ. One of the questions was: One of the questions was: is it possible to make a plant isolated to resemble a crop plant by only modifying the red to far red ratio in the environment? A major concern was to disentangle the effect of light quality (ζ) and light quantity (PPFD, Photosynthetic Photon Flux Density).

Methods: Two experiments were carried out. In the first one, plants in pot were placed at a density of 20 plants.m-2 into mini-greenhouses made of blue filters that reduces the ζ and PPFD (ζ-). Thus two different Controls were added: one with a filter reducing the PPFD but not the ζ (PPFD-), and a second one without any filter. Filters were applied at different periods of times and for different durations. In the second experiment, isolated plants in pots were placed outside. The base of the stem was lighted with far-red diodes to reduce ζ. Plants were compared to Control plants without diodes. In the third experiment, plants grown in the field were placed isolated (by destruction of their neighbours) from the end of winter phase.

Results: We observed no reduction in the number of branches in the plants grown under ζ- and PPFD-. However, plants presented characteristics of the shade-avoidance response: higher stem, and longer ramifications. Plants with far-red diodes did not bear branches at the base of their stem that was longer than the one of the Control plants. Isolated plants grown in the field presented a bushy port.

Conclusions: Results confirmed that ζ triggers or represses branching in WOSR. The plant response seems global with filter device, while more focused on branching using diode device. Interactions with PPFD and thus with carbon resources was also evidenced. Further characterisations on biomass allocation within the different architectures obtained could help understanding plant response and the interaction with the C functioning.

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POSTERS THEME D

Strategies to augment oilseed brassica production in India through systematic evaluation of land resources

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Background: India is world's fourth largest edible oil economy with total consumption of 18.94 mT against domestic availability of 8.96 mT during 2011-12 (DAC, 2013). The gap between demand and domestic supply is expected to widen with annual compounded growth rate of 2.7% in demand in comparison to 2.2% in domestic availability. The gap between production and consumption could be reduced through augmenting productivity, building favourable infrastructure and policy support. And assessment of natural resources and prevailing land use conditions is a pre-requisite for building sustainable production system.

Objectives: Oilseed *Brassica* (OSB) has enormous production potential to meet edible oil demand of the country (Kandpal et al 2001). But, matching requirement of OSB varieties to existing landuse conditions is essential. This calls for systematic evaluation of all land resources to identify existing and potential high OSB production zones in the country. With this hypothesis an attempts has been made to identify dominant land utilization types (LUTs) under OSB production system and suggested suitable strategies. To develop efficient resource and input based dynamic strategies for enhancing mustard production in the country.

Methods: Twelve attributes (Kandpal et al, 2001) from climate normals of 103 observatories and 13 landuse attributes of 242 districts under OSB cultivation were calibrated and statistically analyzed. Various thematic maps were generated and subsequently superimposed to generate LUT map. The final map was used to generate separate strategies using socio-economic conditions, infrastructure and institutional support in respective LUTs.

Results: The important OSB producing districts has been grouped into five LUTs. Subsistence farming is prevalent in 78 districts covering 0.28 mha area. Low adoption of technologies and varieties resulting poor seed yield (<0.78 t/ha). The productivity in this LUT could be improved to 1.35 t/ha through adoption of latest varieties, balance use of NPK fertilizers, soil-water conservation techniques and extensive extension activities. Almost 0.97 mha area of 93 districts with average seed yield of 0.98 t/ha is under transitional phase from subsistence to commercial farming. The productivity potential of 1.8 t/ha has been assessed through adoption of latest varieties, biofertilizer application, ensure use of NPKS fertilizers, protective irrigation, extensive extension activities, promotion of small-scale industries and market support. OSB is one of the important commercial crop in 43 districts occupying 1.26 mha area with average yield of 1.02 t/ha. The LUT has potential to produce seed >2.5 t/ha through assured supply of quality seed, biofertilizer application, soil-test-based application of micro-nutrients, management of biotic stress and market support.

OSB is produced as high acreage-high yielding cash crop in 12 districts occupying almost 12% GCA (1.14 mha) with average yield of 1.32 t/ha. While it is most dominant crop in 16 districts covering 1.52 mha area with average seed yield of 1.42 t/ha. These two LUTs has potential to achieve 3.0+ t/ha yield targets through addressing various soil-health issues and adoption of LUT based efficient production technologies.

Conclusions: There is significant variability among the OSB cultivation conditions and hence in strategies to enhance production. The technologies for different LUTs are already available but needs refinement for easy adoption. A strong support from extension agencies, policy planner and other stakeholders is also required to achieve the targets.

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POSTERS THEME D

The effect of temperature stress on heterosis in spring *Brassica napus L.*

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Background: Early planting date has been identified as a critical component of achieving increased seed yield in spring *Brassica napus L.* (canola) in Canada (Kirkland and Johnson, 2000). Heat stress has been implicated in limiting seed yield of spring canola grown in Canada (Kutcher, et al., 2010). Heat is especially problematic in Canada compared to other canola growing regions because the most sensitive growth stage in spring canola (floral development/reproduction) often occurs during the highest temperatures of the growing season. It is imperative that parental heat tolerance is examined to determine the interaction and impact in the resulting hybrid.

Objectives: To determine the effect of temperature stress on heterosis in a set of elite spring canola inbreds and the corresponding hybrid combinations.

Methods: A group of 10 inbreds (5 females and 5 restorers), 25 hybrids and 2 control cultivars were planted at four locations (2 Manitoba, 2 Ontario) in a split plot randomized complete block design with four replications. The main plot was planting date and the sub plot was genotype. Inbreds and hybrids were blocked together to minimize neighbor effects and the plots were 1.5m x 6m with treatments and replications included in all rows and columns. Temperature was recorded from planting date to physiological maturity. Data was collected on early growth, days to first flower, days to last flower, flower number, pod number, plant height, maturity, seed yield, thousand kernel weight and seed oil, seed protein, glucosinolate and saturate content. Best linear unbiased predictions were calculated for inbred per se yield, hybrid yield and inbred general combining ability.

Results: There was a significant effect of treatment on yield and yield components across three of the four locations tested. Hybrids exhibited heterosis across treatments at all locations and the effect of heterosis increased when the planting date was delayed. A second field season will be conducted in 2015.

Conclusions: The effect of planting date significantly reduced yield and yield components. Heterosis significantly increased the yield and yield components. Subsequent field seasons are required to elucidate the true effect of heat stress and minimize confounding factors that invariably occur in field environments.

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POSTERS THEME D

Soil nitrogen availability affects nitrogen distribution in spring oilseed rape *(Brassica napus L.)*

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Background: Rapeseed has a high capacity to take up mineral nitrogen (N) from the soil, accumulating large amounts of N in vegetative tissues (Rossato et al., 2001). The N content declines with cumulative leaf area index assessed from the top of the canopy, indicating that N distribution is driven to some extent by light distribution within the canopy, which is the main driver of carbon assimilation. However, how environmental factors such as light, N availability and their interaction exactly govern these N gradients, is still largely unknown. This understanding is necessary in any attempt to improve the N-use efficiency of rapeseed, manipulating it by means of plant breeding or optimizing fertilization strategies.

Objectives: The aim of this study was to evaluate the effect of soil N availability and leaf light interception on N content per unit of leaf area and their physiological determinants in rapeseed.

Methods: On April 17th 2013 spring rapeseed (Solar CL) was sown in Wageningen, the Netherlands, under an open-sided shelter. The treatments were two rates of N fertilization (50 and 150 kgha-1) and two plant population densities (50 and 150 plants m-2), arranged in a factorial design with three replications. Photon flux density was measured at canopy level. Phenological growth stages were recorded and leaf photosynthesis measurements were carried out on five plants. A sampling was performed 7 days before flowering to determine leaf area as well as dry matter weight and N content of individual leaves. With this information N content per leaf area (Narea), leaf mass per unit of area (LMA) and N per unit of leaf mass (Nmass) were calculated. The remaining leaves and stems were also collected to estimate N uptake. Soil samples were collected at six stages to estimate N content.

Results: Narea was affected by leaf position in the plant showing variation in response to N availability and plant population density. This trait was asymptotically related to light saturated photosynthesis rate per unit of area. At high N availability, photon flux density was correlated with LMA, which is the physiological trait most associated with Narea. Under N shortage, N availability was closely related to N uptake, which, in turn, was linearly related with Nmass.

Conclusions: Leaf area and total leaf N content were affected by N availability and plant population density.

LMA, the physiological trait most associated with Narea, was clearly associated with photon flux density at high N availability. Under N shortage, N availability became the limiting factor for N allocation. This suggests that manipulating traits associated to LMA (i.e., leaf thickness, density) are the most feasible ways to improve leaf N content. For breeding programs with a focus on low N input, besides LMA, traits associated with Nmass can be manipulated to increase carbon assimilation.

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The impact of *Rhizoctonia spp.* on crop stand establishment in canola and new seed treatment solutions

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Background: Over the years canola in Canada has become a key crop. Introduction of new genetics, hybrid varieties, excellent weed control technology, soil conservation ensuring soil moisture at planting, and precision planters have all led to higher yields and productivity. In addition, canola planted hectares have increased significantly since the introduction of canola which has resulted in changes in agricultural practices such as shorter cropping rotations and continuous cropping. The impact of shorter cropping rotations and crop residue from the previous year have the potential to increase the prevalence and severity of soil-borne pathogens such as *Rhizoctonia* spp. The direct impact is seed rot, pre- and post-emergence damping-off, and seedling blight resulting in poor crop stand establishment.

Objective: A three year survey was initiated across the prairie provinces of Canada to assess the distribution and prevalence of *Rhizoctonia solani* in canola, barley, beans, corn, pea soybean and wheat crops and to characterize recovered isolates for anastomosis grouping and pathogenicity. The second objective also evaluated new seed treatment technology in canola to control early season infection from *R. solani* to protect seedlings from poor establishment early after planting.

Methods: In 2009, 2010, and 2011, field crops were surveyed in Alberta, Saskatchewan, and Manitoba at the early seedling stage. A diamond–shaped pattern of 50 m per side was used for sampling . Twenty seedlings were collected per field with one seedling sampled every 10 m around each side of the diamond. Seedlings were shipped to the University of Guelph for processing. Isolates of *R. solani* recovered from plant tissue were characterized for number of nuclei, anastomosis groups, and pathogenicity. Isolates found to have pathogenicity were used to evaluate seed treatment activity in field.

Results: Of the 61 fields surveyed, *R. solani* was recovered from 35 (57%) of the field samples. A total of 130 isolates of *R. solani* were found belonging to anastomosis groups (AG) 2-1, 4, 5, 9, and 11. Eight binucleate isolates were also recovered. In growth room studies isolates belonging to AG 2-1 were virulent primarily on canola while isolates of other anastomosis groups tended to have a wider host range. Symptoms included pre and post-emergence damping off, crown rot, and to a lesser extent root rot. The majority of binucleate isolates ranged from non-pathogenic to low virulence on the hosts tested. Field trials evaluating seed applied fungicides for early in-season protection demonstrated excellent control of *R. solani* by preventing pre- and post-emergence damping-off in canola. A mixture of various seed- applied fungicides with different modes of action and biokinetic properties proved to be most effective in ensuring strong stand establishment.

Conclusions: Collectively, the survey results are important for documenting the widespread occurrence of *R. solani* in field crops. There is an important need for effective seed treatments in canola to maximize stand establishment to realize high yield potentials. However a holistic approach that includes agronomic practices like crop rotations is key to a sustainable and successful stand establishment in canola.

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Does canola influence soil-emitted nitrous oxide emissions from crop rotations on the Canadian prairies?

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Background: Crop production is an important source of nitrous oxide (N_2O) and contributes directly to the increasing concentration of atmospheric N_2O. Research underpinning estimates of soil-emitted N_2O from cropping systems on the Canadian prairies is based overwhelmingly on data collected from spring wheat-based cropping systems (Rochette et al. 2008). Canola is now seeded to over 30% of the total annual cropped acreage on the Canadian prairies, but limited research has quantified the potential influence that crop type may have on soil-emitted N_2O.

Objectives: 1) Compare soil-emitted N_2O emissions from canola, wheat and field pea 2) compare the influence of preceding crop type (canola, field pea and cereal) on soil emitted N_2O emissions.

Methods: Soil-atmospheric exchange of N_2O was measured approximately weekly from spring thaw to fall freeze-up using nonflow-through nonsteady-stade chambers over a three year period. Measurements were made on selected treatments in a long-term rotation study near Scott, Saskatchewan, Canada. The study was established on a on a loamy textured (Orthic Dark Brown Chernozem) soil. Crops represented in the study included pea (*Pisum sativum L.*), spring wheat (*Triticum aestivum L.*) and canola (*Brassica napus L.*). Specific rotations considered included continuous pea, wheat-pea, pea-canola-wheat, canola-wheat, continuous wheat and, continuous wheat without N fertilizer (check). Measurements on the pea-canola-wheat rotation were taken on the canola phase only. Canola and wheat crops received recommended applications of fertilizer N, with the exception of the wheat "check" treatment.

Results: Annual estimates of direct soil-emitted N_2O ranged from 0.16 to 0.93 kg N2O-N ha-1. Emissions from the pea phase of rotations were low and comparable to the unfertilized wheat check (no N applied). Emissions were similar for wheat or canola crops grown on wheat or pea residues. Over the 3-years, the fraction of fertilizer N lost as N_2O ranged from about 0.1% to 0.2% on the latter plots. Wheat grown on canola residues had significantly higher emissions, with the fraction of fertilizer N lost as N_2O averaging about 0.5%

Conclusions: Nitrous oxide emissions from the pea phase of the rotations were lower than the N-fertilized wheat or canola phases, and were not different from the unfertilized check. Emissions were similar for wheat or canola phases when grown on wheat or pea residues, but N_2O emissions were significantly higher when wheat was grown on canola residue. Further research is required to determine why fertilizer-induced N_2O emissions are higher in the presence of canola compared to wheat or pea residues.

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POSTERS THEME D

Consistency of different waterlogging-tolerance indexes in canola *(Brassica napus L.)* after submerging seeds in the room and plants in the field

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Background: Canola (*Brassica napus L.*) is one of the three most important oil crops in China. It is mainly grown in Yangtze River Basin, where the winter oilseed rape is often followed by a paddy rice crop which is flooded for several weeks during spring and summer and it rains often in autumns. The waterlogging stress happens during the seedling stage, bolting stage and flowering stage of canola. It is extremely important to enhance its waterlogging-tolerance and efficiently breed and screen out the tolerant cultivars.

Objectives: The objective of this study is to determine the consistency of different waterlogging-tolerance indexes in canola after submerging seeds in the room and plants in the field.

Methods: A total of 15 canola cultivars with different levels of waterlogging tolerance were selected for the study. Both indoor anoxic germination and artificial waterlogging under field conditions were carried out to determine several waterlogging related morphological and physiological indexes. For indoor study, germinated canola seeds were submerged in distilled water for 14 hours before further growth. Several morphological indexes were measured to evaluate waterlogging tolerance of these canola cultivars. For the field study, canola plants were subjected to successive artificial water flooding for 10 days at seedling stage. Morphological and physiological indexes after waterlogging treatment, yield traits at mature stage were measured. Correlation analysis between waterlogging-tolerant indexes of germinating seed in the room and those physiological and morphological data in the fields was performed.

Results: The results showed significant variation between 15 canola cultivars. Anoxic germination under room condition resulted in great differences in kinds of waterlogging-tolerant indexes, such as vigor index, survival rate, relative seedling length, relative root length and fresh weight; in the fields, plant growths were repressed seriously under waterlogging stress: root fresh weight, root length, aerial parts fresh weight, plant height, plant fresh weight, aerial parts dry weight, root dry weight and root/shoot ratio were decreased by various degrees. Meanwhile, physiological indicators like contents of soluble sugar, soluble protein, malondialdehyde (MDA) and proline, as well as activity of superoxidase (SOD) increased; on the other hand, plant height, number of effective branches, number of pods per plant, number of seeds per pod, yield per plant decreased significantly. Especially, the number of effective branches decreased by 31.81%~78.02% compared with control. 1000-seed weights were increased in some materials. Waterlogging tolerance capabilities varied between materials, but generally, waterlogging-tolerant plants showed less genotype reduction. Correlation analysis showed that waterlogging-tolerant indexes of germinating seed in the room were significantly correlative to those physiological and morphological data in the fields, as well as the final yield characters.

Conclusions: This consistency demonstrated that different methods of determining waterlogging tolerance in canola came to the same conclusion. Moreover, it provides a potential possibility to screen out or predict the waterlogging-tolerant canola cultivars in the lab conditions so that the breeding of the waterlogging-tolerant cultivars can be accelerated in the future.

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Improved simulation of growth and development of canola in Australia using the APSIM-Canola model

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Background: The canola (*Brassica napus L.*) module in the Agricultural Production Systems Simulator (APSIM) was developed in the late 1990s. APSIM-Canola simulates crop development, growth, yield and nitrogen accumulation in response to temperature, photoperiod, soil water and nitrogen supply, using a daily time-step, with widely-accepted approaches. The model was tested across a wide range of environments in the Australian grains industry and has been applied in studies of numerous agronomic and crop adaptation issues. However since that time no module improvement has occurred while significant change has occurred in canola production systems including new cultivar types (e.g. hybrids, herbicide tolerant), earlier sowing in some environments and inclusion of winter canola in high-yielding environments.

Objectives: To update the APSIM-Canola model parameters to account for the phenological and physiological characteristics of new cultivars and management systems.

Methods: We gathered phenology data (sowing and flowering dates), for a range of cultivars sown at several sowing dates and up to 16 locations across Australia (Lilley et al 2015). APSIM phenology parameters for cultivars were derived from the observed values using the optimisation process described in Robertson et al. (2002). The optimisation process used daily values of daylength and temperature between sowing and the start of flowering to account for the response of a cultivar to vernalisation, photoperiod and thermal time. The APSIM model was then run to investigate optimal management strategies for expansion of dual-purpose canola into high rainfall zone environments of Australia.

Results: Time to flowering ranged from 80 to 189 days across the range of cultivars, locations and sowing dates. The relationship between observed and predicted time to flowering showed minimal bias, with the data for each of the cultivars falling near the 1:1 line. RMSD values were between 8.5 and 12.4 days, 5 to 10% of the mean period from sowing to flowering. A simulation analysis using newly developed parameters showed that in the high rainfall zone of Australia winter canola cultivars could be sown in early autumn to provide significant forage (>2000 sheep grazing days/ha) and mean annual grain yields of 3.3-5.0 t/ha if stock were removed prior to bud-visible stage. Later sowing of spring cultivars produced similar yields but much lower grazing potential.

Conclusions: The APSIM parameters derived in this process enabled simulation analysis of farming systems to address contemporary farming systems issues with current and relevant cultivars. This included an analysis of several management factors to optimise productivity of dual-purpose canola in Australia's high rainfall zone.

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Have your canola and eat it too - European winter canola for dual-purpose (grain-graze) use in Australia

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Background: Dual-purpose crops grazed by livestock during the vegetative stage and then grown on to produce grain are an effective way to intensify agricultural production. Though Australia mostly grows spring crops in low to medium rainfall areas (350-500 mm), cropping has recently expanded into the colder, higher rainfall zones (>600 mm) (Zhang et al 2006, Riffkin et al 2012). Dual-purpose cropping of winter cereals has been practiced in the area for some time, while the idea of using winter canola (*Brassica napus*) as a dual-purpose rotation crop is relatively new (Kirkegaard et al 2008; Sprague et al 2013), but adds flexibility and profitability to the farm business.

Objectives: We investigated the feasibility and profitability of using dual-purpose European winter canola, as both autumn-sown annual crops, and spring-sown biennial crops.

Methods: European winter canola varieties were sown in a number of replicated agronomic experiments in the high rainfall zone of southern Australia. The experiments were designed so that areas of the plots could be grazed by sheep during the vegetative stage with un-grazed plots excluded by fencing. Experiments included autumn-sown plots (March/April) that were grazed in winter (June-August) and harvested in December, and spring-sown plots (sown November) that were grazed from January to May and also harvested in December. Grain yield was measured at maturity.

Results: From 750 to 2500 sheep grazing days/ha could be achieved during the May to August period for March-sown crops, with little impact of grazing on seed yield (range 1.9 to 4.5 t/ha). These data are consistent with earlier studies that used mechanical defoliation or "crash-grazing" (Kirkegaard et al. 2008) and confirm excellent performance of winter canola under more prolonged commercial grazing. The spring-sown crops also provided a significant amount of summer and autumn forage for grazing and recovered to produce high grain yield, although the impacts of grazing on the spring-sown crops was more variable.

Conclusions: The European winter canola types provided large amounts of forage that was highly valuable to the livestock enterprise in winter, and recovered to produce high grain yield. The concept is an excellent avenue for sustainable intensification of food production on mixed farms in Australia's high rainfall zone.

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POSTERS THEME D

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Evaluation and selection criteria of drought tolerance in Chinese semi-winter type rapeseed at different developmental stages

Background: Water deficit has long been considered as the top environmental factor limiting crop productivity worldwide (Boyer 1982), and tolerance to drought is definitely one of the most complex biological traits. It is of great interest to understand the architecture of biological traits that contribute to seed yield under stressed condition, since it is vital for the breeding of drought tolerant variety. So far, little is known about the yield structure and selection criteria for semi-winter type rapeseed varieties adaptable to the drought-prone environments.

Objectives: The present study was conducted to (1) clarify whether drought tolerance is stage-specific in Chinese semi-winter type rapeseed; (2) evaluate the impact of exceptionally long and severe climatic drought on seed yield and its component traits; and (3) establish selection criteria for the breeding of drought tolerant varieties.

Methods: Thirty seven newly bred Chinese semi-winter type rapeseed varieties were used as plant materials in this study. This panel includes 35 F1 hybrids and 2 open-pollinated varieties. The method of sand cultivation was employed (Hu et al. 2013). At seedling stage, nutrient solution plus 14% (w/v) PEG6000 was used to stimulate an osmotic stress. The field experiments included two treatments, i.e. rainfed (drought stress) and irrigated (moisture condition). A randomized complete block design was used, each with three replications. Plants were harvested when they ripened in April. Thirteen biological traits were measure both under stress and control conditions.

Results: Severe osmotic stress has great impact on seed germination and caused a reduction in Seeds vigor by 33.1%. Seed yields of 37 genotypes ranged from 45 to 2339 kg/ha, with an average of 759.5 kg/ha under drought stress. Drought susceptible index for yield was significantly associated only with relative water content (r=0.622). Seed weight, height of first branch, plant height, and number of pods per plant were all markedly reduced under drought condition and thus seemed to be sensitive to drought. Two (i.e. 08SH09 and Mianza03-33) out of the top three tolerant genotypes at germination stage were also shown to be tolerant based on seed yield drought susceptibility index. To maintain higher seed yield under drought environment, a plant should grow shorter and faster but with higher seed weight and more pods per plant.

Conclusions: Tissue relative water content is a good indicator for early screening of drought tolerance. The important contributors to seed yield under drought environment were listed, in descending order, as: 1000-seed weight, days to maturity, number of pods per plant, and plant height; however, height of the first branch and number of primary branches are more vital for seed yield in moisture condition.

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Identification of drought stress-responsive genes in leaves of *Brassica napus* by RNA Sequencing

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Background: Drought is the uppermost natural stress factor causing reduction of crop yield. The major rapeseed (*Brassica napus*) production region is often threatened by drought disaster, severely affecting the supply security of edible oils.

Objectives: To identify the candidate genes involved in drought stress response in leaves of *Brassica napus* thereby exploring the molecular mechanism of drought stress adaptation of it, the transcriptomes of *B. napus* seedlings leaves under two different conditions were compared using RNA sequencing (RNA-Seq).

Methods: Total RNA were extracted from leaves of *B. napus* cultivar ZY821 at six-leaf stage under normal (ZY) and natural water loss (ZY8D) conditions, and then were used for RNA-Seq analysis on the Illumina Hiseq 2000 platform. Ambiguous reads and low-quality reads were filtered using NGSQCTookit v2.3.3. The TopHat2-Cufflinks-Cuffmerge-Cuffdiff standard pipeline was applied to identify the differentially expressed genes (DEGs), taking the *B. rapachromosome* v1.5 and *B. oleracea Scaffold* v1.0 as reference. In order to perform GO term and KEGG enrichment analyses, the up- and down-regulated DEGs were further analyzed using the BiNGO plugin in Cytoscape v3.1.0 and KOBAS2.0, respectively. Subsequently, the qRT-PCR assays were implemented to verify the expression patterns of three representatives of the up- and down-regulated DEGs, respectively.

Results: After filtration, a total of 26192312 and 28378899 high-quality reads were acquired in ZY and ZY8D for screening DEGs, 86.6% and 85.8% of the filtered reads derived from ZY and ZY8D could be accurately mapped to the reference sequence, demonstrating the high confidence of the RNA-Seq and the reference. Of the 3 657 DEGs, 1 431 and 2 226 genes were detected to be up- and down-regulated, respectively. GO enrichment analysis indicated that the up-regulated genes were mainly enriched in response to abiotic stress and chemical stimulus, and 127 and 141 out of these DEGs were involved in response to water deprivation and ABA stimulus, respectively. However, down-regulated DEGs were mainly overrepresented in defense response to plant pathogen, protein kinase activity and response to SA stimulus. KEGG enrichment analysis showed that up-regulated genes were significantly associated with phenylpropanoid and carotenoid biosynthesis pathways, and starch and sucrose metabolism, while the down-regulated DEGs mainly enriched in plant-pathogen interaction and signal transduction pathways of ABA, SA and jasmonic acid (JA). The results of qRT-PCR analysis of six DEGs were consistent with those of RNA-Seq data, further confirming the reliability of RNA-Seq results.

Conclusions: In total, 3 657 drought stress-responsive genes were identified using RNA-Seq. GO and KEGG pathway analyses identified the overrepresented molecular function categories and pathways of DEGs.

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The transitional cultivation patterns of winter oilseed rape in China and the rorresponding nutrient management strategies

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Background: Both direct-sowing and transplanting are the dominated methods to establish winter oilseed rape (*Brassica napus L.*) in the current Yangtze River Basin, China, which play important roles in the development of national oilseed rape industry and edible oil supply security. Direct-sowing was the main cultivation pattern at the beginning and transplantation get started from 1960s with direct-sowing as primary, and then transplantation became get full-scale adoption during 1980s to 1990s. Nowadays, direct-sowing and transplantation cultivations have co-existed in winter oilseed rape production of China. Correspondingly, nutrient management practices had progressed from farmyard manure application to nitrogen (N) and phosphorus (P) chemical fertilizers application, and then converted to advocate the balanced application of N, P, potassium (K), and borax (B) fertilizers, and now formed the high-yielding and high efficiency technique system for transplanted oilseed rape.

Objective: There were significant differences in the cultivation characters and growth progresses between direct-sown winter oilseed rape (DOR) and transplanted winter oilseed rape (TOR), their growth stages, plant density, population structure and individual morphology were emphatically compared. Furthermore, the differences in nutrient responses, absorption and distribution, requirement and utilization between DOR and TOR were emphatically compared and discussed.

Results: The DOR showed generally shorter growth stages, weaker plants and lower individual yield, compared with TOR. However, DOR played group effects under the higher plant density and had stronger abilities to absorb nutrient and water due to the greater root group, and therefore showed the potential of high yield and high efficiency. DOR were more sensitive to nutrient deficiency and insufficient nutrient supply leaded to weak individual growth and population decline. DOR had lower biomass and nutrient transport efficiencies, and it showed higher requirement for P and K than TOR. The nutrient management strategy of "promotion in early and stabilization in late" for DOR was presented according to the existing researches, and it included: ensuring P and K supply based on the rational and balanced nutrients application, applying organic fertilizer and returning straw, and paying more attention to the role of N fertilizer in the development of individual and population. The N fertilizer as basal should be reduced and seedling topdressing need to be increased to improve plant growth in the early stage, and appropriate topdressing before flowing are also required to ensure population density and yield formation. The recommended N fertilizer application practice of DOR is basal fertilizer: seedling fertilizer: overwintering fertilizer: bolting fertilizer = 40%:30%:15%:15%.

Conclusions: Nutrient management should work with other cultivation practices, e.g. selecting early-maturing and density-resisting variety, adopting mechanization precision sowing technique, increasing appropriately plant density to reduce fertilizer rate, compensate late-sowing, and improve sink and source, and enhancing plant protection to control diseases, pests and weeds. Furthermore, the key points in future studies for DOR were also proposed in this paper, in hope of providing references for further improvement of cultivation practices and scientific fertilization technique.

Ideotype population exploration: Growth, photosynthesis, and yield components at different planting densities in winter oilseed rape *(Brassica napus L.)*

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Background: Rapeseed is one of the most important edible oil crops in the world and the seed yield has lagged behind the increasing demand driven by population growth. Winter oilseed rape (*Brassica napus L.*) is widely cultivated with relatively low yield in China, so it is necessary to find the strategies to improve the expression of yield potential. Planting density influences the yield by regulating growth, yield components (Diepenbrock 2000), and photosynthesis, which are the target traits closely related to the ideotype of crops (Donald 1968). Few studies have described the ideal population structure in winter rapeseed.

Objectives: The objectives of this study were to optimize the yield and yield components of two elite winter varieties that were commonly grown in the Yangtze River basin under several planting densities and to identify the physiological mechanisms that contribute to the high yield.

Methods: The field experiments were conducted in Wuhan in the Yangtze River basin with one conventional variety (Zhongshuang 11, ZS11) and one hybrid variety (Huayouza 9, HYZ9) at five planting densities (27.0 × 104, 37.5 × 104, 48.0 × 104, 58.5 × 104, 69.0 × 104 plants ha–1) to investigate the yield components. The physiological traits for high-yield and normal-yield populations were measured.

Results: Our results indicated that planting densities of 58.5 × 104 plants ha–1 in ZS11 and 48.0 × 104 plants ha–1 in HYZ9 have significantly higher yield compared with the density of 27.0 × 104 plants ha–1for both varieties. The higher leaf net photosynthetic rate (Pn) and water use efficiency (WUE) were observed in the high-yield populations. A significantly higher level of silique wall photosynthesis and rapid dry matter accumulation were supposed to result in the maximum seed yield.

Conclusions: The ideal morphological traits of the two varieties were moderate number of siliques and primary branches per plant as well as high number of siliques and primary branches per unit area. Furthermore, higher LAI (~5.0), Pn, and WUE were observed in the high-yield population, whereas they decreased more rapidly after anthesis compared with the normal-yield population. It was suggested that the higher SAI (~7.0) and longer duration of high silique wall photosynthesis likely resulted in a significantly higher biomass at the seed-filling stage and a subsequently higher seed yield.

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POSTERS THEME D

Leaf-pod senescence, root morphology and seed yield of winter oilseed rape *(Brassica napus L.)* at varying plant densities

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Background: Oilseed rape is one of the most important sources of edible oil in human diet. Winter oilseed rape (*Brassica napus L.*) is widely cultivated along the Yangtze River in China, which represents about 30% of total seed yield worldwide and 89% of that national wide. With the increasing demands driven by population growth, it is necessary to increase the seed yield of rapeseed crops. Plant density is an important factor affecting seed yield and yield components of oilseed rape as well as creating a difference between individual and group performance that can be utilized. Photosynthate supply plays an important role in pod and seed development (Alex et al. 2006). The root is the most important organs of plants for uptaking water and nutrients (Gersani et al. 2001).

Objectives: The objective of the present study was to (i) investigate leaf-pod senescence and the root morphological parameters and their effects on seed yield at different plant densities by using two elite winter rapeseed varieties that were commonly grown in the Yangtze River basin; and (ii) determine possible mechanisms behind this effect.

Methods: The conventional winter rapeseed variety Zhongshuang 11 (ZS 11) and the hybrid variety Zhongyouza 12 (ZYZ 12) were used. The assay of leaf and pod wall photosynthesis, chlorophyll and lipid peroxidation, root morphology and dry matter biomass and nitrogen use efficiency in high yield population (HYP) and normal yield population (NYP) were determined.

Results: HYP showed a rapid decrease in GLAI, leaf photosynthetic rate and chlorophyll content after peak anthesis. The high yield highlighted the rapid increase of PAI and longer duration of high pod wall photosynthesis accompanying with the accelerated leaf senescence after peak anthesis. Moreover, the larger reduction of root morphological parameters (root length, root tips, root surface area and root volume) showed the availability of more assimilation from vegetative organs to the pods and seeds.

Conclusions: The high yield highlighted the rapid increase of PAI and longer duration of high pod wall photosynthesis accompanied with the accelerated leaf senescence after peak anthesis. Moreover, the larger reduction of root morphological parameters showed the availability of more assimilation from vegetative organs to the pods and seeds.

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Mineral nutrient efficiency remobilization during leaf senescence and modulation by nutrient deficiency

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Background: As sessile organisms, higher plants have to cope with permanently fluctuating mineral resource availability. Besides strategies such as stimulation of root growth (Gruber et al., 2013), increased transporter activities (Gojon et al., 2009) and biotic interactions, nutrient storage and further mobilization have been mostly studied for only a few macronutrients, nitrogen being the most described (Avice and Etienne, 2014).

Objectives: The aims of this study were firstly to monitor the apparent remobilization of macro- and micronutrients from senescing leaves in 5 crop species (*Brassica napus, Triticum aestivum, Hordeum vulgare, Pisum sativum, Zea mays*) with the aim to describe contrasting patterns of remobilization. Finally, the putative remobilization of each nutrient was quantified using *B. napus* subjected to 13 individual nutrient deficiencies in order to maximize remobilization and decipher whether remobilization is also triggered by senescence and/or nutrient deficiency.

Methods: Leaves of *Brassica napus, Triticum aestivum, Hordeum vulgare, Pisum sativum, Zea mays* grown under field conditions were harvested regularly during their life span and analysed to evaluate the net mobilization of 13 nutrients during leaf senescence. Further experiments were performed with rapeseed plants subjected to individual nutrient deficiencies

Results: While N was remobilized in all plant species with different efficiencies ranging from 40% (maize) to 90% (barley), rapeseed has intermediate remobilization efficiency. Other macronutrients (K-P-S-Mg) were mobilized in most species. Ca and Mn, usually considered as having low phloem mobility were remobilized from leaves in wheat and barley. Leaf content of Cu-Mo-Ni-B-Fe-Zn decreased in some species, revealing that they can be remobilized. Overall, wheat and barley appeared to be the most efficient at remobilization while maize and rapeseed were the least efficient. In rapeseed, compared to field conditions, remobilization from leaves was similar (N-S-Cu) or increased by nutrient deficiency (K-P-Mg) while nutrient deficiency had no effect on Mo-Zn-B-Ca-Mn, which seemed to be non-mobile during leaf senescence under field conditions. However, Ca and Mn were largely mobilized from roots to shoots.

Conclusions: Following 13 different nutrients suggests that rather different mechanisms will need to be considered: remobilization from organic storage forms (such as for N) tightly linked to senescence, mineral storage that requires more or less specific transporters (S-Mg-K-P), the effect of deficiency that increased remobilization compensating under reduced root uptake, restricted transport, and finally remobilization from shoots or from roots (Mn-Ca).

Using 5 plant species suggests that remobilization efficiency is probably affected by previous plant breeding, the plant development scheme (source sink ratio or environmentally induced senescence), and plant evolution.

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POSTERS THEME D

Some aspects of intercropping fall-sown rapeseed with annual legumes for fresh forage production

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Background: Fall-sown brassicas, such as fodder kale (*Brassica oleracea L.* var. *viridis L.*) or rapeseed (*Brassica napus L.*) are considered the first sources of fresh forage in the spring in many temperate regions, such as South Eastern Europe, and are highly esteemed in feeding milk cows. Despite considerably high fresh forage yield and prominent earliness, rapeseed usually contains about 10% of forage dry matter and thus is often regarded as being less overall productive than other annual forage crops.

Objectives: In order to enhance the agronomic performance of rapeseed, a model was developed of intercropping rapeseed with annual legumes, such as pea (*Pisum sativum L.*) and vetches (*Vicia* spp.), aiming at increasing the total fresh forage and forage dry matter crude protein yields, decreasing the weed infestation and demonstrate the superiority of rapeseed-legume intercrops over their sole crops. Such models were previously demonstrated as beneficial for the mineral nutrition of both components (Mikić et al. 2015).

Methods: A series of small-plot trials was carried out from 2010/2011 to 2012/2013 at the Experimental Field of IFVCNS at Rimski Šančevi, in the vicinity of Novi Sad. It included four intercrops at a ratio of 50%: 50% of rapeseed, playing the role of a supporting crop, with four annual forage legume cultivars, namely pea and Hungarian (*V. pannonica Crantz*), common (*V. sativa L.*) and hairy (*V. villosa Roth*) vetches, as the supported crops, and the sole crops of all five cultivars. Rapeseed was cut in full budding, while annual legumes were cut in full bloom. Forage dry matter (FDMY, t ha-1) and forage dry matter crude protein yields (FCPY, kg ha-1) were determined in all cultivars and their intercrops, with land equivalent ratio (LER) calculated for both parameters.

Results: The average FDMY ranged between 7.4 t ha-1 in the intercrop of rapeseed with Hungarian vetch and 9.4 t ha-1 in the intercrop of rapeseed with hairy vetch. In the first of these two intercrops, rapeseed contributed more to the total FDMY, while in the second one it was rather dominated by hairy vetch. All the values of LER for FDMY were higher than 1, proving an economic reliability of all four intercrops. Regarding the average FCPY, it was highest in the intercrop of rapeseed with hairy vetch (1996 kg ha-1). This intercrop also had the highest average LER for FCPY of 1.18.

Conclusions: The overall agronomic performance of intercropping rapeseed with annual legumes for forage production proved to be superior over the sole crop rapeseed cultivation for the same purpose in both higher forage dry matter yield and forage dry matter crude protein yield, suggesting it as a potential novel component in farming systems in temperate regions.

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The accelerated aging of *Brassica napus* seed under salt stress

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Background: In the previous decades, the problem of salinization has become more prominent due to reduced availability of fresh water and increased use of inadequate irrigation water higher in salt. Under such conditions, seed germination is particularly difficult due to the high concentration of salt in the sowing zones after capillary action of soil solution. There are various endogenous (plant) and exogenous (external environment) factors affecting seed germination in saline conditions, but the most important are seed viability and seed aging. At the same time, due to the high content of oil, seed of rapeseed is very sensitive to the storage and deterioration.

Objectives: Considering the growing demand for food production on the one hand and increasingly growing areas of saline soils on the other hand, studying the tolerance of seed to increased salt content in soils becomes greatly important. The aim of this study was to investigate the effect of different NaCl concentrations on germination after exposing the seed to stressful conditions that contribute to the accelerated aging.

Methods: The seed germination and the intensity of lipid peroxidation were measured in three rapeseed genotypes: Banaćanka, Jasna and Kata. These parameters were determined in fresh seeds and repeated after exposing seeds to double stress conditions of high temperature and high humidity (100%). The accelerated aging test was performed according to the Hampton & TeKrony (1995) method in which seeds were kept in a water bath at 39°C for a period of 72h. To determine whether different concentrations of NaCl (control, 100, 150, 200 mM) cause oxidant damage in seeds, the intensity of lipid peroxidation was measured by malondialdehyde (MDA) content (Ng et al., 2000) as the most important product of lipid peroxidation.

Results: The results showed that the seed germination and intensity of lipid peroxidation depended both on the level of salt stress and on the genotypes. With increasing NaCl concentration the lipid peroxidation intensity gradually increased until the percent of seed germination decreased. Although genotype Banaćanka showed the most significant increase of lipid peroxidation intensity at the highest level of salt stress (338.1% compared to control), the lowest decline in seed germination (31.8% compared to control) was also observed.

Conclusions: The negative correlation relationship between the intensity of lipid peroxidation and seed germination indicates that the degree of peroxidation of lipid membranes is of great importance for normal processes in cells under stress conditions during the process of germination. In oilseed species autoxidation of lipids during storage is the main reason for the sudden deterioration of seeds.

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POSTERS THEME D

Brassica carinata as a winter cover crop in the southeastern United State

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Our goal is to deliver crop oils and bio-based products that are priced competitively and are commercially viable. Taking advantage of underutilized winter fallow land is a primary focus of this project. Row crop land is often some of the most fertile lands in Florida and the Southeastern United States. If winter cover crops are not grown nutrients leach out of the root zone during the off season, possibly impacting the environment. Our farm plan will demonstrate how crop rotation with a biofuel crop, *Brassica carinata*, during the dormant season of food and fiber crops can increase farmer revenue and reduce farm risk through crop diversity. In the 2014-2015 winter season over 1500 ha were planted in Florida, Georgia, and Alabama. This planting was based on 3 years of research conducted at the University of Florida's North Florida Research and Education Center in Quincy, Fl. Specific projects include development of advanced breeding lines appropriate for the region, determining optimum planting dates, planting density, fertilizer requirements, tillage practices, and row spacing. The impact of B. carinata on soil microbial activity, plant pathogenic nematodes, and soil health is also being investigated. Crop rotation aspects are being considered as well, especially the impact of carryover herbicides and the potential impact on the following summer crops including soybean, peanuts, and cotton. Thus far we have found that a mid-November planting date using 35 cm row width and a seed planting density of 8 kg/ha is optimum. With 80 kg/ha of nitrogen (25 at plant and 55 in late January) we expect a minimum yield of 1500 kg/ha. In our studies we obtain a mean yield of 3000 kg/ha with some advanced varieties being over 5000 kg/ha. With present varieties a mid-November planting can be harvested in mid-May. Major efforts are underway to select for genetics that are cold tolerant, resistant to common herbicides, shorter season, and high quality and quantity of oil.

Incidence and severity of foliar diseases in *Brassica juncea L.* (Czern. & Coss.) under elevated CO_2 is affected by plant defense chemistry

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Background: The atmospheric concentration of [CO_2] has increased by at least 35%, since the start of industrial revolution (IPCC, 2007). With increasing concern about the effects of global climate change on food production, it is important to devote greater effort towards studying the impact of various aspects of elevated CO_2 on the development of plant disease epidemics and the specific plant-pathogen interactions under field conditions (Chakraborty et al., 2008). *Brassica juncea (L.)* Czern. and Coss. (Indian mustard) is an important oilseed crop cultivated on about six million hectares of land in India. The crop accounts for nearly one-third of the oil produced in India and is considered to be country's second most important edible oil (Damodaran and Hedge 2005). Most of the previous studies reported the effect of elevated CO_2 on agronomic traits of *Brassica spp.* but none of them have analyzed its effects on plant-pathogen interactions.

Objectives: Natural incidence and severity of foliar diseases on mustard plants grown under free-air CO_2 enrichment (FACE) were examined. Effect of elevated CO_2 was also studied on plant's structural, biochemical and defense parameters and correlated with disease expression.

Methods: *B. juncea* plants were grown under FACE supplied with CO_2 concentration at a level of 550 ppm. The control plants were grown in an open field under natural conditions where concentration of CO_2 was 390 ppm. Disease incidence was recorded in mustard plants through visual inspection beginning one week after seedling emergence till inception of leaf senescence. Investigation of various structural and biochemical changes in leaves under elevated CO_2 were performed using scanning electron microscopy (SEM), spectrophotometry, and high pressure liquid chromatography (HPLC).

Results: The study revealed that there is increased incidence and severity of White rust caused by *Albugo candida* while decreased incidence and severity of *Alternaria blight* caused by *Alternaria brassicae* and Downy mildew caused by *Hyaloperonospora brassicae* in mustard plants grown at elevated CO_2. Leaves of mustard plants grown under elevated CO_2 possessed more amount of epicuticular wax which, together with higher concentration of total phenols and phenylalanine ammonia lyase activity, may have increased the ability of mustard plants to resist infection by *A. brassicae* and *H. brassicae*. Mustard plants grown under elevated CO_2 showed a decrease in stomatal density and pore size, and consequently also in stomatal conductance. This might explain the decrease in disease index of downy mildew caused by stomata-invading pathogen *H. brassicae*. There was three times higher concentration of total sugars in leaves of plants grown under FACE. A significant increase in the concentration of total glucosinolates (GSs) was also observed in plants grown under elevated CO_2, but a decrease in their diversity. Higher sugar availability and lower GSs diversity may account for higher incidence and severity of white rust caused by an obligate biotroph, *A. candida*.

Conclusion: This is the first report on altered plant-pathogen interactions under FACE from India. Our results signify the impact of elevated CO_2 on disease development in *B. juncea,* model crop, enabling to conjecture its performance in projected scenario of elevated CO_2 regime. The study highlights the fact that different pathogens of a crop may respond differently to elevated CO_2 depending on how the host itself is affected by the changed conditions. Studies on one crop cannot be extrapolated to another.

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POSTERS THEME D

Effects of solar radiation and temperature on alpha-linolenic acid content of High Oleic Low Linolenic (HOLL) Oilseed Rape

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Background: Temperature and solar radiation are known to affect fatty acid profile of crop species. Alpha-linolenic acid (C18:3) content of oilseed rape (OSR) is negatively correlated to average minimum temperature during grain filling (Baux et al. 2013). Solar radiation is also negatively correlated to OSR linolenic acid (Izquierdo et al. 2009).

Objectives: As low C18:3 content is a major quality parameter for HOLL oil, we intend to assess the effect of temperature and solar radiation on the fatty acid profile of HOLL winter OSR, in field experiments and under semi-controlled conditions.

Methods: Two HOLL varieties were grown in growth chambers from the onset of flowering until physiological maturity. Temperature was set to 10/18 °C or 15/23°C (14 hours daylight), and artificial light was either total or shaded. Fatty acid content was analyzed after hand-harvest. This trial was repeated for two growing seasons. In a field trial, we hand-harvested grains of HOLL mature plants from four different height levels. We aimed to test the hypothesis that lower pods receive less solar radiation than those from upper pods, and therefore contain seeds with higher C18:3 content. Lastly, the relationship between linolenic acid content of the HOLL hybrid variety V280OL and average minimum temperature during seed filling (as described by Baux et al. 2013) was studied by means of linear regression using data from four years of field trials.

Results: Under controlled conditions, light and temperature were both negatively correlated with linolenic acid content. The lowest C18:3 percentage was found in the treatment with highest temperature and light intensity. In the field trial, we measured more solar radiation on the top of the plant, and observed significantly lower levels of linolenic acid compared to the lowest part of the plant. The regression analysis showed that linolenic acid content of HOLL OSR was negatively correlated with average minimum temperature, even if the effect was not as strong as for conventional varieties. The parameters obtained for V280OL ($y = -0.13x + 4.06$) could be introduced in a crop model, to predict the linolenic acid content depending on the temperature during seed filling.

Conclusions: Field trials as well as experimentation in growth chambers confirmed that for HOLL OSR, temperature and solar radiation have a significant effect on linolenic acid content. To guarantee heat-stability of HOLL oil, linolenic acid content has to be as low as possible. Our results show that C18:3 content is minimized in the upper part of the plant, and with high solar radiation and warm temperature during the seed filling.

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Nitrogen fertilizer rates impacts on agronomic and environmental performance of ethiopian mustard *(Brassica carinata)* in South Dakota

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Background: The introduction of non-food oilseed crops can aid in diversifying biofuel sources and lessen the demand of producing biofuels from food-based crops such as corn and soybean. Ethiopian mustard (*Brassica carinata*) has been identified as a potential non-food biofuel crop suitable for production in South Dakota. However, the best fit for the crop in current cropping systems, best management practices, and environmental impacts remain to be determined. South Dakota State University has ongoing research projects involving carinata, including variety evaluation, fertility requirements and greenhouse gas emissions, on-farm demonstration plots, oil extraction and meal recovery, meal processing and utilization, economic and insurance analyses, and life cycle analysis. This presentation will report on this ongoing work with emphasis on N fertility requirements and environmental impacts.

Objectives:

a) Evaluate the response of carinata to various nitrogen fertilizer rates in South Dakota.

b) Evaluate soil and environmental impacts associated with carinata production managed with nitrogen fertilizer in South Dakota.

Methods: Separate nitrogen fertility trials were conducted in 2013 and 2014. In 2013, trials evaluated the response of one carinata variety to five nitrogen rates (0, 34, 67, 101, and 134 kg/ha) at four locations (Brookings, Pierre, Wall, and Bison) in South Dakota. Plot size was 1.5 m x 7.6 m, with no border rows between plots. The variety 080814EM was used at Brookings and AAC A110 was used at the other three locations. In 2014, trials evaluated the response of two carinata varieties to four N rates (0, 28, 56, and 84 kg/ha) at two locations (Brookings and Pierre). Plot size was 1.5 m x 7.6 m, with border plots between treatment plots. The nitrogen treatments were broadcast over the top of the plots immediately after planting. Soil samples were collected at the start of the experiment and at harvest from 0-10, 10-20 cm depths for analyzing soil organic carbon (SOC), soil inorganic carbon (SIC), pH, EC, and total nitrogen (TN). Soil surface greenhouse gas (GHG) fluxes were also monitored.

Results: Seed yields in 2013 were highest at Brookings, likely owing to better stands and more precipitation during the seed-filling period. In 2013 there was no yield response to applied nitrogen at any of the locations, despite early visual differences between low and high levels of applied N. Lack of border rows between treatment plots may have confounded the response to N. In 2014, both carinata varieties showed a positive, statistically significant response to applied N at the Brookings location. The best yields were observed at the N rate of 84 kg/ha. The trial at Pierre was abandoned due to herbicide drift injury. Soil parameters such as SOC, SIC, TN, pH and EC were not impacted by N rate treatment. Whereas soil surface CO_2, N_2O and CH_4 fluxes were highly variable in all the treatments and did not provide any clear trend, work is ongoing to address these further.

Conclusions: The trials showed that good yields of carinata are possible with adequate plant stands and precipitation. In 2014, the greatest carinata yields were observed at the highest nitrogen fertilizer rate used in these studies.

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POSTERS THEME D

Relative importance of pre- and post-flowering growth of *juncea* canola hybrids in water-limited environments in Australia

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Background: Canola quality *Brassica juncea* (juncea canola) has been developed as an oilseed crop for low rainfall environments. Studies on *B. juncea* have also shown that there is exploitable heterosis in seed yield. Breeding programs to develop juncea canola hybrids have been initiated by SeedNet Australia. However, there is lack of knowledge on the plant traits that promote yield heterosis under low rainfall environments.

Objectives: Field and glasshouse research aim to compare the importance of pre- and post-anthesis growth in maintaining seed yield of hybrid juncea canola in water-limited environments of Victoria, Australia.

Methods: Replicated experiments were conducted in the Mallee (low rainfall) and Wimmera (medium rainfall) regions of Victoria. Glasshouse experiments were conducted at Parkville, The University of Melbourne. The experiments were conducted for two years (2012 and 2013) and consisted of juncea canola hybrids, some of the parental lines and control cultivars of juncea canola and canola in fields. The glasshouse experiments included juncea canola hybrids, parental lines and a juncea canola control cultivar. The glasshouse experiments had two treatments: well-watered and drought imposed after first flower open to maturity.

Results: In the field trials, biomass at flowering consistently had stronger positive relationship with seed yield at low yielding sites than at higher yielding sites in both the years. Biomass at flowering had a significant and positive relationship with final biomass and harvest index at low the yielding site only. In contrast, post-anthesis growth (growth from anthesis to maturity) and final biomass had stronger positive relationship with seed yield at the high yielding site than low yield sites. At the low yielding site, biomass at flowering was more strongly related than post-anthesis growth to seed yield whereas post-anthesis growth had a stronger relationship than biomass at flowering with seed yield at the high yielding site. In the glasshouse experiments, number of pods per plant consistently had positive correlations with seed yield under well-watered condition while seeds per pod and thousand seed weight consistently had positive correlations with seed yield under drought.

Conclusions: The field results indicated that early vigour with high harvest index was desirable for seed yield at low rainfall site; and higher post-anthesis growth leading to higher total biomass is desirable for relatively high rainfall site.The glasshouse results suggested that higher seed yield under water deficit came with relatively lower number of pods but better filling leading to higher seeds per pod and thousand seed weight. In favourable moisture condition, seed yield came from higher number of pods.Breeding for low rainfall environments should target for good early growth with higher harvest index and relatively few pods allowing better seed filling under water deficit.

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Impact of water-deficit during seed development on seed yield and yield components of juncea canola

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Background: Canola quality *Brassica juncea* (juncea canola) has been developed as an oilseed crop for low rainfall environments. However, yield needs to be improved to commercialize it as an alternative crop for the low rainfall environments. Several studies have shown that *B. juncea* has exploitable yield heterosis indicating that hybrid cultivars could be a means of yield improvement. There is limited research on hybrid juncea canola. In particular, there is lack of understanding on yield components and other traits that help maintain yield heterosis under low rainfall environments.

Objectives: The glasshouse trails aim to determine most important yield components in maintaining seed yield of juncea canola hybrids under water deficit during reproductive stage.

Methods: Two glasshouse trials (one planted in February and the other in July) were conducted at the University of Melbourne, Parkville in 2014. The trials consisted of juncea canola hybrids, their parental lines and a juncea canola control cultivar. The trials had two treatments: well-watered and water-deficit after first open flower to maturity. Data were recorded for phenological traits (days to first open flower and physiological maturity), biomass at harvest, seed yield per plant, yield components (number of pods per plant, number of seeds per pod and thousand seed weight) and harvest index.

Results: In the first trial, thousand seed weight and seeds per pod were the only two traits not significantly affected by water stress. There were significant ($p<0.05$) differences between genotypes for all others traits measured. Effects of treatments were significant for days to maturity, biomass at harvest, seed yield per plant and number of pods per plant. None of the traits measured showed significant effects for genotypes x treatment interaction.

In the second trial, there were significant differences between genotypes for all the traits measured. Effects of the treatments were significant for days to maturity, biomass at harvest, seed yield per plant, number of pods per plant and thousand seed weight. Genotypes x treatment effects were significant for biomass at harvest, seed yield and number of pods per plant.

Number of pods per plant had consistently strong positive relationship with seed yield per plant in both the experiments. Thousand seed weight was not associated with seed yield in both the experiments whereas number of seeds per pod was positively associated with seed yield per plant only in the first experiment. In the both the experiments, earlier flowering and maturity was positively associated with higher harvest index and higher number of seeds per pod.

Consistent effects of treatments on number of pods per plant indicated that number of pods per plant was the major yield component responsible for seed yield variation.

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POSTERS THEME D

Improving grain quality by exploiting Genotype – Environment – Management Interactions (GEMI)

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Background: Genotype – Environment – Management Interactions (GEMI) are widely studied for grain yield, but not so much for quality parameters like oil and protein contents, fatty acid profiles, amino-acids composition, vitamins etc… Yet, with such knowledge it would be possible to define agronomic recommendations which would favor quality stability, and to complete some stakeholder's needs for quality rapeseed grains in view to produce enriched products.

Objectives: The aim is to identify the factors which affect grain quality parameters such as oil and protein contents, and to determine if these parameters generate GEMI. If GEMI are observed on winter rapeseed multi-environment trials (MET), they will be analyzed as it is usually done on the yield, and cultivar resistance to stress will be characterized.

Methods: First, statistical methods such as multiple regression or PLS regression were achieved on data from rapeseed MET, to assess the effects of environmental conditions and crop management practices on grain quality. Then, GEMI for grain quality parameters were considered and quantified by a common approach often used for grain yield. GEMI were described through an Analysis of Variance (ANOVA) model, partitioning oil or protein content variability into components linked to different sources of variation: genotype, environment, and GEMI. If GEMI are revealed to be significant, they will be explained by environmental covariates, using the DiagVar approach, in view to characterize cultivars. The used model expresses GEMI as the sum of the cultivar's specific responses to each of those stresses and resources. In that case, estimated coefficients quantify genotypes resistance to the main environmental stress.

Results: There is a negative correlation between oil and protein concentration, which is why factors affecting oil content should be opposite to those affecting protein content. These factors are mainly climatic stresses during the seed filling stage. Protein and oil contents generate significant GEMI, but remain difficult to understand entirely.

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Allelopathic effects of winter wheat stubble on winter canola germination and biomass accumulation

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Background: Winter canola (*Brassica napus L.*) is an important rotational crop for Oklahoma winter wheat (*Triticum aestivum L.*) as a tool to clean up weed infested fields. Many growers in this region are relying more and more on no-till systems to improve soil moisture holding capacity and prevent soil losses to runoff and erosion. However, establishing winter canola into no-till systems following wheat can be challenging.

Objectives: Wheat is known to have allelopathic exudates which can inhibit weed germination (Zhang et al. 2015). We hypothesize here that certain wheat varieties exert an allelopathic effect on winter canola survival in no-till systems where crop stubble is not removed.

Methods: Wheat straw samples were collected from 2 locations of Oklahoma State University's 2014 wheat variety trials, Chickasha and Lahoma, OK. Experiments were initiated as a complete 2 x 42 factorial with canola variety as factor one and wheat variety as factor two. Straw was chopped to 5cm lengths and a "tea" was made from the straw simulating a 35 bushel wheat crop with 2.5 cm of rainfall between harvest and canola planting. Wheat straw was "brewed" 48 hours and vacuum-filtered. Ten canola seeds of each variety were treated with three mLs of tea and subsequently watered as needed with distilled water. Digital images were taken at 3, 5, and 7 days after treatment (DAT). Fresh and dry weights were taken for each plot at the conclusion of the study. Digital images were evaluated for plant biomass pixel counts.

Results: One-third of the 42 varieties tested across two locations significantly decreased winter canola fresh weight 7 DAT. Wheat stubble samples from Chickasha had greater allelopathic effects than those sampled from Lahoma. The following straw samples affested canola germination and biomass accumulation as much as 50% regardless of collection location or canola variety: 'Endurance', 'Pete', 'Armour', 'OK Rising', 'WB-Grainfield', and 'Doublestop CL+'. The following wheat straw samples from Chickasha, OK significantly reduced biomass accumulation for both canola varieties: 'Deliver', 'OK Bullet', 'CJ', 'WB-Redhook', 'LCS Mint', and 'Centerfield'; however, samples of the same varieties from Lahoma did not reduce canola germination and biomass. 'Doans' was the only wheat variety to reduce canola biomass accumulation collected from Lahoma, while Chickasha samples of the same variety had no effect.

Conclusions: It is important to further investigate the capacity for wheat straw from particular varieties to impact canola germination and biomass accumulation in the fall, as this is vital to establishment and winter survival. Remaining wheat straw samples from this experiment which had an effect on canola germination will used to investigate effects in the field in Fall 2015.

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POSTERS THEME D

Enhancing soil resilience and productivity of Indian mustard through green manuring and residue management in semi-arid tropics

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Background: Oilseed brassica (OSB) is an important edible oil crop of Indian subcontinent and shares one-third of domestic edible oil production. However, yield stagnation has been experienced in last decades. Multiple soil health and climate change issues are major physical reasons for the yield stagnation which needs to be addressed immediately. And building soil organic carbon (SOC) content is most reliable but challenging option to make OSB production system sustainable in semi-arid tropics.

Objectives: Mustard residue due to poor fodder value is usually brunt to clear the field but its incorporation into the soil system could pave ways to improve the soil organic pool (DRMR, 2011). Additionally, green manuring during rainy season is advocated for improvement of fallow-mustard sequence. Therefore the purpose of the study was to evaluate the effects of mustard residue and green manure on soil health and mustard productivity.

Methods: The long term replicated experiment keeping conventional practices (CS), Sesbania Green Manuring (SGM) and 2.5 t/ha mustard straw recycle + SGM (MSGM) in main plot and eight combinations of NPK fertilizers in subplot was started in 2004-05 at Bharatpur. The crop and soil health attributes on each treatment were recorded at regular intervals over the study period. The actual yield was transformed to relative yield to minimise the temporal effect on the data. The standard ANOVA was performed to compare the treatments in a year and pooled information to draw logical conclusions.

Results: SGM significantly improved the SOC, soil organic microbial biomass, infiltration rate, available NPK status, but decreased bulk density over CP. MSGM further augmented the soil health attributes. The increase in fertilizer levels from N40P8.7K0 to N80P17.4K33.3 also improved the soil attributes gradually. This gradual improvement in soil health was clearly visible in yield attributes and seed yield from 4th year of experimentation. Overall, mustard seed yield was increased by 40.6% due to SGM and by 61.1% due to MSGM over CP in 9 years. Increase in fertilizer levels from N40 to N80 and P8.7 to P17.4 also improved the seed yield significantly while results of K application were inconsistent. The combined application of N80P17.4K33.3 synergistically increased the seed yield by 53.6% over N40P8.7K0. The growth in relative yield of mustard over years followed logarithmic function and predicted the achievement of plateau yield in 11 years under MSGM and 18 years under SGM in comparison to 33 years under CP.

Conclusion: OSB is important source of edible oil and has great potential to make India self reliant in edible oil. But the yields are presently stagnating with negative growth in area and production. The trend could be revered through application of these findings and double the seed yield and profit margin to bring back the crop to the path of sustainable production and thereby the country to reduce the import bills.

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Coefficient of correlation in winter rapeseed

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Background: Rapeseed profitability and market demands determine whether farmers will choose to grow it or not. Stable rapeseed production depends on many factors (Radić et al. 2011a). Considering that only rapeseed cultivars and hybrids with high genetic potential are grown today, for yield (over 5t per acre), oil (45-50%) and protein content (18-20%) in seed, as well as that serious growers apply adequate and opportune agricultural practices, it can be concluded that stable rapeseed production is significantly affected by various climate factors (Radić et al. 2011b). Some seed characteristics can be positively or negatively correlated, and the correlation can largely affect rapeseed seed yield.

Objectives: The aim of this study was to determine correlations between observed parameters and effect of locality on the tested winter rapeseed cultivars.

Methods: Testing took place on two localities in the Republic of Srpska, Bosnia and Herzegovina (Bijeljina and Brčko) in 2009/2010. Five different rapeseed genotypes (G-1 to G-5) were tested. The trial was laid out in three replications. Seed yield of certain genotypes was determined on an experimental plot, while 1000 seed weight, seed germination, oil and protein content were determined in the laboratory of Oil Crops Department of the Institute of Field and Vegetable Crops, Novi Sad (Serbia). The study used these parameters: climate factors, seed yield, seed germination, 1000 seed weight, seed oil and protein content. GENSTAT computer program was used for the analysis of variance of two-factorial experiments.

Results: Yield ranged between 1,838 kg (G-5) and 2,543 kg (G-3). Thousand seed weight showed similar results with lowest 3.5 g (G-5) and highest 4.3 g (G-3). Seed germination ranged between 75% (G-5) and 91% (G-3), while oil content ranged between 44.64% (G-2) and 48.15% (G-4). Protein content ranged between 17.27% (G-5) and 20.03% (G-4). Based on the results we concluded that production location significantly affected all observed parameters. There was a significant correlation between seed yield, 1000 seed weight and oil content. Observing all five cultivars and parameters, genotype G-3 was the best cultivar in the production conditions. On the other hand, G-5 had the lowest results for almost all observing parameters.

Conclusion: Based on the obtained rapeseed yield results, it can be concluded that there was a significant effect of locality on the choice of cultivars and hybrids. Therefore, it is necessary to choose appropriate cultivars and hybrids for certain localities.

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POSTERS THEME D

Study on heat stress traits tolerance in rapeseed/canola *(Brassica napus L.)*

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Background: Heat stress is an alarming threat for crop production including rapeseed/canola (*Brassica napus*). It causes early abortion of flowers and causes the pollen mother cells to rapidly enter into meiotic prophase and finally causes pollen grain death which leading to pollen sterility (Parish et al., 2012). Seed yield contributing traits, such as pods per plant, pod length, seeds per pod, seed weight are suffered by heat. High temperature during flowering time significantly reduces the seed oil and seed protein content. Seed production reduced sharply at 7d 350C and 150c HTS during early flowering stage (Angadi et al., 2000).

Objectives: To identify canola germplasm containing heat stress tolerant trait through natural and artificial screening.

Methods: A total of 160 previously genotyped *Brassica napus* germplasm of spring type canola were naturally screened in the field. Data on pollen sterility, racim height, number of pod per racim, flower abortion per racim, pod length, seed weight were taken. Different degrees of pollen sterility, flower and pod abortion, seed weight were observed in the germplasm in the field. Screening of the same germplasm under artificial heat stress simulating condition in a walk-in plant growth chamber is in progress. The heat stress simulation condition in the growth chamber is designed as 180C for 8 hours, temperature ramped up from 180C to 350C in 6 hours, followed by a constant 350C for 4 hours, and then the temperature will be ramped down from 350C to 180C in 6 hours. The heat treatment will be given for 5 day, and then will bring back the treated plants into a normal greenhouse growing conditions. A controlled experiment has set with the same germplasm without the heat stress treatment. The phenotypic data will be aligned with the SNP genotyping data to identify the genomic region controlling the heat tolerant gene(s) in the wide accessions of *B. napus* through a genome-wide association mapping.

Results: Variable pod abortion and pollen sterility were identified among the germplasm screened in the field. Under heat stress simulation condition in the growth chamber, high variation on pollen sterility, flower abortion, yellowing desiccated pod, pod abortion were observed compared with the control experiment conducted in normal greenhouse conditions. Several germplasm were identified tolerant to heat stress in growth chamber heat simulation conditions.

Conclusions: The heat stress tolerant accessions will be used in breeding program to introgress the trait into elite breeding lines. Genome-wide association mapping will be conducted to find the genomic region controlling the trait.

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Genotype by environment interactions for seed yield and physiological traits in Indian mustard *(Brassica juncea L.)* under heat stress and normal environments

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Background: Among the ever-changing components of the environment, the constantly rising ambient temperature is considered one of the most detrimental stresses (IPCC, 2007). Physiological traits are limited in number and often do not reliably portray genetic relationships since genotype by environment (G x E) interaction reduces the rate of genetic improvement. This makes it necessary to test selections over several environments. Indian mustard, because of its resilience to diverse agro climatic conditions and sustainability towards abiotic stresses (heat), occupies the premier position as an important oil producing crop in India. However, the sensitive behaviour of the existing varieties of Indian mustard to different growing environments in Rajasthan leads to fluctuations in its yield, which is mainly attributable to the occurrence of G x E interaction.

Objectives: To evaluate the G x E interaction on seed yield and physiological traits and to isolate the promising and stable genotypes based on their stability parameters.

Methods: The experiments were conducted at the experimental farm, ICAR-DRMR, Bharatpur, India during rabi 2012-13 and 2013-14 under heat stress and normal temperature situations. Two hundred seeds of each genotype including two checks (BPR-543-2 and RH-30), were sown under heat stress and normal temperature conditions in crbd with three replications. The crop was raised strictly under conserved moisture conditions. All genotypes were grown in two rows of five meter length. Growth and physiological characters, including, percent population survival at 10 days after sowing (PPS 10DAS) and percent population survival at 25 days after sowing (PPS 25DAS), percent membrane stability index (PMSI), percent excised-leaf water loss (PELWL), percent relative water content (PRWC), percent water retention capacity of leaves (PWRCL), seed yield per plant (g), 1000-seed weight (g) and percent oil content were recorded from five randomly selected plants of each genotype. Percent leaf membrane stability index (PMSI) was determined following the method of Premachandra et al., (1990) as modified by Sairam (1994).

Results: The mean sum of squares due to genotype and environment interactions was found highly significant for all the traits under study except oil content. Stability analysis was carried out as per Eberhart and Russell (1966) model for all the observed characters in order to verify the presence of variance due to component of G x E interaction. The genotype CS-54, Kanti, DRMR-1826 and RGN-48 attained more percent population survival at 10 and 25 days after sowing alongwith regression coefficient equilant to unity and S2di near to zero considered as stable. The stability parameters for PRWC revealed that genotype JN-031 (mean = 67.14, bi= 0.69, S2di=0.25), DRMR-1346 (mean = 66.67, bi= 1.03, S2di=-1.26) and DRMR-1351 (mean = 67.95, bi= 0.98, S2di=0.78) recorded high mean PRWC to population mean alongwith regression coefficient near to unity and S2di near to zero exhibiting the stability, therefore their performance was stable and desirable. The genotype GM-3 (mean=20.94, bi= 0.90, S2di=0.40) and DRMR-541-41 (mean=21.59, bi= 0.92, S2di=0.29) recorded maximum mean seed yield per plant to population mean alongwith regression coefficient near to unity and S2di near to zero considered as stable. While the genotype JN-031 had attained maximum seed yield per plant alongwith regression coefficient near to unity, exhibit average stability.

Conclusions: By genotype by environment interactions for seed yield and physiological traits it was concluded that genotype JN-031, DRMR-541-41, GN-3, JN-032, CS-54, Kanti, RGN-48, DRMR-1826, DRMR-1346 and DRMR-1351 were found as stable. Additionally these genotypes may be included in any breeding programme where objective is to develop high-yielding stable genotypes under heat stress situation.

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POSTERS THEME D

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Water use efficiency, productivity, gas exchange traits and sustainability of Indian mustard (*Brassica Juncea L.* Czernj & Cosson) under micro irrigation and fertigation system

Background : Indian mustard (*Brassica juncea*) is an important edible oilseed crop in Indian subcontinent. The area, production and productivity of rapeseed-mustard were 6.6 Mha and 8.3 mt and 1250 kg/ha. India holds 9% of world's arable land and only 4% of the water resources. Rapeseed-mustard is mainly grown under limited irrigation water conditions. The limited water can be suitable and efficiently utilized through proper irrigation scheduling under micro irrigation and fertigation of soluble major elements. Adaptive advantages of mustard to water stress also reported, but the effects of use of limited water through micro irrigation system (MIS) and different levels of N fertigation on growth, physiology, yield attributes, yield and water use efficiency had not reported adequately.

Objectives: In this background an experiments was conducted to assess the impact of irrigation methods on growth, gas exchange traits, yield attributes and yield of mustard crop, to evaluate the moisture dynamics of soil during crop growth period and the economics MIS and the check basin irrigation (CBI) on mustard based crop.

Methods: The experiment on MIS and fertigation methods for Indian mustard was conducted at DRMR farm located at 77.300 E longitudes, 27.150 N latitude (2009-12). The treatments consisted of five irrigation system in main plot viz. micro-sprinkler system (MS), MS followed by CB, drip irrigation system (DS), DS following by CB and CB alone. In sub-plot four levels of N , control (0 kg/ha N), 40 Kg/ha N, 80 Kg/ha N and 120 Kg/ha of N doses were taken.

Results: The outcomes revealed that MS, DS significantly influenced dry weight, chlorophyll concentration, photosynthetic rate, photo synthetically active radiation (PAR), internal CO_2 concentration (ICC), primary and secondary branches, main shoot length, total siliquae and 1000 seed weight. The accumulation of soluble nitrogen, sugars, starch, proline and increased internal CO_2 concentration and net photosynthesis might be the plausible reason for increased photosynthetic rate and biomass under these micro irrigation and fertigation with higher levels of N (Sharma and Ramachandra 1990, Singh).The mustard seed yield was increased by 24 % due to micro-sprinkler irrigation (MS) and by 18 % due to drip irrigation. Increase in N-fertigation levels from N0 to N80 had significantly improved mustard yield attributes, seed and oil yield while results of N120 application were inconsistent. The higher photosynthetic rate was observed with higher internal CO_2 concentration. The sustainability index MIS was > 0.50 and higher production efficiency (9-13 kg/ha/day) was also recorded under MIS.

Conclusions: Micro irrigation sytems (MIS) at every level of N fertigation out yield the effect of check basin irrigation (CBI), save up to 50 % of irrigation water and enhanced the seed and oil productivity of Indian mustard.

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N-Efficiency in winter oilseed rape and prediction by hyperspectral reflectance

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Background: Nitrogen efficiency of oilseed rape is low and high amounts of fertilizer are applied (Pouzet 1995). This causes environmental problems. Due to EU-legislative restrictions N efficiency has moved into focus of breeders. N use efficiency (NUE) is the product of N uptake efficiency (NupEff) and N utilisation efficiency (NutEff). They contribute to different portions to genetic variation in NUE (Kessel et al. 2012). Direct selection for N efficiency parameters is laborious. Indirect selection methods would be very helpful. Hyperspectral reflectance correlates with several N efficiency parameters (Müller et al. 2008).

Objectives: Genetic variation in N uptake (Nup), NupEff, NutEff and NUE is analysed. The contribution of NupEff and NutEff to genetic variation in NUE is estimated. Hyperspectral canopy reflectance is validated for its applicability as selection tool for N efficiency. Therefore calibrations for several N efficiency parameters are developed.

Methods: A diverse set of 29 genotypes was tested in 5 environments in Central and Northern Germany in two parallel trials. One was harvested at end of flowering (eof), the other one at maturity. Both trials were conducted at 2 N-levels (N0: no N fertilizer, N1: 160–180 kg N/ha). Aboveground biomass at eof and seed and straw at maturity were harvested. N content was determined. Nup, NupEff, NutEff and NUE were calculated. Hyperspectral canopy reflectance was measured in the field before flowering and during fruit development using a HandySpec Field spectrometer (tec5, 2 sensors MMS1 305–950 nm, PGS-NIR2.2 951–2215 nm). Unscrambler 10.3 (Camo) was used to calculate calibration models. Several approaches were tested.

Results: Seed yield, Nup, NupEff, NutEff and NUE showed siginificant genetic correlation. Heritabilities ranged between 0.76 (NupEff) and 0.92 (NutEff). NupEff, NutEff and NUE were significantly higher at N0 than at N1. Except NupEff the traits were significantly affected by the interaction between genotype and N level. NutEff contributed to a higher portion to genetic variation in NUE than NupEff. For Nup at maturity, Nup at eof and seed yield promising calibrations based on hyperspectral canopy reflectance were developed.

Conclusion: Significant genetic variation was found for N efficiency parameters and heritabilities were high. It can be concluded that N efficiency is a selectable trait which can be implemented in breeding programs. Hyperspectral canopy reflectance can be used as selection tool for N efficiency.

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POSTERS THEME D

Electrical capacitance: A selection tool for root traits and N-efficiency?

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Background: N-efficiency of oilseed rape (OSR) is low. High amounts of N-fertiliser are applied (Pouzet 1995). This causes environmental problems. EU-legislative restrictions have moved N-efficiency into focus of breeders. Root characteristics are crucial for N-uptake (Nup), but direct selection is difficult. Electrical capacitance (EC) has been discussed as in-situ measurement for root traits (Dalton 1995)

Objectives: EC of winter OSR is analysed for genetic variation and its relationship to root traits and N-efficiency.

Methods: 29 genotypes were tested at 2 N-levels in 5 environments in Germany (EC29). Nup, N-uptake efficiency (NupEff), N-utilisation efficiency (NutEff) and N-use efficiency (NUE) were determined. EC was measured at end of flowering and during fruit development. Ten genotypes differing in EC were tested in field trials (2 locations, EC10f) and under controlled conditions (EC10c). In EC10f EC, root mass and stem diameter were determined. In EC10c EC and stem diameter measurements were followed by root sampling. Root masses were determined. An image-based platform (Bucksch et al. 2014) was used to capture projected root area, root density, root system width and tip diameter.

Results: EC showed significant genetic variation and heritabilities of 0.65–0.95. EC29 revealed genetic correlations (N=29) between EC and NupEff (r=0.64), NutEff (r=0.40), NUE (r=0.58) and N-content (r=-0.54). In EC10f correlations on plot level (N=40) were significant between EC and root masses (r=0.33–0.46) and stem diameter (r=0.78). The latter was also significant for single plants. In EC10c EC genetically (N=10) correlated to stem diameter (r=0.91), lateral root mass (r=0.67) and root area (r=0.59). For single plants correlations were significant between EC and stem diameter, root mass, root system width, tip diameter and projected root area.

Conclusions: EC showed significant genetic variation and high heritabilities. It has to be considered as a genetic trait. It remains open if EC measures root traits. Significant correlations were found. But correlation coefficients to stem diameter were higher. As genetic correlations to root traits and N-efficiency parameters are only medium (r=-0.54-0.64), EC should not be considered as appropriate selection tool.

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POSTERS THEME D

Effect of seed size and suitable cleaning on seed viability, vigour and quality of rapeseed *(Brassica napus L.)* cultivars

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Inspection on seed physical purity in order to produce seeds with suitable size, good viability and free of inert matter is the most important step in the process of seed quality control. According to the effect of seed size on seed quality, this study was conducted in the laboratory, green house and the field of Seed and Plant Certification and Registration Institute (SPCRI) in 2009-10, based on completely randomized design and randomized complete block design with three replications. The four factors experiment with 16 treatments that consisted of two canola's cultivar (Okapi and Talaye), four separated seed size (1.4, 1.6, 1.8 and 2 mm) and two levels of using and none using of gravity separator tool were applied. So for conducting of this project 48 samples were provided randomly from each land race and placed to seed analysis laboratory of the SPCRI and samples were affected by treatments and finally rate of seed, seed purity, noxious weed seeds and whole number of weed seeds was recorded. Some part of the seed samples was planted on the germination paper and final germination (7 day after planting), seedling dry weight was recorded and also some indices as mean time to germination, germination speed and seedling vigor was calculated by using of seedling vigor index (SVI). The second part of the seed samples was used for carrying out the green house experiment and the third part of the seed sample was used for conducting the field experiment and also seedling emergence speed, final green percentage of seedling and some related characteristics was determined. Based on the results using of 1.6 mm sieve size accompanied to gravity separator tool is recommended for cleaning these two varieties while germination percent and seedling emergence was improved and also higher seed loss percent was attained by using of sieves with 1.8 and 2 mm size. Whatever lower seed loss percent was attained using 1.4 mm sieve size but percentage of seed purity was decreased and also number of weed seeds increased which resulted in rejection at standard seed certification process. So the best treatment was related to the sieve with 1.6 mm size that was standard in the aspect of physical purity and germination percent.

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POSTERS THEME D

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Developing production technology of canola quality rapeseed-mustard for north-west India

Background: India has to import about 50 % of its requirement of edible oils and there is not much scope in the country for area expansion under oilseeds (Paroda 2013). To meet the increasing demand of edible oils, alternate strategies through superior cultivars and matching agronomic management are required. Availability of rapeseed-mustard varieties/hybrids with canola traits is anticipated to enthuse farmers towards cultivation of these crops.

Objectives: To assess hybrids and cultivars of canola Indian mustard (*B. juncea*) and oilseed rape (*B. napus*) to nitrogen applications and row spacings; and to find out optimum age of seedlings for transplanting of current canola oilseed rape cultivars.

Methods: Study comprised of three field experiments. In experiment 1, two hybrids (PHR 1, PHR 2) and three cultivars (MCP 633, RLC 3, RLC 1) of Indian mustard and in experiment 2, three hybrids (PGSH 52, PGSH 53, PAC 401) and one cultivar (GSC 6) of oilseed rape were evaluated. In both the experiments genotypes were allocated to main-plots whereas combinations of two nitrogen (100 and 125 kg/ha) doses and row spacings (30 and 45 cm) comprised the sub-plots. Third experiment comprised combinations of two transplanting dates (25 November, 10 December) and two cultivars (GSC 7, GSC 6) of canola oilseed rape in the main-plots and three ages of seedlings (30, 35 and 40 days old) in sub-plots.

Results: Indian mustard hybrid PHR 2 produced 2.4, 11.6, 6.1 and 32.2% higher seed yield (2494 kg/ha) and 5.2, 13.0, 20.8 and 38.6% higher oil yield (1041 kg/ha) than PHR 1, RLC 3, RLC 1 and MCP 633, respectively. Oilseed rape hybrid PAC 401 produced 6.8, 9.8 and 14.4% higher seed yield (2727 kg/ha) and 6.8, 19.5 and 15.4% higher oil yield (1160 kg/ha) than PGSH 52, GSC 6 and PGSH 53, respectively. Differences in yields and quality due to nitrogen and row spacing in both Indian mustard and oilseed rape were marginal and non-significant. Oilseed rape transplanted with 30 days old seedlings produced 5.8 and 12.1% higher seed yield and 7.4 and 13.3% higher oil yield than 35 and 40 days old seedlings, respectively. Quality seed, oil and seed meal remained unaffected by dates of transplanting, cultivars and age of seedlings.

Conclusions: The study demonstrates higher yield potential of hybrids than cultivars of canola Indian mustard and oilseed rape. These promising hybrids and cultivars respond to application of 100 kg N/ha and 30 cm row spacing. Transplanting of younger seedlings (30 days old) of oilseed rape up to second week of December performed better than older seedlings.

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Genetic variation for heat tolerance in *Brassica juncea*

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Background: Heat stress causes adverse alterations in plant growth, physiological processes and productivity (Sharma 2014). Exigencies of the intensive/multiple cropping systems results in delayed planting of rapeseed-mustard crops in north-west India. This can cause significant yield losses due to forced maturity. Heat stress during seed filling stages results in low yields and poor seed quality. Development of new cultivars tolerant to heat stress is a major challenge and thrust area for rapeseed –mustard research.

Objectives: Documenting differential tolerance of Indian mustard genotypes to terminal heat stress. Morpho-physiological traits and stress indices associated with thermo tolerance were also investigated.

Methods: A set of 44 advanced breeding lines/varieties from different agro-climatic zones of India were sown at optimum (third week of October) and late sown (3rd week of November) conditions. Seed filling periods under delayed plantings normally coincide with rising end season temperatures. Each genotype was sown in paired rows with three replications in random block design. Photosynthesis was recorded on 3rd and 4th fully expanded top leaf (90 DAS), yield components and SY at maturity. Heat tolerance indices and correlations (SSI, STI, HTE and YSI) were computed for biomass and yield.

Results: Normal sown cultivars had higher photosynthetic rates (Pn, 14.1-26.8 mean 21.3 umolm-2s-1), lower average stomatal conductance (Cs, 0.892 molm-2s-1) and Tr (7.09 molm-2s-1). Late planting down regulated Pn (9.92-16.7 mean 14.3) but upregulated Cs (1.01) and Tr (8.29). Pn estimates were comparable for RB50, NRCDR701 and DRMR537-40 across two planting dates. WUE was lowest in DRMR541 (2.42 umol/mmol) and maximum in RH-555A (3.87) .Overall, average Pn declined by 32.8%, WUE by 42.4%.while Cs and Tr increased by 10.8 and 16.9% with delayed planting. Terminal heat stress significantly influenced most productivity related traits except siliquae on main shoot and seed weight. Trait depreciations were observed @ 6.3% for plant height, 2.9% for main shoot length, 32.0% for primary branch number, 39.5% in secondary branches, 28.8 %, for total siliquae and 9.5% for siliqua length over normal planting. NRCDR-02 showed the least (37.3) number of siliquae on main shoot and BPR549-9 the highest (60.2). Seed weight varied from 3.88g (EJ17) to 6.4g (BPR-543-2). Lower biomass (14.7-45.2 mean 31.1) and SY (2.58-9.25 mean 6.45) were recorded under late planting. Decline in biomass was 27.6 % and SY 25.4% over timely sown crop. Genotypes namely, PBR331, RGN197, Parasmani, RRN631, CS54, BPR541-4, RB50 and SKM 301 were considered heat stress tolerant. Positive correlation existed between yield under timely sowing (Yts) and HSI, while negative correlation existed between Yts and HTE for yield and biomass. Under late planting, yield (Yls) was negatively associated with HSI.

Conclusions: Modified tolerance indices revealed PBR331, RGN197, Parasmani, RRN631, CS54, BPR541-4, RB50 and SKM 301 as promising for terminal heat stress tolerance.

References:

Sharma, P., 2014. Heat tolerance in Indian mustard (*Brassica juncea*) at seedling and terminal stage. Ann. Pl. Soil Res. 16(3): 224-228.

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POSTERS THEME D

Allelic variation for shp-1 gene in crop *Brassicas*

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Background: Unsynchronized pod shattering in *Brassica* leads to significant yield losses (Wang et al. 2007). The appropriate approach to solve this problem is by revealing the genes involved in the regulation of pod dehiscence. There are many genes involved in the mechanism of pod dehiscence that have not been identified in *Brassica*. So far only the orthologue of shp-1 has been reported in *Brassica napus* and is available at NCBI repository. Based on this information attempts were made to isolate and clone putative gene shp-1 from different species of *Brassica*.

Objectives: To characterize the natural variation in shattering in *Brassica* by determining the allelic differences in the gene/coding sequence of the shp1 gene clones among the six species viz, *B. rapa* (2n=20, AA), *B. nigra* (2n=16, BB) and *B. oleracea* (2n=18, CC), and three amphidiploid species, *B. juncea* (2n=36, AABB), *B. carinata* (2n=34, BBCC), and *B. napus* (2n=38, AACC).

Methods: A set of primer pairs (shp-1F 5′-ACAGGTACGCTTCTCCTACTC-3′and shp-1R5′-TGAAGAGGAGGTTGGTCTTGA-3′) were designed from the functionally characterized shp-1 gene sequence of the *B. napus* cv Bridger (BnSHP1 gene, Accession no. AF226865) for amplification of a putative shp-1 in diploid and amphidiploid species of U's triangle. The amplified PCR products were eluted and ligated into pGEM®-T Vector System I and bacterial strain JM109 of E.coli was used for the maintenance of all recombinant plasmids. Colonies carrying the recombinant plasmids were confirmed by restriction analysis. The positive clones were sequenced using M13-Universal primers through Sanger Sequencing. The identities of the clones were compared to known sequences using BLAST. The sequences reads were analyzed in Geneious software v5.5.7. Sequence features were identified in all sequences using Arabidopsis model in FGENESH and GeneMarkHMM. Phylogenetic and molecular evolutionary analyses were conducted using MEGA6.

Results: Multiple sequence alignment of shp-1 gene of various *Brassica* subspecies models the informative and non-informative sites that have occurred over the evolution. Such allelic variation of shp-1 gene showed significant effect at structural and functional aspects of proteins. Extensive shatterproof1 sequence-based analysis of *Brassica* species genome have provided the evidence of shp-1 gene existence and similarity between three separate but closely related diploid species (AA, BB, CC) and creation of three new amphidiploids (AABB, AACC, BBCC) genes derived from the genes of ancestral diploid species.

Conclusions: The complete full length gene sequence of *Brassica* subspecies is under further investigation and more detailed examination will be presented during the conference, highlighting the relationships between the members of U's triangle.

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Full sib progeny selection for genetic improvement of Indian mustard *(Brassica juncea L.)* under moisture stress conditions

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Background: Indian mustard (*Brassica juncea L*) is considered as self pollinated. However, out crossing of 7-18% (Abraham, 1994) has been reported which indicates certain level of heterozygosity and suggests use of population improvement strategies to expose hidden variability Success of any population improvement approach depends upon genetic gains per cycle of selection. The information on this aspect is almost lacking in Indian mustard.

Objectives: Study was carried out during 2006-07 to 2013-14 to study the effect of different cycles of full sib progeny selection in creating genetic variability for yield and its components under moisture stress conditions.

Methods: Experiment was started during rabi 2006-07 involving Varuna and BPR-148 in crossing programme. From F2 variable population, 5 sets of five plants were selected randomly. This constituted the male plants. Each male plant in each of the set was crossed to a set of 4 randomly selected plants from the population using them as females. Total 100 crosses were made to develop biparental progenies (Comstock and Robinson, 1948). Full sib progenies were evaluated during rabi 2009-10 in augmented design under rain fed conditions with check varieties. Significantly superior progenies for seed yield/plant in comparison to checks and base population were selected and equal amount of seed from these progenies was mixed and sown in crossing block (2010-11). From this variable population, 124 full sib progenies as per North Carolina Design-I (NCD I) were developed and evaluated (2011-12) in augmented design under moisture stress conditions. Again significantly superior progenies were selected from second cycle of selection and equal amount of seed from these progenies was mixed and sown in crossing block (2012-13) for development of full sib progenies. 120 full sib progenies so generated were evaluated (2013-14) in augmented block design under moisture stress conditions with four checks. Data were analyzed statistically as per standard procedure.

Results: Genetic gains were compared between 1st and 3rd cycle of selection and it was observed that genetic gain has increased appreciably from 1st cycle to 3rd cycle of selection for seed yield /plant (from 57.16 to 85.47). This indicates accumulation of favourable alleles in enhancement of yield per se through full sib progeny selection. There were 18 progenies selected in first cycle of selection, 17 progenies in second cycle of selection which showed significant superiority over checks and base population. In third cycle of selection 25 progenies not only showed significant superiority and selected over general mean of the progenies.

Conclusion: Population improvement revealed significant genetic gain in each cycle of selection. Therefore, it is advocated to follow selected sib-mating between selected progenies plant for accumulation of favorable allele(s) as well as breaking the undesirable linkages.

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POSTERS THEME D

Analysis of characteristics of winter oilseed rape *(Brassica rapa L.)* growth and development in cold and arid areas of Northern China

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Background: With the application of winter rapeseed cultivars with ultra cold-tolerance, the growing area of winter rapeseed in China has shifted northerly from Tianshui (Negative Accumulated Temperature, NAT, -151.0°C) to Zhangye (NAT -729.55°C), Jiuquan (NAT -746.83°C) and Urumqi (NAT -1092.0°C) etc.. Thus, it is necessary to characterize the changes of the growth and development of winter rape under severe natural conditions in Northern China.

Objectives: This study sought to analyze the characteristics of winter oilseed rape (*Brassica rapa L.*) growth and development in its northern adapted area, aiming at offering a theoretical basis for breeding new winter oilseed rape cultivars (*B. rapa L.*).

Methods: Field tests were conducted during 2006-2013 in eight locations in China including the original growing area and seven northern adapted areas of *B. rapa L.* Analyses were conducted based on the major climate factors of the testing locations, overwintering ratio, changes in the agronomic traits of the selected winter oilseed rape cultivars (*B. rapa L.*) during their growing period. Comparing with the original growing area.

Results: This study showes that the overwintering ratio of the selected cultivars in the northern adapted area reduced from 93-100% to 40-95%, while their growing period increased from 280-284 days to 287-289 days. The life cycle of winter *B. rapa L.* could be characterized as the long overwintering stage, the short growing period before winter, in the northern adapted area. Compared with those grown in the original growing area, winter oilseed rape grown in the northern regions exhibited phenotypic differences including a shorter plant height and and smaller thousand seed weight. Yield of Longyou No. 6, a cultivar with strong cold-tolerance, had increased significantly from 0.74 t/ha (inTianshui) to 3.33 t/ha (in northern adapted area).

Conclusions: Winter oilseed rapes grown in the cold and arid areas of Northern China suffer from a relatively adverse weather conditions. Thus, cultivars used for agricultural production in these areas are required to have excellent tolerance with cold conditions. Seeding has to be done at an appropriate time to ensure enough accumulation of vegetative growth before winter.

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POSTERS THEME D

Effect of seeding date on production of organic and conventional rapeseed

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Background: Being the third-leading source of vegetable oil in the world, rapeseed is popular oil crop for various purposes, while cultivated *Brassica* species are generally regarded as excellent rotation crops. Rapeseed is also organically grown for oil production, as green manure and is a useful cover crop. *Brassica* species can also be used in pest management though the efficiency of their application is variable and relatively low. Considering appropriate rapeseed cultivation practices, seeding date (SD) can significantly affect plant vigor and the ability of plants to compensate damage by biotic or abiotic stress (Valantin-Morison and Meynard 2008). Due to rising interest in organic rapeseed, additional information on appropriate agricultural practises could be useful.

Objectives: The performance of conventional rapeseed varieties at various SD in organic growing was tested. Results should be useful to both breeders and farmers to determine the need for specific organic breeding programs or agricultural practice improvement. The objectives of this study were to: (1) compare conventional rapeseed cultivars performance in conventional and organic farming systems, and (2) investigate the effect of SD on some basic rapeseed production traits like emergence, survival rate, seed, oil and protein yield.

Methods: Five winter rapeseed 00 type cultivars were sown in two farming systems, each with three seeding dates and four repetitions. The trials were organized in a randomized block design and the effect of cultivar and farming system on emergence, yield, oil and protein content was evaluated. The fields were kept free from weeds, insects and diseases according to the recommended practices. In organic field, weeds were removed mechanically and manually, while insects were treated with an insecticide used for organic production. The seed samples for analysis of oil and protein content were taken during harvest.

Results: We found that some conventional rapeseed cultivars like Slavica could be successfully used in organic farming systems, and concluded that developing new cultivars specifically for organic farming is not necessary. Yield and oil content were lowest in SD3 in both farming systems. There was no significant effect on the protein content. It was found that late sowing date and shallow soil tillage are related to high ratio of weed biomass, especially in organic production.

Conclusions: Rapeseed can be used in organic agriculture, but further improvement of agricultural practices is needed. The biggest problem is the complete lack of chemical options for organic weed management, which makes good agricultural practices such as farm hygiene more important, to prevent the spread of pests, diseases, weeds and that may reduce production. Preliminary results will be used to further improve the initial organic agricultural practice and select the most appropriate cultivars for further testing and organic production.

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POSTERS THEME D

Using mason bees *(Osmia* spp.*)* for rapeseed yield improvement

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Background: Pollinators can play a significant role in rapeseed production. Honeybees are excellent pollinators, but in the previous decades the number of bee hives has dramatically decreased due to the yet unexplained colony collapse disorder. Due to these reasons, alternative pollinator species and their use come into focus for research.

Objectives: Orchard bees, or mason bees, *Osmia* spp. (Hymenoptera: Megachilidae) are used for pollination of orchards and certain berry crops worldwide (Krunić and Stanisavljević 2006). The aim of this study was to evaluate the effectiveness of *Osmia cornuta* and *O. rufa* pollination in rapeseed production and their effects on the yield.

Methods: The effects of orchard bees on rapeseed yield and their value as pollinators were studied during spring 2013 at Rimski Šančevi site, near Novi Sad, Serbia (N 45° 20′ 22″ E 19° 50′ 9.62″). Fine netted isolation cages of 48 m2 each were used for two trials set up under the same field conditions. In the first trial, the efficiency of *O. cornuta* and *O. rufa* was compared on four rapeseed varieties. In the second, the effect of rapeseed genotype was tested using only *O. cornuta*. A total of 20 males and 10 females were introduced into every cage at the beginning of the flowering stage. Every tested rapeseed variety had a control cage without bees. Statistica 12, StatSoft was used for statistical analysis.

Results: Average yield for all cages without bees was 1.710 kg/ha, for *O. cornuta* cages 1.941 kg/ha and *O. rufa* cages 2.116 kg/ha. The only significant yield differences were found due to the effect of genotype in the second trial where genotype variability was higher. Considering oil content, thousand seeds weight and hectoliter weight, only hectoliter seed weight was significantly affected by genotype in the first trial, while the presence of bees had no significant effect. In the second trial, the only significant effect was that of genotype on oil content and hectoliter weight. Average oil content was 39.14% for all cultivars in the control cages, 39.72% for cultivars with *O. cornuta* and 39.95% with *O. rufa*. Thousand seeds weight was the lowest for seeds from *O. rufa* cages (4.83 g), followed by *O. cornuta* (4.95 g) and control cages (5.04 g). Hectoliter seed weight varied from 69.50 in cages with bees to 69.73 kg in control cages.

Conclusions: Obtained data suggest that *Osmia* bees could be a useful addition, if not a substitute for honey bees. Interactions between rapeseed varieties and solitary bee species should also be taken into account when planning further long-term trials. The genotype and environment effects could be prevailing due to variable genotype attractiveness to bees, insecticide treatments or unfavorable climatic conditions. Nevertheless, the results are promising and encouraging for further research.

Acknowledgements: This research is a part of the project TR 31025 financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia

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POSTERS THEME D

Enhanced accumulation of *BnBiP*, a *HSP70* molecular chaperone binding protein improves tolerance to drought stress in transgenic *Brassica napus*

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Background: Drought is one of the greatest worldwide environmental constraints for agriculture. Therefore engineering drought tolerance in plants has huge economical importance. Molecular and genomic analyses facilitate gene discovery and enable genetic engineering using several functional genes to activate drought tolerance. Molecular chaperones are key components contributing to cellular homeostasis in cells under adverse growth conditions. The binding protein (*BiP*) is an endoplasmic reticulum (ER) resident molecular chaperone, assists in the folding of proteins and also acts in the ER quality control mechanism. Water stress disrupts ER homeostasis and promotes the accumulation of misfolded or unfolded proteins in the ER lumen caused ER stress. *BiP* plays a major role as a sensor of disturbances in protein folding. The ER resident molecular chaperone *BiP* mediates an increase in drought tolerance and delays drought-induced leaf senescence in soybean and tobacco (Valente et al, 2009).

Objectives: The overexpression of *BnBiP* in *Brassica napus* can increase tolerance to water deficits, osmotic stress and tunicamycin treatment. The detail molecular mechanism of *BnBiP* conferring drought tolerance will be discovered.

Methods: Plant expression cassette containing the *BnBiP* gene was transformed into *Brassica napus*. Water stress and tunicamycin treatment are applied to untransformed (WT) and overexpression (OE) transgenic line plants. Drought-tolerance parameters are measured. Subcellular localization of *BnBiP* is performed by *Arabidopsis thaliana* protoplast transformation. Expression of *BnBiP* protein is induced in *E.coli*.

Results: *BnBiP* is localized in the plasma membrane. 73.8 kD *BnBiP* protein is soluble. The observation that enhanced accumulation of *BnBiP* prevents dehydration. Fluctuations of *BnBiP* levels correlate inversely with the activity of oxidative stress-induced enzymes. *BnBiP* overexpression correlated with the decreased oxidative damage and a delay in leaf senescence under water deficit conditions. *BnBiP* OE transgenic lines show increased resistance to the cell death-promoting effect of tunicamycin in germination and further growth. qRT-PCR analysis suggests *BnBiP* overexpression delays UPR (unfolded protein response) and NRP(N-rich proteins)-pathway mediated chlorosis and appearance of senescence-associated markers.

Conclusions: the prosurvival effect of *BiP* was associated with the modulation of the ER and osmotic stress-induced NRP-mediated cell death signaling. The enhanced expression of *BnBiP* prevented *BnNRP*-mediated cell death. The results implicate *BnBiP* as a negative regulator of stress-induced NRP-mediated cell death response. Thus, it is not surprising that the overexpression of *BnBiP* delays drought-induced senescence in *Brassica napus* OE lines, and confers the increased adaptation of these transgenic lines under water deprivation conditions compared with the wild plants. The dynamic competition model for *BnBiP* competed with misfolded proteins will be confirmed in the future.

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POSTERS THEME D

Model-based analysis of potentials to increase nitrogen use efficiency of winter oilseed rape

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Background: Winter oilseed rape (WOSR) is characterized by high nitrogen (N) uptake efficiency and lower N utilization efficiency (Malagoli et al. 2005). Early leaf senescence due to self-shading and incomplete N translocation to pods and seeds cause low N use efficiency (NUE) and N harvest index (NHI) (Schjoerring et al. 1995).

A model could provide scenarios to quantify the effects of improvements of physiological processes like N translocation on NUE and NHI.

Objectives: The aim of this work is to quantify the effects of changing dry matter partitioning, N dilution or improved N translocation on NUE and NHI by means of a validated dynamic crop model.

Methods: A dynamic crop growth model based on the light use efficiency approach was developed. It contains dry matter production and partitioning, N uptake and partitioning, leaf, stem and pod area growth, as well as senescence and translocation processes and yield formation. In addition, drought stress and N depletion effects on growth of WOSR are included in the model.

The model was parameterized with data from field experiments conducted in northern Germany and validated with independent data sets from several sites in Germany as well as Châlons, France.

Long-term scenarios (1980-2010), calculated for different sites include variation of allometric relations between leaf, stem and pod dry matter, as well as improvement of N translocation processes.

Results and Discussion: Parameterization and validation of the model showed its capability to simulate dry matter and N dynamics as well as leaf, stem and pod area growth. Effects of management practices like sowing date and N fertilization level are well represented by the model.

Therefore, the model can be used to calculate scenarios, e.g. genetic improvements by a decrease of remaining N concentration in stems and roots at harvest. Scenarios of decrease of remaining N concentration in stems and roots from 1% to 0.5% indicate additional 30-40 kg N/ha available for translocation into pods but the sink capacity of pods for N during seed filling has to be considered.

Conclusion: The crop growth model is able to simulate physiological crop development under varying conditions. Scenarios simulated with the model could be helpful to estimate potentials to increase NUE. Further improvements of the model may be achieved by implementing a layered canopy representation, which would allow an analysis of effects of N distribution and canopy architecture on WOSR productivity and NUE.

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Genetic variation and inheritance of seed longevity in the oilseed rape DH population Sollux x Gaoyou

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Background: Volunteer oilseed rape plants may emerge in succeeding crops in high numbers. This appear¬ance is based on the seed capability to survive for 10 years or longer in the soil. Seed survival is related to dormancy and to seed longevity. Seed longevity in crop species is in part genetically determined (Nagel et al. 2014). The half-viability period is estimated to be 7.3 years for different cabbage (*Brassica* spp.) varieties under ambient conditions (20 °C, 50% RH; Nagel et al. 2014). Artificial ageing methods are usually used to mimic seed behavior in storage, but real data of long term stored seeds are rarely available.

Objective: The aim of this study was to investigate the germination rate and the germination vigor of seeds of the DH population Sollux x Gaoyou after thirteen years of storage in a semi-conditioned seed storage room.

Methods: The DH population was developed from a cross between the German winter cultivar Sollux and the Chinese semi-winter cultivar Gaoyou and consisted of 292 lines. The DH population was grown in 2000/01 in the field at two locations in western Germany and at two locations in China (Xian and Hangzhou; Zhao et al. 2005). Seeds harvested from open pollinated plants were ever since stored in Göttingen in a seed storage room with temperatures varying from about 7°C to 25°C depending on the season. Germination test was conducted from July to Dec. 2014. 50 seeds per line and location were placed on filter paper in Petri dishes, watered with 12 ml of deionized water, and kept in dark condition at 16-17 °C. The percentage of fully germinated seeds as well as the hypocotyl length was determined after 10 days.

Results: There were large and highly significant differences in the germination rate and the germination vigor of the DH population after 13 years of storage. As a mean over 4 locations the germination ranged from 0 to 70% (mean 19%), while hypocotyl length varied from 0 to 3.88 cm (mean 0.99 cm). There were also highly significant effects of the locations for both seed germination and germination vigor. Seeds harvested in Hangzhou germinated to 26%, while seeds from Reinshof, Xian and Weende germinated to 15, 17 and 19%, respectively. Heritabilities ranged from 72% to 77% for germination and germination vigor. Spearman's rank correlation between seed germination and germination vigor was positive (0.74**).

Conclusions: Results show large and significant differences in seed germination and germination vigor. QTL analysis is in progress to identify genomic regions involved in seed longevity.

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POSTERS THEME D

Oilseed rape yield evaluations under controlled conditions: Not a load of rubbish!

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Background: Evaluation of yield performance and other relevant agronomical traits under variable environmental conditions is a major aim of crop breeders. However, efficient selection for genetic variation of yield traits in connection to diverse abiotic stress factors, such as drought or nutrient efficiency, is still challenging. Results from controlled pot and greenhouse trials for complex traits are generally poorly transferable to field experiments. In winter oilseed rape (WOSR, *Brassica napus L.*) one reason for this is the great potential for environmental fluctuation during the long, 11-month lifecycle. Another reason is the restriction of adequate root growth by small pots, which strongly influences the response to water and nutrient availability.

Objectives: To improve the field transferability of greenhouse pot experiments, we established a plant growth system comprising large refuse containers (120 L "wheelie-bins") that allow detailed phenotyping of field crop populations under semi-controlled growth conditions with minimal constriction of root growth. We tested the system to assess traits related to drought stress and nitrogen use efficiency in highly diverse WOSR cultivars.

Methods: Genetically diverse WOSR cultivars were grown at field densities throughout the entire crop lifecycle in "wheelie-bins" with a quadratic planting area of 0.16 m^2, which were filled to a depth of 90 cm with a dried soil mixture that was prepared according to the requirements of the specific experiments: For drought experiments a sandy soil was separated in topsoil and subsoil fractions and the well-watered control was held at a level of 60% WC, whereas the drought control was only watered to a level of 30% WC. For nitrogen experiments a clay-loam soil mixed with sand at a ratio of 1:1 was filled in the containers and the low nitrogen (LN) treatment received an equivalent of 40 kg N ha-1, while the containers with the high nitrogen (HN) treatment received an equivalent of 200 kg N ha-1 (split into two applications). The different experiments were carried out over two years to compare seed yields from individual containers to plot yields from multi-environment field trials.

Results: Comparisons of yield data from the containers to full-plot field trials demonstrate that results from controlled-environment pot experiments are highly transferable to field conditions. In particular, we were able to accurately predict yield levels in the field from measurements taken on container-grown plants. Furthermore, since the variation in root morphology is an important aspect in consideration for enhanced abiotic stress tolerance, the container system builds a compromise in terms of root growth between field and pot experiments and allows the assessment of root morphology and biomass. In this regard we found a huge genetic variation of root morphology, particular under contrasting N-fertilization. The large-container system reperesents a highly promising platform to evaluate breeding material for physiological and yield-related abiotic stress responses.

Effects on cold tolerance of winter *Rapa* under ABA spraying on leaves

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Background: By the changes of the global temperature, northern China becomes the new district for winter oilseed rape. But this district is very cold in winter, the lowest temperature is always reach to -30°. There only *Brassica rapa* can survive. The rapa leaves will gradually become yellow and dry from 5 leaf stage before wintering. Until the end of November, the whole seedling is yellow and dry only leave the root in the soil from which the new leaves will sprout next year. So roots plays a very important role in this time. ABA is currently recognized as the important plant hormone to cope with water stress and it always start from root.

Objectives: Spraying ABA on leaves to analysis the effects of exogenous ABA on cold tolerance of winter rapa before the wintering, then make sure the best time and spraying concentration on them.

Methods: Setting the test in the field, Longyou 8(*Brassica rapa*) as the material, sprayed ABA on leaves by different concentrations(5, 10, 15, 20, 25 mg·L-1) and sprayed in different periods (3 leaf stage, 5 leaf stage, 6 leaf stage, 7 leaf stage) by 15 mg·L-1 before the wintering. Spraying distilled water was as the CK. Determined the overwintering rate, the activities of SOD ,POD ,CAT and content of soluble protein, soluble sugar.

Results: Spraying ABA can significantly improve overwintering rate and physiological and biochemical substances content. The effect is extremely significant when the concentration is 20mg·L-1. The overwintering rate improve 26.7%, and the activities of SOD ,POD ,CAT and content of S protein, soluble sugar, were significant increased 32.3%, 71%, 451.8%, 78.5%, 78.3%, 22.1% than CK respectively. It also can reduce the content of MDA, lower 42.5% than CK. At the 6 leaf stage, the MDA content of winter rapa decreased the most, and the content of soluble sugar, the content of soluble protein and winter survival rate increased 4.4%, 35%, 10%than CK respectively.

Conclusions: Exogenous ABA can decrease the damage under low temperature and improve the cold tolerance of winter rapa in north China. It is suggested that the best time to spray ABA on winter rapa is 6 leaf stage, and the best concentration should be 20 mg·L-1, so it can effectively improve the cold tolerance of winter rapa.

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POSTERS THEME D

Evaluation of four *B. juncea* genes for pod shattering resistance in *B. napus*

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Background: Silique dehiscence (pod shattering) in canola (*Brassica napus*) can result in significant yield losses. Therefore, one of the goals in canola breeding is to develop pod shattering-resistant cultivars. Although many attempts have been made to increase shatter resistance through conventional breeding, so far traditional breeding methods have been unsuccessful. On the other hand, transgenic manipulation of *Arabidopsis* genes, such as SHP1/2, FUL, ALC and IND, resulted transgenic lines where silique fails to split; breaking of the silique with excessive force is needed to release the seeds (Liljegren et al., 2000; Liljegren et al., 2004; Østergaard et al., 2006). Pod shattering resistance in *B. juncea* is generally greater when compared with *B. napus* (Kadkol et al., 1984.). Transgenic manipulation of canola with *B. juncea* genes which are involved in silique dehiscence (Jaradat et al., 2014) may increase resistance to pod shattering to a reasonable extent that excessive force would not be needed to release the seeds.

Objectives: To engineer *B. napus* with four putative dehiscence genes from *B. juncea* and evaluate these transgenic lines for resistance to pod shattering.

Methods: Standard molecular biology methods were used to produce transgenic canola plants through Agrobacterium mediated transformation. To assess pod shattering, an optimized method was used where the siliques were shaken with metal rods or metal beads in polypropylene tubes on a reciprocating shaker.

Results: Homozygous lines with single insertion were identified. Several transgenic lines displayed greater resistance to pod shattering than controls. The pod shattering range is 35%-80% for controls, but 5%-40% for transgenic lines. Thus, the four *B. juncea* genes may be useful to develop pod shattering resistant canola.

Conclusions: Laboratory tests showed that manipulation of *B. napus* canola with *B. juncea* genes improved pod shattering, however, field test is necessary to validate this.

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Influence of straw mulching on cold resistance and yield of rape

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Background: The damage of low temperature and freezing is one of the main limitations ofthe production of winter rapeseed in the Yangtze River region of China. The extreme cold weather occurs frequently in the Yangtze River region of China and has seriously affected the safety of the winter rape's overwintering of safely in the region. In recent years, theworkers who research rape breeding of cold resistant varieties have done lots of work andcultivates a series of new cold resistance *Brassica napus L*, while we seldom see the studyon cold resistance of cultivation measures of the late sowing rapeseed.

Objectives: This paper main studies the effects of different agronomic measures on the regulation of late sowing rape field soil temperature and the freezing injury degree, yield, effect. It can not only put forward the corresponding technical measures for freezing winter rape in Yangtze River region of China, but aslo provides scientific basis for the development of antifreeze cultivation of late sowing rape.

Methods: (1) Soil temperature was determined with long pole soil thermometer. Soil temperature in 10 cm and 20 cm layer in each plot was recorded in 15:00pm after treatment. Mean soil temperature of every continue 10 days made as the temperature of these duration.

(2) Plant cold injury investigation standard referred to Liu Houli's method. 50 plants samples were surveyed randomly on each plot on 5-7 days after severe frost. Cold injury index is calculated by formula (1) with surveyed each plant.

Cold injury index (%) = [(1×S1+2×S2+3×S3+4×S4)/(N×4)]×100 (1)

*S1, S2, S3 and S4 mean plant numbers with1-4 grade cold injury; N means total surveyed plant number.

(3) Plant height, first branch number, effective silique number, seeds per silique, 1000-seed weight and some other characters were determined from these plant samples. Yield wasdetermined from a subplot in each plot.

Results: The result shows that Straw mulching (TI) can affect the soil temperature and cold resistance of Qing you 19. When the ambient temperature is lower than the ground temperature, Straw mulching (TI) play a better role of resisting the low temperature than the treatment of heaping soil around roots before winter (T2), whereas the T2 is better.

Conclusions: If the Straw mulching (TI) can be widely used, it can improve canola yield andsolve the problem of straw burning. Besides, although T2 (heaping soil around roots before winter) can increase yield for rapeseed, it needs too much money and labor. How to make the maximum benefit of the T2 should e further research.

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POSTERS THEME D

Analysis of chloroplast ultrastructure, stomatal characteristic parameters and photosynthetic characteristics of chlorophyll- reduced mutant in *Brassica napus L.*

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Background: Chloroplasts are unique and important organelles in the plant cell, which capable of carrying out photosynthesis, but also, the place of synthesis chlorophyll, starch, lipid and amino acid. The development of chloroplast and chlorophyll biosynthesis play crucial role for normal photosynthesis in plant. Abundant leaf color mutants, the ideal material to carry out the research of structure of photosynthesis system and function of gene and its regulation mechanism, which is excellent germplasm resource of heterosis utilization.

We found the chlorophyll-reduced mutant NY in 2005 had been bred stable recessive genic male sterile two-type line was less reported spontaneous mutant in *Brassica napus L.*, to study its chloroplast ultrastructure, stomatal characteristic parameters, photosynthetic pigment content, photosynthetic characteristics, agronomic traits and the relationship between each other is of important theoretical value and practical significance.

Objectives: In order to discuss the yellowing mechanism and provide a theoretical basis in rape breeding practice, the relationship between chloroplast ultrastructure, stomatal characteristic parameters, photosynthetic pigment content and photosynthetic characteristics of the spontaneous chlorophyll-reduced mutant NY in *B. napus L.* were studied.

Methods: Taking the rape mutant NY, wild type NG, F1 (NY×NG) and rF1(NG×NY) as research materials, the heart-leaf and the flatten-leaf at five-leaf stage were used for chloroplast ultrastructure observation, stomatal characteristic parameters investigation, photosynthetic pigment content determination, photosynthetic characteristics measurement and agronomic traits investigation.

Results: In general, the chloroplast development degree in yellow heart-leaf and yellow-green flatten-leaf from mutant NY was worse than that of wild type NG, F1 (NY×NG) and rF1(NG×NY) from chloroplast ultrastructure; the chloroplast numbers of heart-leaf in a lower epidermis stoma guard cell from mutant NY was decreased about 40%, whereas the number in yellow-green flatten-leaf was close to that of the wild-type NG in stomatal characteristic parameters; the Chla, Chlb, Chl(a+b), carotenoids and the net photosynthetic rate of mutant were significantly lower than those of the same period of wild-type and F1, rF1 in content and composition of photosynthetic pigment as well as photosynthetic characteristics. Correspondingly, the growthperiod delayed, economic traits deteriorated and grain yield per plant decreased, which happened in the mutant, but the above agronomic traitsand photosynthetic characteristics from F1 and rF1 were restored to normal levels.

Conclusions: The mutant NY is one of total chlorophyll deficiencytype caused bychloroplast structure developmental defects. Abnormal chloroplast structure, less grana and grana lamellaand lowerchlorophyll contentare main reasons for mutantlower net photosynthetic rates andworstagronomic traits.

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High temperature stress studies in Indian mustard *(Brassica juncea L.)* tolerant genotypes under rainfed conditions

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Background: Indian mustard is the major crop of winter season in southern Haryana state of India and is grown also as a rainfed crop in some pockets. High temperature at seedling stage causes seedling mortality and also increases painted bug population, thereby, reduces proper plant stand in the field. At terminal stage, high temperature shuts down photosynthetic machinery causing shriveled seeds that ultimately reduces crop yield.

Objectives: Early sown crop faces seedling mortality upto 100 percent due to high air temperature prevailing at that time. If this crop is sown too late, it faces high temperature stress later on causing heavy yield losses due to forced maturity. Therefore, it is imperative to breed varieties that are tolerant to high temperature stress.

Methods: The trial was conducted under three dates of sowing [(30th September (early sown), 22nd October (normal sown) and 11th November (late sown), 2012 and 2013)] with 57 identified high temperature tolerance genotypes received from different centers in India (CCSHAU, Hisar; RAU ARS, Ganganagar; IARI, New Delhi and DRMR, Bharatpur) under rainfed conditions. These genotypes were sown in two rows each under rainfed conditions. One hundred seeds of each genotype were sown in each row. Seedlings were allowed to grow under natural conditions in the field. All the agronomic and plant protection measures were followed as per recommendations.

Results: (a) High temperature tolerance at seedling stage: Germination % and seedling mortality (%) were recorded at 7 DAS and 10 & 20 DAS, respectively. Maximum temperature range between 7 DAS (recording of germination %) and 10 DAS (recording of mortality %) was 31.00 C to 34.5 0C. Some of the genotypes survived high temperature (34.5o C) at seedling stage. Genotypes showing <20% seedling mortality at 10 DAS were categorized as thermo tolerant.

(b) High temperature tolerance at terminal stage: These genotypes were sown in the field at two dates of sowing i.e. Ist optimum, D1 (22.10.2012 & 13) and IInd late, D2 (11.11.2012 &13) to allow the crop to experience the high temperature at terminal stage viz. grain filling stage (100 DAS-maturity) under natural conditions. Observations were recorded on seed yield/plant (g) and 1000-seed wt. (g). Reduction % in these traits under D2 over D1 was computed. The genotypes having <20% reduction in seed yield and 1000-seed wt. were rated as high temperature tolerant at terminal stage..

Conclusions: Mean of data of 2 years on plant mortality at 10 DAS showed that only 5 genotypes viz. Pusa mustard-27, RH-1003, Pusa mustard-25, RH-0748 and Pusa Bold were identified as High temperature tolerant at seedling stage. whereas mean of 2 years data on % reduction in seed yield & 1000-seed wt. of mustard genotypes RH-725, DRMR-659-49, RB-55, BPR-543-2, RH-673, RH-819 and RB-100 were identified as High temperature tolerance at terminal stage . These identified genotypes are being used in crossing programme (13 x 13 Partial diallel) at Bawal during 2014-15 season.

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POSTERS THEME D

Screening for canola *(Brassica napus L.)* accessions with contrasting early vigor for genetic studies and breeding

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Background: Seed germination and successful seedling establishment are two independent events of major concern in crop production which affect crop yield (Jain and Staden 2007). Selecting accessions with rapid germination and good establishment which are recognized as two useful parameters of early vigor is important for improving crop production (Pinthus and Kimel 1979; Yamauchi and Winn 1996).

Objective: The objective of this study was to evaluate germination speed of canola accessions from a world-wide collection to identify accessions with high and low early vigor. In addition, the relationship between germination speed and seed weight, and how smoke water, ABA and GA affect germination speed were assessed.

Method: A total of 137 accessions originating from 17 countries were used to conduct germination trials in petri dishes at 25 °C in darkness. Comparisons of germination speed among the various accessions were based on T50, i.e. the time at which 50% of seeds germinated (Limami et al. 2002). The accessions were classified into three categories fast (F), medium (M) and slow (S). The fast and slow accessions were identified and validated in repeated petri dish and pot experiments, and also treated with four chemicals i.e. deionized water (control), smoke water, gibberellic acid (GA) and absicisic acid (ABA).

Results: The 137 accessions were grouped into three categories: F, M and S and each category accounted for 6.6%, 84.6% and 8.8% of the accessions, respectively. Finally, 9 fast and 12 slow germination accessions were identified. Although accessions in the F category showed significantly faster germination and emergence than those in the S category, seedling growth parameters did not differ greatly. Based on germination speed and seedling characteristics, 4 accessions with high early vigor and 4 with low early vigor were identified. Seed germination speed was not affected by seed weight and was not directly influenced by the application of GA and ABA, but 10% smoke water significantly delayed seed germination.

Conclusions: Early seedling vigor can be reliably estimated through a combination of germination speed with seedling vigor index, as these represent germination, emergence and seedling growth. The identified accessions for high and for low early vigor can be used to look into the genetic and molecular mechanism that determines early vigor. Breeding of superior canola cultivars with high early vigour has the potential to be of great significance in canola production.

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Research on easy and reduced cultivation techniques of rapeseed in Yangtze River Basin of China

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Background: In China, conventional high-yield cultivation in rapeseed overly depended on manual work leading to high yield not high-efficient, so comparative benefit of planted rapeseed reduced. And, too much water and chemical fertilizers influence the quality of rapeseeds and increase the cost of cultivation, but pollute farmland and water system. So it is very important to discuss new cultivation techniques for rapeseed.

Objectives: To study easy and reduced cultivation techniques of rapeseed according with china's national condition in Yangtze river basin of China, in order to save labour and reduce cost and increase benefit of cultivation.

Methods: From 2010 to 2014, double-low rapeseed variety Qinyou 19 was tested for the cultivation. After harvesting rice planted in heavy viscosity soil in WuHu of Yangtze river basin of China, the two techniques of mechanized tillage and sowing and harvest and mechanized tillage and soil preparation for broadcast sowing and harvest were compared with conventional seedlings transplantation technique.

Result: After continuous test of four years, the results showed that the output value of rapeseed only increased 3.88% and 4.00% respectively to compare the two new cultivation techniques with conventional tcchnique , but from cost saving on fertilizer, pesticide and expense for mechanized tillage and labors, pure profit increased 6794.10 RMB/hm2and 11422.2 RMB/hm2 respectively, and ratio of output and input both increased 1.25 times.

Conclusion: Easy and reduced cultivation techniques of rapeseed combined agriculture traits with agricultural machinery may save cost greatly and improve economic benefit, so it is a development direction of rapeseed cultivation techniques in China.

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POSTERS THEME D

Effects of nitrogen fertilizer types and application times on the nutrient uptake and yield of winter oilseed rape under high density and direct-sowing conditions

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Background: China is an important country of winter oilseed rape production in the world. The traditional way of rapeseed cultivation in China consists of seedling raising and transplantation, manual field management, and manual harvest, with no or little mechanization. Thus it consumes a lot of labor and requires a high production cost in per unit area (mainly labor cost) (Zhang C L et a1. 2010; Guan C Y 2011). In resent years, new cultivation ways by machineries with high density and direct-sowing in winter rapeseed are accepted by more and more farmers because large quantity of farm labors are shift to cities, causing decrease in manual labor availability and increase in labor cost in the rural areas(Wang H Z 2005; Guan C Y 2006; Ma N et a1., 2011). Chemical fertilizers (especially nitrogen fertilizer) are usually applied for 3~4 times in the traditional cultivation system of winter oilseed rape, whereas little information about the types of nitrogen fertilizers and times of fertilization is available for the management of winter rapeseed under high density and direct-sowing conditions.

Objectives: Field experiments were carried out to investigate the gain of grain yield, amounts of nutrient(N, P, K) uptake and efficiency of nutrient utilization under high density and direct-sowing with different N fertilizer types and different times of fertilization. Suitable, feasible and labor-saving fertilizer application methods were expected in this study.

Methods: Three field experiments were carried out for the study in the Chengdu Plain under a rice-rapeseed rotation system from 2011~2014. The first experiment included 3 different modes of N fertilizer application times (one time as a basal fertilizer, two times as a basal fertilizer and a top dressing, three time as a basal fertilizer and two times of top dressing), using the same rates of fertilizers (225kg N/hm2, 112.5kg P2O5/hm2, 112.5kg K2O/hm2) under high density (36×104/ hm2) from direct-sowing. The second experiment consisted of 4 different treatments of N fertilizer types applied only once as a basal fertilizer (normal Urea, coated Urea, compound fertilizer, 50% normal Urea +50%coated Urea) and 2 different treatments of two time fertilization (50%normal Urea as basal fertilizer +50%normal Urea as top dressing, 50%coated Urea as basal fertilizer +50% normal Urea as top dressing) at the same fertilizer rates (189kg N/hm2, 90kg P2O5/hm2, 90kg K2O/hm2), plus one contrast treatment(without N fertilizer). The third experiment included 3 different N fertilization times only (as same as in the first experiment), but lower fertilizer rates (180kg N/hm2, 90kg P2O5/hm2, 90kg K2O/hm2) were applied.

Results: The differences in plant nutrient uptake, grain yield, oil content (%) and nutrient utilization efficiency (grain yield/plant available N) were not significant among different N fertilizer application times under high density and direct-sowing conditions. Grain yields from different fertilization times varied in different years and showed a tendency of relatively higher yield with higher fertilizer rates. Grain yields and amounts of nutrient accumulation were significantly different between the treatments with N fertilization and without N fertilization. The types of N fertilizers showed no significant effects on grain yield, oil content (%), nutrient uptake and nutrient utilization efficiency. Overall, the slow-releasing type of N fertilizer (coated Urea) resulted in a relatively higher grain yield or nutrient accumulation under the same fertilization times.

Conclusions: Based on the above results of experiments in winter oilseed rape under high density and direct-sowing, we concluded that the times of N fertilization could be reduced to one time as a basal fertilizer or two times as a basal fertilizer and a top dressing. Moreover, the slow-releasing N fertilizer type (coated Urea) could be applied to get higher yield, higher nutrient accumulation and to alleviate the pressure on environment.

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Stress-responsive gene ICE1 from winter oilseed rape *(Brassica campestris L.)* confers cold tolerance in transgenic tobacco

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Background: ICE1 acts upstream of the CBFs in the cold-response pathway. Arabidopsis ICE1 activates CBF3 expression during cold treatment. The activated CBF3 binds to the CRT/DRE cis-acting element in the promoter regions and induces the expression of downstream cold-responsive genes, thereby improving freezing tolerance (Chinnusamy et al. 2003). Overexpression of ICE1 in transgenics resulted in improved freezing tolerance, supporting an important role for ICE1 in the cold stress response.

Objectives: Winter oilseed rape (*Brassica campestris L.*) cultivar Longyou 6 seedlings can survive winter at −32 °C in the cold and arid regions in Northern China. Longyou 6 was used as experimental materials. ICE1 gene was isolated and characterized from Longyou 6. The ICE1 gene was transferred into tobacco and the effects of ICE1 transformation on the cold tolerance of tobacco under low temperature was studied.

Methods: The full-length ICE1 cDNA sequence from *Brassica campestris* (rape) was obtained by the technology of rapid amplification of cDNA ends (RACE). The recombinant plasmid, pBI121-ICE1, was introduced into the *Agrobacterium tumefaciens* strain GV3101. Transformation of tobacco was performed using *Agrobacterium*-mediated leaf disc transformation method. Transgenic lines and non-transgenic plants were planted on MS medium to allow the seeds to germinate under greenhouse conditions. Six-week-old tobacco seedlings were treated with 2°C for 7 d, and then leaves was collected for physiologic parameters measurements.

Results: A novel gene, ICE1 (GenBank accession number: JF268687), was isolated and characterized from B*rassica campestris* (rape) cultivar Longyou 6. The cDNA length of ICE1 is 1737 bp with an open reading frame of 1500 bp. The ICE1 contains the conserved bHLH domain. The ICE1 gene, with the CaMV35S promoter, was introduced into tobacco. When transgenic and non-transgenic plant stressed by 2 °C with seven days, the transgenic lines were characterized by increased levels of chlorophyll content, photosynthetic rate, stomatal conduntance, relative water content, proline content, soluble sugar content, SOD and CAT activities, and decreased levels of electrolyte leakage and MDA content.

Conclusions: These results indicate that the ICE1 from winter oilseed rape cultivar Longyou 6 is a positive regulator of cold tolerance, which may play an important role in the regulation of the cold stress responses in plants.

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POSTERS THEME D

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The effect of waterlogging on yield at the early flowering stage in *Brassica napus L.*

Background: Different from those waterlogging-tolerant species, rapeseed (*Brassica napus L.*) is sensitive to waterlogging stress due to the lack of aerenchyma and high rate of radial oxygen loss from the root base. In China, 80% of rapeseed is planted along the Yangtze River, as a rotation crop in rice paddy fields. Seeds are sown in rice paddies in autumn directly after the rice harvest. Young seedlings are exposed to the still-humid paddy soil and often encounter rainfall during the flowering stage in spring, which is a very critical stage in whole-plant development for ultimate yield.

Objectives: The aim of this study is to answer the following questions: (1) what are the adverse effects of waterlogging on yield and seed quality at the early flowering stage? (2) which morphological traits play a key role in yield loss? and (3) are there any differences in the evaluated traits among these varieties?

Methods: A field experiment was conducted using 20 rapeseed varieties to evaluate the effect of waterlogging at the early flowering stage on yield and seed quality. The field experiments were conducted in three different environments in China. 10 agronomic traits were evaluated including plant height (Ph), branch number (Bn), branch height (Bh), main inflorescence length (Mil), siliques on the main inflorescence (Smi), siliques on branchs (Sb), siliques per plant (Spp), seeds per silique (Sps), main root length (Mrl) and thousand seed weight (Tsw). Finally, the plants in each plot were harvested for yield evaluation. In addition, some traits related to seed quality were also assessed using FOSS-NIR systems. The waterlogging tolerance coefficient (WTC) was used to evaluate waterlogging tolerance.

Results: The results showed that waterlogging stress affected rapeseed growth and caused yield loss. Except for Bh and Tsw, all other traits were significantly affected by waterlogging. A correlation analysis revealed that the WTCs of all the morphological traits were significantly correlated with that of yield, except of the WTCs of Bh and Bn. However, the WTCs of seed weight and seeds per silique were not found to be significantly correlated with that of yield. Additionally, waterlogging affected the oil quality by increasing erucic acid and glucosinolate content. Waterlogging also caused an increase in linolenic acid and a decrease in linoleic acid, indicating that waterlogging might affect metabolic pathways involving lipid biosynthesis.

Conclusions: The reduction in the number of siliques per plant after waterlogging is mostly due to the decrease of siliques on branches, which governed the final yield after waterlogging. Our study reveals the effects of waterlogging on different varieties of rapeseed at the early flowering stage and provides some data that may be useful for breeding more tolerant varieties.

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Changes of endogenous hormones in seedling influence on flower bud differentiation for early maturing rapeseed

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Background: Early maturing rapeseed benefit adapting multi-plant system and escaping hot harm season in China. Early-maturing and early flowering is significantly correlated (r≥0.90), and flowering time is an important factor that determine maturation time (Amiri-Oghan et al. 2009). The bud differentiation of the rape flower is regulated comprehensive by a variety of hormones; the effects of the GA on flower buds differentiation and flower development play a dominant role (Ruth et al. 1992). Hormone changes in rapeseed plant tissue regulate and control flower buds differentiation.

Objectives: Investigate the impact of endogenous hormones changes on flower bud differentiation process and the development of floral organs for early mature rape under different sowing date, to do so can guide early maturing rapeseed breeding and high efficient cultivation practices.

Methods: 1358, Zhongshuang11 and Zheshuang8 represents early maturing, mid-maturation (CK1) and late-maturing variety (CK2) separately. Test was conducted in testing base located in Wuhan (30 ° 34'N, 114 ° 20'E) in 2013/14. Three sowing date with a 7d interval, planting density 150,000 plants per hectare. Endogenous hormone was determined during seedlings.

Results: The earlier they were sowed, the sooner flower bud differentiation.1358 takes the shortest time at all the three sowing date. By sowing delaying, the flower bud differentiation time for 1358 is getting longer and longer. As for the flowering time, early-maturing variety 1358 is earlier than CK. Its differentiation, squaring and bolting for 1358 required less active accumulated temperature then CK. GA3 and ZR average content in 1358 seedlings of each sowing are significantly higher than CK, IAA and ABA cont is significantly lower than CK, higher GA3 and ZR and lower IAA and ABA could promote flower bud differentiation early.

Conclusions: Duration time for flower bud differentiation is shortest for 1358 than CK. By the sowing delaying, early varieties prolong flower bud differentiation. And early maturing variety rape bloom earlier and has longer flowering period. High GA3 is benefit for bud differentiation. ZR had the same function with the GA3.

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POSTERS THEME D

Effects of paclobutrazol on yield and mechanical harvest characteristics of direct-seedling winter rapeseed

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Background: In order to control the problem of lodging, plant growth regulators (PGRs) (stem shorteners) were applied to control plant height, which could help to meet mechanical seed harvesting demands. However, there was not a precise recommendation of paclobutrazol application time and concentration. Besides, little research was available about paclobutrazol affected on pod shatter resistance in oilseed rape to date.

Objectives: The aim of this research was to study the effects and mechanism of paclobutrazol (PP333) treatments on rapeseed yield and mechanical harvesting.

Methods: Paclobutrazol was foliar sprayed at the concentrations of 0, 150 and 300 mg L–1 to canopy closed stage and the early bud stage, on two cultivars of rapeseed Yangguang 2009 and Fengyou 520. The degree of lodging was measured for 20 plants per plot at maturity. Lodging was assessed by measuring the angle of inclination of the stem base from the vertical; severe root lodging was recorded when the stem base was at an inclination of > 45° whilst the stem remained undamaged and stem lodging was recorded when the stem had buckled locally. Lodging rates (lodging %) was scored with the formula [(the lodging in plot/the plot area)× 100%] at maturity of three replications, as described by Peng et al. (2014). The snapping resistance and culm lodging resistance index (CLI) were measured at maturity stage according to the methods Islam (2007) and Wang (2014) with some modifications. Silique shatter resistance was determined according to Morgan (1998). After random impact tests, dry weight of the pod was recorded.

Results: Our results demonstrated that: 1) PP333 treatment significantly increased the rapeseed lodging resistance, silique shatter resistance and yield. 300 mg L–1 PP333 at the bud beginning significantly more enhanced lodging resistance and silique shatter resistance, but 150 mg L–1 PP333 at closure period more significantly enhanced yield of two rapeseed varieties. 2) PP333 treatment reduced rapeseed seed numbers per pod, while pods per plant, 1000-grain weight and yield were all enhanced. At the same time, increased thickness of rhizome, root-top ratio (fresh) and snapping resistance, reduced plant height and culm lodging index resuled in reduced angle of plant lodging, which indicated an improvement in the ability of root and stem lodging resistance, Silique shatter resistance increased as increased silique water content and silique dry weight, and delayed pod maturity.

Conclusions: In summary, closure period sprayed with 150 mg L–1 of PP333 is the best time and concentration, it significantly enhanced ability of lodging resistance and silique shatter resistance and yield, which could meet rapeseed mechanized production model.

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Rape seed value creation from the perspective of industry chain - Survey data from Yangtze River Basin

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Background: With the deepening of market reform and opening to the world, to improve core competitiveness has been top priority for China's seed industry to cope with the increasingly fierce competition caused by multinational seed enterprises. Under market environment, core competitiveness of an enterprise or industry is embodied in value creation ability. How is the value creation ability of each industry chain segment? How much is each segment's contribution to total seed value? Which is the strategic segment in seed industry chain value creation? The current literature has not systematically studied on these issues.

Objectives: This research examines the contribution of each segment of industry chain and explores the value creation rule of seed industry chain through construction and evaluation of value creation model, which provides reference for China's seed industry to improve seed value creation ability and value management level to enhance the overall competitiveness.

Methods: Based on farmers' seed purchasing behavior and research, six main rape seed value elements have been selected, including internal core value, internal general value, appearance and image, brand, advertisement, and service. Seed industry chain includes breeding, production and development, agent and retailing. Taking value elements and their contribution to total value and value creation segments and their contribution to value elements as the main themes, the questionnaire consists of two aspects, respondent's basic information and respondent's evaluation on factors accounting for the proportion of total seed value and each segment's contribution to value elements.

Results: (1)The contribution rate of internal core value, internal general value, seed appearance, brand, advertising and service to total seed value is 35.17%, 18.13%, 9.76%, 14.23%,8.80%, 13.92%. (2)Breeding, production and development, agent, and retailing create 50.14%, 31.00%, 9.82%, 8.76% of internal core value; 43.08%, 40.92%, 8.33%, 7.67% of internal general value ; 22.15%, 51.10%, 15.48%, 11.27% of seed appearance; 22.11%, 26.22%, 31.97%, 19.70% of brand; 10.35%, 30.11%, 33.31%, and 26.23% of advertisement promotion; 10.13%, 25.58%, 30.57%, 33.72% of service. (3)The contribution rate of breeder, manufacturer, agent and retailer to rape seed industry chain value creation is 33.70%, 33.85%, 17.63% and 14.82%.

Conclusions: According to the matching principle of value creation and profits, profits gained by each segment bearing value creation activities should be generally consistent with its contribution to value creation. Therefore, seed industry chain should adjust the existing distribution pattern and construct reasonable interest distribution mechanism to guarantee the benefits of breeders, developers and farmers, making them have enough capital and power input into value creation activities especially seed breeding and development, strategic segment of rape seed industry chain.

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POSTERS THEME D

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Parable of the rapeseed seed

Background: The Parable of the Mustard Seed is one of the most renowned stories from the New Testament. The economic significance of rapeseed today may justify an attempt of interpretating this parable with this crop as its main object. The parable of the mustard seed and the kingdom of heaven appears in three Gospels: in verses 31 and 32 of Chapter 13 of the Gospel of Matthew, 'Another parable put he forth unto them, saying, The kingdom of heaven is like to a grain of mustard seed, which a man took, and sowed in his field: Which indeed is the least of all seeds: but when it is grown, it is the greatest among herbs, and becometh a tree, so that the birds of the air come and lodge in the branches thereof'; in verses 31 and 32 of Chapter 4 of the Gospel of Mark and verse 19 of Chapter 13 of the Gospel of Luke. These three versions have common crucial elements.

Analysis: From a theological viewpoint, the mustard/rapeseed seed may be considered a single grain of faith, that, if tended well, may produce countless fruits of a spiritual nature to the benefit of one's soul and being. There is also an emphasis on the contrast between the size of a mustard seed and the plant it produces: the mustard/rapeseed plant, if sown and nourished well, grows into 'a great tree', 'greater than all herbs', indeed up to 2 m at their full physiological development. The second part of the parable carries its moral impact: it is faith that opens one's soul to spiritual benefits, here in the form of 'the birds of the air', with this 'great tree' of a mustard/rapeseed plant depicted as providing them with dwelling. Again, it may produce more than 15 lateral branches per plant, with a length up to half that of the stems, more than 30 large and broad leaves per plant and the fresh aboveground biomass yields of more than 20 t ha-1. Ultimately, the alighting of 'the birds of the air' on the mustard/rapeseed crop may be a token of all positive changes within a person of firm faith. The mustard/rapeseed plant may therefore be regarded as a human body, within which faith may find its lodging, but also as a crop with a substantial inner potential, such as a high seed and biomass oil and protein content.

Conclusions: Learning more about our past may assist us in better contemplating our future: by this reason, such broad and complex interdisciplinary studies, touching upon both the spiritual and earthly spheres of everyday human lives, indeed may result in the casting of more light on the very dawn of agriculture, where both mustard and rapeseed surely have their deserved position.

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POSTERS THEME D

Pest Surveillance Initiative (PSI)- Advancing research into grower practice

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Background: Pest Surveillance Initiative (PSI) is a grower led molecular detection laboratory focused on identification of risks to successful canola production. In partnership with government and public sector researchers, PSI plays a key role in advancing the research discoveries off the lab bench, optimizing methodology for high throughput analysis and providing commercial testing services for crop pathogens.

Objective: Using an 'orphan drug' strategy, provide growers access to molecular assays that under normal market conditions the testing industry has shown little interest in marketing due to high cost per sample or a small number of end users. The first project of the Initiative is to optimize technologies for the detection and quantification of low concentrations of clubroot (*Plasmodiophora brassicae*) in Manitoba.

Methods: To date, Manitoba has reported very low number of plant positive samples for clubroot. In order to establish a benchmark of clubroot status, soil samples from the field access points of representative fields from 450 township-range coordinates across southern Manitoba were collected, dried and ground. Subsamples were analyzed for presence of clubroot DNA at low levels using modifications to the quantitative polymerase chain reaction (qPCR) technology (Cao et al 2007). Standard dilution curves from clubroot galls as well as artificially infested soils were used as controls.

Results: While individual field results are provided to the submitter only, the aggregate data is posted to a dynamic map tool (www.mbpestlab.ca) that provides an up to date status of the occurrence as well as severity (measured by number of spores per gm soil) of clubroot infection in Manitoba. Results form the foundation of extension and field management programming.

Conclusions: DNA-based surveillance provides a powerful early warning system of pending crop pests before visible symptoms of damage occur. Field level information using advanced technology, coupled with training tools and extension programs, work together to provide growers information they need to make informed management decisions. The surveillance strategy model is being applied to other crop-pathogen combinations.

References:

Cao,T., J. Tewari, and S.E. Strelkov, 2007. Molecular Detection of *Plasmodiophora brassicae*, Causal Agent of Clubroot of Crucifers, in Plant and Soil. Plant Dis. 91:80-87

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POSTERS THEME D

Food losses and waste in the French oilseed sector

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Background: Recently published reports suggest significant amounts of food losses and waste across the world, but reliable data is scarce. In industrialized countries, little attention has been put so far on losses and waste at the upstream stages of food supply chains (primary production, post-harvest operations, processing). A general food losses and waste approach was initiated by INRA on most relevant vegetable and animal sectors in France, from primary production to food supplying. This study is a contribution to close knowledge gaps on food losses and waste in the French oilseed sector.

Objectives: The overall objectives of this study were to i) identify causes and determinants of oilseed losses and waste at the different stages, ii) quantify them, and iii) discuss potential measures and research perspectives for reduction.

The main French oilseed sectors were targeted (eg rapeseed, sunflower and soybean oils as well as tofu from soybean).

Methods: In this study, food losses and waste are considered all edible parts of food intended for human consumption which are removed from the food supply chain and are not used for animal feed. All process steps in the oil supply chain were described from harvest to supplying, including storage, transportation, crushing, refining and packing to identify the key steps impacting losses. For tofu, all process steps from harvest to supplying were described, including soy milk and tofu production. Data were collected mainly from professionally qualified experts, due to a lack of publications on the topic.

Results: Whilst oilseeds and vegetable oils are adapted to long-term storage compared to other products, total vegetable oil losses from harvest to supplying remain very significant (around 71,4 kT equal to 10% of the oil consumption in France). It was established that the main determinants for oil losses are harvest and refining. The total food oil losses for rapeseed, sunflower and soybean were 9.8%, 7.0% and 6.0% of the potential French oil production, equal to about 50.6, 14.3 and 6.5 M€ or equal to the annual consumption of around 3.029.000, 856.000 and 389.000 people, respectively. For tofu losses, harvest is the main factor. The total tofu losses were 8,2% of the potential soybean production.

Conclusions: The total of food losses from harvest to supplying come out as substantial in the French oilseed sector. Losses are higher for rapeseed than for soybean or sunflower mainly due to cutting and threshing steps. Measures to improve the efficiency of the oilseed system at the key steps are discussed: genetic traits (resistance to shattering in rapeseed or soybean, resistance to lodging in sunflower, upper basal pods in soybean), design of the combine harvester or refining conditions (soft refinery). Our study recalls that besides oilseed loss reduction, measures to improve the oilseed system efficiency should also target yield losses (in extreme years, up to 12% of the multiannual mean yield).

References:

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