GCIRC News

Global Council for Innovation in Rapeseed and Canola

"Building a World community for Innovation on Rapeseed and Canola"

N° 12, June 2022

Table des matières

Editorial

Greetings and welcome to GCIRC Newsletter N°12, June 2022.

Supply constraints for oilseeds continue as the impact of the war in Ukraine affects global sunflower and rapeseed supplies. Our thoughts go out to our colleagues in Ukraine who are applying best endeavours to maintain supply chains for oilseeds and veg oils under the most challenging conditions. Thoughts also extend to oilseed farmers who are determined to plant crops despite the dangers involved and the uncertainty of being able to harvest.

Reports on World production of rapeseed/canola see expected increase in many regions. European production is expected to reach 18.3mmt, up 8% on last year. Double digit growth in production is expected in France (up 16%) and Germany (13%) while most other major European production states are reporting an increase in area sown to rapeseed. (Source: EU Commission. AMI).

Canadian canola production will be significantly up on last year's very low tonnage, but they are experiencing variable growing conditions with some regions quite dry, while other production areas are wet. Current estimates place Canadian production in line with2020 at 19-20mmt. (Source: Greg Kostal)

Australia is forecasting another above average (10-year average) production year but not expected to be as high as 2021-22 record year, with latest estimates of 5.2mmt. (Source: AOF)

The on-going COVID-19 continues to provide challenges impacting our day-to-day activities such as the restrictions around close contacts and the resulting disruptions on the work force

as a whole (depending on country rules and regulations). Globally the world is learning to live with COVID, and a return to pre-COVID levels for the rapeseed/canola-using hospitality and transport sectors is pleasing to see. Good news is that we are increasingly able to go about business in what is described the 'new normal' which is great news as we head towards 2023 and in particular for IRC-16 in September.

As a global organisation, GCIRC will embark on many scientific and industry challenges, some of which that may not be present today, while other such as changing climatic conditions, carbon footprint, protein applications and nitrogen use command much research focus right now. IRC-16 and future Congresses will be key platforms to showcase the development in these extremely important areas.

As I highlighted in the January newsletter, while IRC-16 Sydney 'Global Crop – Golden Opportunities' will be utilising a hybrid format, there will be a strong focus (need) for active delegate presence at the Congress and pre-congress field tour. Please keep an eye on your inbox for news on the Congress, which will also appear on the newly launched website, https://www.ircsydney2023.com

Robert Wilson, GCIRC President

Activity/ News of the association:

16th IRC in Sydney, Australia

IRC-16 Sydney 2023 – September 24-27

15 months and counting down IRC-16. *'Global Crop – Golden Opportunities'* planning and execution is progressing well.

Congress Executive Committee - meeting regularly, hitting timelines for activities.

- Congress venue booked
- Sponsors prospectus completed and approaches commenced
- Writing up expression of interest for Registration
- Budget (work in progress)
- Developing list of key Congress speakers (Government, Industry etc.)
- New website launched: https://www.ircsydney2023.com

Thematic Committee Chairs - (Australia) finalised. They have been requested to form their committees engaging both local and international members that will prepare the program including list of potential plenary speakers.

- GENETICS, GENOMICS and BREEDING Chair: Prof Wallace Cowling
- CROP PROTECTION Chair: Prof Jacqui Batley
- AGRONOMY, PHYSOLOGY & CROP MANAGEMENT Chair: Dr John Kirkegaard
- QUALITY & PRODUCTS Chair: Dr Allan Green
  Science and technical focus on oil and protein for food, feed & industrial
- END USE / CONSUMPTION Chair: Nick Goddard
  Current needs from end users for - food, feed and fuels
- ECONOMY & MARKETS Chair: Rosemary Richards
  Big picture on global oils and fats markets/climate/policies

Call for Abstracts: This will open in the next 2 months – watch your inbox for notifications.

Pre-congress Field Tour Committee – Core members engaged, planning underway.

We look forward to welcoming as many friends and colleagues as possible to Australia in September 2023. Remember, Sydney ***– "it's closer than you think."***

For further info go to https://www.ircsydney2023.com

News from the GCIRC Board

The new GCIRC Board has begun to work actively since its appointment by the General Assembly, on 30th September 2021, with regular online meetings (13th December 2021, 14th February, and 23rd May 2022). The first meeting was devoted mainly to mutual presentations in a Board team that has known and important turn over. The next sessions reviewed past and future activities, accounts, budgets, memberships and progress of the International Rapeseed Congress organization and related issues.

Welcome to New GCIRC members

Since last January we have welcomed four new members:

HEMKER	Reinhard	oil seed rape breeder, Limagrain GmbH	GERMANY
JAUVION	Vincent	Head of seed and cake analysis laboratory, Terres Inovia	FRANCE
RUCK	Laurent	Head of insecticides evaluation, Terres Inovia	FRANCE
YADAV	Shankar Lal	Plant breeder, SEEDWORKS	INDIA

You may visit their personal pages on the GCIRC website directory, to better know their fields of interest. We take this opportunity to remind all members that they can modify their personal page, especially indicating their fields of interest in order to facilitate interactions.

GCIRC Technical Meeting 2021: insect pest session

September28th-29th, 2021, the GCIRC hold online its Technical Meeting initially scheduled to be held in Poznan (Poland). It focussed on two thematic issues: «insect pest management in rapeseed, technical situation and research progress towards sustainable control» and «rapeseed protein production and added value: research issues from agronomy to product quality and process».

Dr Samantha Cook, from Rothamsted Research (UK) coordinated the first session on insect pests assisted by **Prof Andreas von Tiedemann**, University of Göttingen (Germany) to animate the discussion live session.

Samantha Cook introduced the insect pests control issue for rapeseed by reminding that insects love rapeseed citing a recent study that revealed 151 different insect species could be found on rapeseed in UK. Insects may attack the crop at different stages of their life cycle, which makes it difficult for producers to control them as they have to keep abreast of their field surveys to maintain an optimal pest management for the crop. Fortunately, most of the insects found in rapeseed can be considered benign or even beneficial. They can include some natural enemies of other crop pests allowing some pest control for free for the producers. Pollinators, such as bees and butterflies, can improve the yield of the crop and therefore benefit producers. Other species like detritivores are also very important for decomposition and soil improvement processes. Moreover, all insects provide very important food resources for farmland birds, making oilseed rape very important in the agri environment. Unfortunately, this importance has taken a long time to come to emerge: 20 years ago, in 1999, the GCIRC 10th international rapeseed Congress in Canberra (Australia) included 25 sessions and only one of them had anything to do with insects and integrated pest management. There were only five presentations in that session with one additional presentation from the breeding for resistance session on flea beetle. There was very little interest on insects back then. Today, 2021, the GCIRC Technical Meeting dedicated a whole session to insects with speakers for every GCIRC committee and there was enough to fill an entire session as there will be at the next rapeseed international Congress in Sydney (Australia) in 2023. Today, most regions in the world know insect pests control problems. In Europe notably, oilseed rape has stagnated in the recent period due to yield instability, maybe due to issues regarding nitrogen fertilisation, susceptibility of insect pests and lack of alternatives to insecticides, scarcer for some and loosing efficacy for others due to insects' resistance.

Samantha Cook gave a summary of the presentations to introduce the live debate. The first speaker was Dr Sabine Andert from the University of Rostock in Germany who talked about a survey on future farmer perspectives and their management of winter oilseed rape in Nort-Eastern Germany: there is a clear trend that growers are starting to stop growing oilseed rape or reduce it, mainly due to insect pests in autumn, as number one reason and spring pests, as the number two reason. Framers in Northern Germany tend to replace OSR by maize or winter cereals. By not replacing OSR by other flowering crops, it raises questions about the effects on bees and crop pollination. Samantha Cook observed that farmers did not consider Turnip Yellow virus as a very big problem, seemingly because of the recent availability of resistant cultivars. Andreas von Tiedemann express doubts about the relevance of lengthening the rotation to better control insects: once there are enough oilseed rape fields in a region, it will allow pests to perform their life cycle since it originates on the landscape level as they're roaming around and are mobile. Sabine Andert answered that beside insect pests in autumn and spring, farmers gave more answers regarding the main reasons of OSR cropping decline: if with a very high share of

WOSR, the main reason for decrease are insect pests from the perspective of farmers, however clubroot, weather extremes or nitrogen fertilizer uses are other main reasons for OSR cropping decline. The other crops are not always more profitable; however, they are more manageable for the farmers and that is also a main reason for some of them.

Is it a relevant answer regarding insect pests? and is integrated pest management part of the answer? These issues were discussed

Different speakers from all around the globe presented the situation in the major rapeseed producing countries, informing on the main pests and the control situation that each of these regions are facing, and what are the main alternative control methods available in these countries. **Dr Sarina Mac Fadyen** (CSIRO), **Dr Boyd Mori** (University of Alberta), **Dr Meike Brandes** (Julius Kühn-Institut), **Dr Sarwan Kumar** (Punjab Agricultural university) and **Prof Shu-Min Hou** (Anhui Academy of Agricultural Sciences) spoke for Australia, Canada, Europe, India, and China respectively. It was clear that insect rapeseed pests are diverse in the different regions with different pest problems due to the different climatic and cropping practices. Meike Brandes showed very clearly that even within a region of the world, different countries have very different problems making the management of the pests within the crop really difficult. It was clear that all regions have very high reliance on insecticides, particularly the broad-spectrum type that are less pensive. This is a main reason why we are starting to see pest problems due to widespread resistance in some of those regions, particularly those relying likely one or two active ingredients. The most interesting was of the mention of new pests, maybe emerging as a result of insect resistance or because crop surveys are increased. Sarina Mc Fadyen mentioned ear wigs, Boyd Mori and his team have identified a new species of midge that is a problem in Canada.

Everybody mentioned that agronomic practices for pest reduction are available and quite common. Early sowing being a particular strategy, farmers sowing their crops early to try to avoid pest infestation. Only a handful of commercially available alternatives to insecticides are available: an important point for discussion in future research.

The open debate following these presentations focussed on several issues:

- **The use of neonicotinoids** insecticides used in various regions of the world, notably to control aphids: In Canada, they are currently used, but not for aphids, they are not a problem there; in case of aphids' attacks at the end of the season, the seed treatment would already worn off. Neonics are banned in Europe, notably on rapeseed. In the case of India, Sarwan Kumar mentioned that even if neonics are banned of the pool of solutions, there are still **alternatives** in India such as chlorpyriphos and dimethoate, but for a sustainable pest management, host plant resistance needs more testing, and varieties with moderate levels of resistance could significantly help at reducing the insecticide applications on the crop. Samantha Cook observed that farmers want to replace those insecticides with cultivars that do not need insecticides, because it is easy, but at the moment they go in the fields to physically pick off the infected racemes with aphids. It is enormous physical effort and surely Indian farmers would be more willing to adopt strategies like trapping or intercropping strategies that take a little bit more effort than just spraying insecticides. Sarwan Kumar said that most of the farmers in India are small farmers with small fields: in the presented study, they do this kind of strategy early in the season and populations are very low. Moreover, in the areas where fields are available in the season, early planting is very useful and can lead to asynchrony between the aphid population and the flowering of the oilseed brassicas. If the fields are available early in the season,

farmers can go for early planting and the crop can simply escape from aphids that way. For insecticide application, practically just one application is sufficient in India to manage aphids, the second peak would start when fields are already mature and near harvesting.

- On the example Swede midge in Canada, for which winter canola seems to be more resistant, a question was asked about the possibility to escape some pest attacks by **moving winter canola to the north to replace spring canola**, playing on the different flowering phenology of these crops: Boys Mori answered that winter hardiness would really need a significant improvement to survive to the low temperatures. In southern Ontario, with its moderate climate, winter canola acreage is increasing, but is still minor crop in that region. Even with a yield increase for winter canola compared to spring canola. in the south of Canada, winter canola yields remain limited, around 5 to 10 Bu/acre more than spring canola.

Albin Gunnarson mentioned that in Sweden, both spring and winter oilseed rape are grown, and that winter oilseed rape has been increasing over the last 10-20 years and tends to move to more northen areas, spring oilseed rape also being affected by the neonics ban. Major insect problems are observed in the border zone where both spring and winter oilseed rape are present, and where pollen beetles can have up to 4 generations. Problems are lessened in regions where only spring or winter oilseed rapes are grown. The two must be kept apart. Similar observations were made in UK, Germany, and France.

- On **the development of new pest species** observed notably in Australia, Andreas von Tiedemann wondered how manageable the situation was and if having a multitude of insecticides could drive the emergence of new species, perhaps because they eradicate the traditional ones. She questioned if that a theory had weight or what else peoples were thinking we're going through? Sarina Mc Fadyen developed this question in an interesting way; she did not think some of these new pests were due to insecticide uses but maybe to agronomic practise changes over many years. European earwigs have been present in Australian systems for many years and only they are becoming a pest. Some of these pests, particularly detritivores and omnivores, are very hard to manage because some of them there have no registered pesticides, and the rest would probably be not very effective. It is really a relationship between how we are changing the farm environment as a resource for detritivores and omnivores, more generally around stubble management, changing our seeding patterns, and then how those rotation systems keep biomass on the field throughout the whole year. Insecticides are probably not causing new issues, but the key problem around insecticides is that there is a chance that European earwigs already have resistance, because even though there's nothing registered for them, they are in the field the whole year, and so they get exposed to a lot of various insecticide applications. The concern is that if they are now becoming a pest and are moving from a beneficial category into a pest one, then they get a decent level of resistance, we can really create a problem that potentially could have benn avoided if we had done other management strategies early on. There is a table that shows the propensity of different species, at least theoretically, to develop resistance and actually European earwig is relatively high. Keeping that it is not targeted, it should not really have any target sprays, but because it gets so many non- targeted applications, it is at risk. There is now no evidence that European earwigs are resistant, it has not been tested, but it would not be a surprise: they have a long-life cycle, not like aphids that has a very short life cycle. Therefore, there is a much bigger risk. Resistance testing is limited on specific species, and we do not have a coordinated approach for resistance monitoring across our invertebrate pest species. Andreas von Tiedemann ob-

served that the use a broad range with different modes of action could lead to multiple resistance. Sarina Mc Fadyen agreed but added that considering the numbers of modes of action is one thing and what farmers use each year in the field is another thing. If there is a couple of modes that are really popular because the products are very inexpensive, they will get used more frequently. In this case, it is likely that there will be resistance. The second aspect is that we also have resistance management plans for a number of invertebrate pests for other crops than canola, but we cannot say whether those resistance management plans are scientifically sound. We do not have strong evidence to say that if you implement this plan, you will delay the development of resistance in that species.

- Concerning agronomical practices, earlier sowing interest on aphids as disease vector may depend on the population growth or movement, and on climate conditions. Early sowing may also interact with stubble management. Some studies in Australia suggested that stubble higher than the germinating canola crop may reduce aphids landing on the green canola plants, but it has to be confirmed, it is not certain that it will actually reduce the aphid transmission of viruses. Samantha Cook added that a small study on stubble management in UK against cabbage stem flea beetle has shown that long stubbles reduced flea beetle landing... There is something to study further in this kind of techniques.

Wish list of every country was a call for resistant cultivars. This is what **Dr Maxime Hervé** (Inrae, France) talked about, observing that developing insect resistant cultivars is very challenging, and that a major bottleneck for breeding process as it is the difficulty for phenotyping at large scales (insects' availability, labour intensive, mobility of insects and spatial effects in fields…) with added with the scarcity of major resistance genes. It is probably the reason why we have not got any insect resistant variety yet. Several approaches have been tried:

- Transgenes: (Bt, protein inhibitors, lectins, chitinases… Hairy canola has been most successful, but we still have not got any commercial varieties with that strategy.
- resistance in *Brassica napus*: screening of available genotypes and genetic variations has been worked out. There has been some success with stem weevil, pollen beetle, aphids, cabbage root fly. There is actually quite a lot of ongoing work across Europe, in particular to find resistant varieties for cabbage stem flea beetle, but it is a long way to go. Maxim Hervé wondered if the mission was possible.
- Resynthetized lines integrating two types of brassicas (*B. Oleracea x B. alba*) may be an alternative solution to this problem,
- Introgression: may be the best strategy so far is to introgress lines. *Synapis alba* seems to be resistant to most of the pests tested, giving a real hope for the future.

Resistance mechanisms involved in *Synapis alba* resistance: it probably involved flanonoids but has not clarified yet. Transferring genes from Synapis species to Brassicas has been done with some successes in creating hybrids or additional lines, but hardly leading to brassica lines. The major problem seemed to be the wide genetic distance between the various Brassica species to transfer genes; even crosses between *B. rapa* and *B. Oleracea* being difficult. Works carried out in Poland (Janetta Niemann) on resistance to cabbage root fly did not identified resistance in S*ynapis alba* for this pest, but *B fruticulosa* and *B. carinata* may be a source. Rod Snowdon confirmed that successes to introgress from *S. alba* to *B. napus* and other brassicas with actual chromosome integration are limited. He considers that two strategies are possible: (1) to focus on chromosomes, and break up the *Synapis* chromosomes to get them in Brassicas, via a chromosome engineering approach - a slow and long way, seemingly

adopted by a French team and (2) to focus genetic studies on *Synapis* in order to identify the responsible genes and try gene editing approaches, maybe GM, to get it in canola… still with the uncertainties regarding GM or even gene editing in Europe.

Andreas von Tiedemann mentioned that in Germany, Bernd Ulber tried an approach looking for a relationship between glucosinolates patterns and resistance to insects with apparently some lines looking better than other. A von Tiedemann raised another issue on the durability of resistances: if we find resistances in the gene pool, the third challenge is how to design a resistance which will not be overcome very quickly when established in cultivars. The management of Bt transgenic varieties in Canada and Australia keeping 10% acreage with sensible varieties as refuge zones is the only reference at present, but results may depend on the types of resistance. A. von Tiedemann observed that from a European perspective with many pest species, a single resistance to a specie would not solve the problem of insecticides applications. Hairy canola seems to be the less specific type of resistance.

Maxim Hervé also concluded that diversity is needed, especially including within field and crop diversity strategies. These last aspects are central in what **Mrs Celine Robert** from Terres Inovia (France) talked about in agronomy. She presented different strategies that farmers can implement for agronomical methods for insect suppression. Farmers can try to avoid the problem in the first place by companion planting: planting different frost sensitive legumes to help the crop grow faster during its susceptible stage. Farmers also practice early tillage after harvest to preserve moisture in field and sowing early, timed with rain. Plant tolerance to insect attacks is very important, and maybe these frost sensitive legumes are giving plants an extra nutrition, helping the biomasses of these plants to increase. Céline Robert and her team found that increased biomass in oilseed rape led to less damage. Early vigour was important, robust plants that grow through the winter and that can get growing again in the spring was really important and there was difference between cultivars regarding early vigour. Maybe there is some hope for tolerance, if not resistance. She presented an innovative agroEcological system, which included a 9-years rotation with barley or durum wheat as a preceding crop, direct seeding, deep non inversion tillage and the use of these cover crops and companion planting with legumes, and found that these systems could increase the biomass of the plants, increase yield, increase the profit margin at the farmer and reduce the availability of use of insecticides, which reveals a strong potential for these agronomical methods to manage insect pests. Céline Robert commented was that there is great potential for beneficial insects by habitat and landscape management, which leads into an actor's tool.

The mechanism of the effects of companion plants on insects in not understood yet: we do not know if there is a repellent effect or only disturbance, but less larvae on rapeseed were observed with companion plants. Hector Carcamo mentioned the new practice of intercropping canola with peas ("peola") in the Canadian Prairies with farmers reporting that they have less pest problems with intercrops. Such techniques are also tested in UK (spring canola and peas) and Finland (with beans).

Would agronomical techniques allow to grow rapeseed without insecticides? Céline Robert observed that getting robust crops limits the harmfulness of autumn insects, especially when plants can restart early at spring, but may be insufficient against flea beetle larvae when winter lasts longer, and insecticides are still needed in these situations.

Dr Sandra Lindström (Sweden) looked at the effect of bees and pollination on yield and quality of rapeseed. Interestingly, pollination is not currently considered as macroenomic planning process due to the lack of studies on pollination. Most rapeseed cultivars are wind pollinated and the effect of

pollination has been neglected. Sandra Lindström reviewed the literature and found that pollination in oilseed rape can increase the oil content by 2% in spring cultivars and 7% in winter cultivars. Bee pollination increases seed yield by 10 to 50% pending on literature references. In her study, she found a yield effect which depended on crop cultivar. Open pollinated cultivars responded better than hybrids. It supports Samantha Cook's own research that showed that on genetic male sterility hybrids produce more nectar than cytoplasmic male sterility hybrids and open pollinated hybrids. So maybe there's some possibilities to manipulate or to improve the value of oilseed rape crop through pollination via flower visiting insects. Sandra Lindström make the hypothesis that for OP cultivars, increased pollination would increase cross pollination and create more heterosis, and higher oil content. She recommends integrating pollination in cultivars trials to compare all cultivars in equal terms.

Lastly, Sandra Lindström found that insecticides could actually increase yields due to improved pollination. An example with a treatment against pollen beetle during bud stage showed that insecticide helped the bees because there were more flowers were produced with less damages, there was more nectar per flowers or more pollinators and there were less pollinator visits without nectar foraging. Selected insecticides could actually increase yields due to pollination and not necessarily due to impact on or improved pest regulation. This concept would deserve more attention. Sandra Lindström's constant comment was that we need insecticides that do not directly harm pollinators.

Regarding alternatives that are coming now through the research pipeline, Hector Carcamo (Agriculture and Agri-Food Canada) presented classical biological control research, trying to control seed pod weevil by *Trichomalus perfectus*, an introduced species which has established itself in Canada, and the Lygus bug with *Perisenus digoneutis*, which is another parasitoid that was present in America as a native species, and also species that come from America. Research is looking very closely at their safety requirements: can we release these species into Canada without causing problems to the native insects? Hector Carcamo considers that within Quebec province, where ecosystems are more or less similar, risks are limited, but that the issue may be quite different in the perspective to extend to Western Canada Prairies with very different ecosystems and very different species of parasitoids: it would need to have better ideas about the potential impact on the native weevils here and potential indirect effects on native parasitoids. Another issue is the capacity of (introduced) parasitoids to survive in the environment, which would deserve specific studies for better understanding and imagine management.

Would parasitoids allow to reduce insecticides uses? The situation in Quebec reveals quite high levels of parasitism – more than 50% - in some cases when farmers have reduced the use of insecticides, but they never rely on a single lever: combined techniques and more integrated approaches are needed.

Dr Perran Stott-Ross (Australia) looked to harnessing endosymbiotic bacteria and aphids crop protection, so aphids have bugs within them, which is mostly doing good and something that didn't harm. He found a diverse range of endosymbiotics with positive and negative effects, which can be manipulated for pest management. We could add them to insects, or we can knock them out by use of antibiotics and for example. They showed that *Rikesiella* causes colour changes which reduces natural reproductive behaviour, and *Buchnera* is essential since without it, insects become infertile. So, this lead to nice potential future control strategies, but research is still needed to deliver this approach in fields. Also, these techniques are limited to aphids, each aphid species having its particular strains.

Prof Eve Veromann (Estonia University for Life Sciences) presented RNAi technology that silenced genes. Her team showed the possibility of developing an RNAi approach, based on the coatomer protein alpha-COP, using micro injection and sucrose nectar feeding bioassays. They showed that they could kill 100% of pollen beetles that were tested. However, when the RNAi test was applied to the buds (spray induced gene silencing approach), to mimic how the crops behave, there was less mortality, but it was still good; growers could likely use it for control. Interestingly, they showed that with simulated chronic feeding (host induced gene silencing) simulating a GM approach, beetles died faster than when it was sprayed on the outside of the bud (short term feeding). Genetic approach in a plant would perform better than a spray approach. In similar works under way in Canada (University of Manitoba) against flea beetle, sprayable application is looking more effective than transgenes.

Lastly, **Prof Guy Smagghe** (Ghent University, Belgium) looked at registration process of an RNAi, which is really complicated, and changes greatly between the USA, Europe and the rest of the world and is especially frustrating in New Zealand. It depends on how the RNAi technologies as assessed, fine chemicals pesticides or just other natural products.

To conclude the session, Samantha Cook drew the following wrap-ups:

1) Is a lack of (synthetic) active ingredients driving pest problems via resistance? Yes, likely for some species. The lack of synthetic active ingredients is probably driving resistance in some species, but it is probably not the case globally.

2) Can we grow rapeseed without insecticides? And what tools do we have now in the pipeline that are most likely to enable it? Yes, we could grow without insecticides, but it is difficult. If yields have to be maintained, insecticides have their place in modern agriculture and new technologies like RNAi or endosymbiotic bacteria offer possibilities if we work on the methods to deliver them in the fields. Regarding other alternatives like trap cropping, biological control… we should think collectively about the most likely technologies.

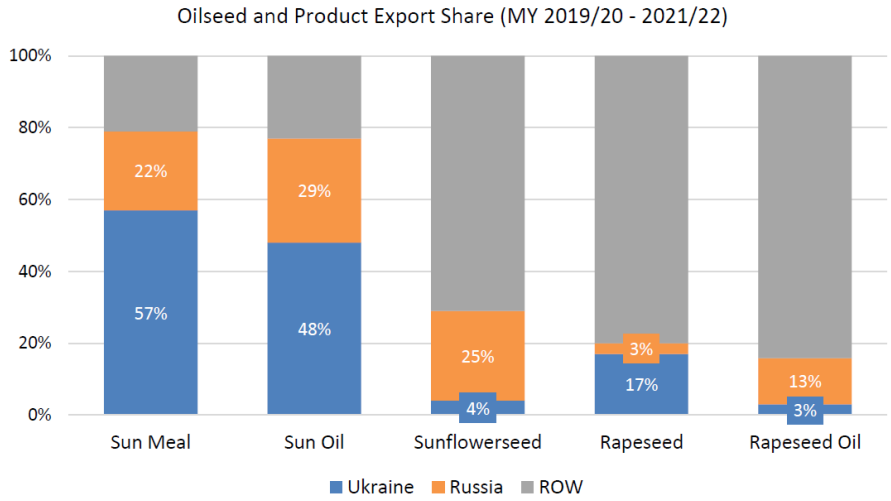
3) what are the main barriers to achieve sustainable production at the moment? Beyond understanding biology, we need to understand famers' behaviour more, in order to implement alternatives on the market. IPM has a lot of potential, but more work is needed to deliver it is still really hard for full IPM on any species in rapeseed.

Value chains and regional news

War in Ukraine and vegetable oils and oilseeds markets

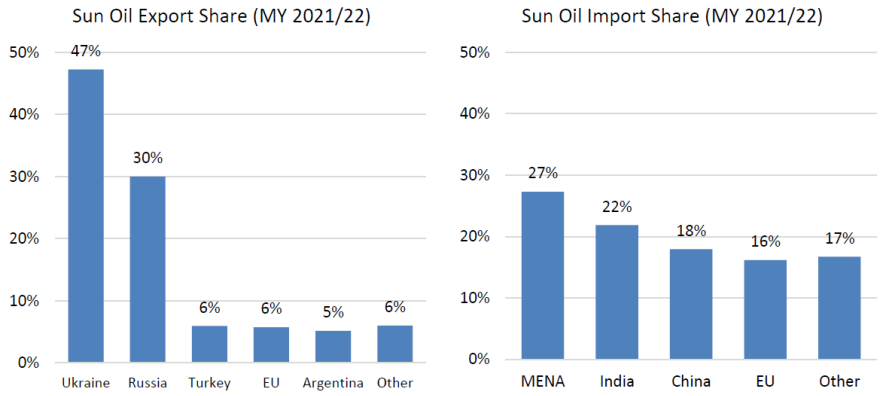
The war in Ukraine which started on 24th February affects the main sunflower producing and exporting region in the world. Ukraine alone represents 30% of the world sunflower seed production and 33% of the sunflower oil production. The major part of this production is processed in the country, Ukraine is the first sunflower oil exporter in the world with almost half of the sunflower oil exports. Ukraine also produces other oilseeds about 4500kT of soybeans and 1250-2000 kT of rapeseed.

USDA NIFA March report summarizes the situation regarding importance of Ukraine and Russia on Sunflower and Rapeseed/Canola markets with the next charts (see: https://usda.library.cornell.edu/concern/publications/tx31qh68h?locale=en):



Concerning the rapeseed issue, The March NIFA report commented: "Together, Ukraine and Russia account for about one-fifth of rapeseed exports and a little more than 15 percent of rapeseed oil exports. Ukraine rapeseed and product exports are frontloaded during the marketing year, and as a result were largely shipped prior to the conflict. Hence, Ukraine rapeseed exports are unchanged this Month as nearly all were shipped between July 2021 and December 2021. Similarly, rapeseed meal and oil export forecasts are unchanged this month. Conversely, Russia rapeseed exports are down 33 percent this month on weak exports to China over the first half of the marketing year. However, Russia rapeseed crush and oil exports are both forecast up this month on lower rapeseed exports and strong rapeseed oil sales to China and Norway in 2021."

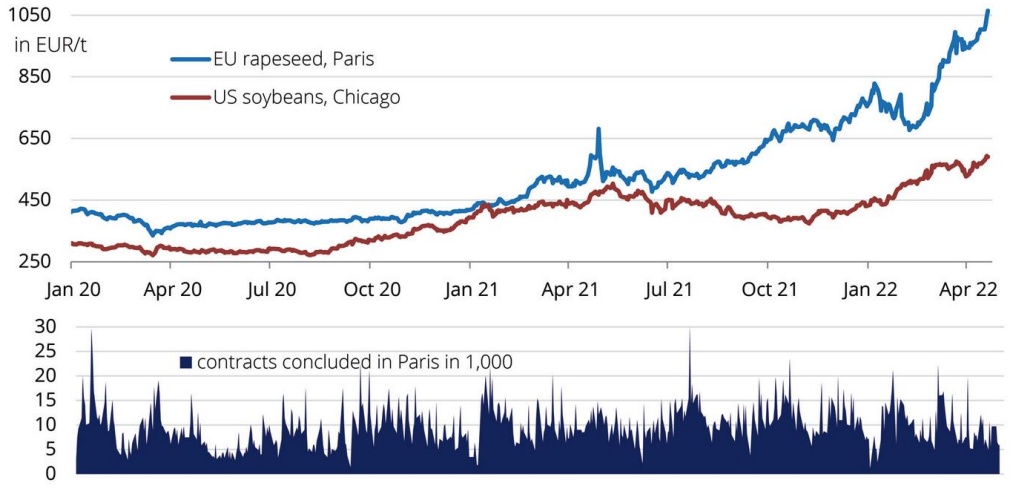
Global Vegetable Oil Markets Tighten Further on Disruption in Black Sea Exports



These events in Ukraine came to reinforce the higher price trends on vegetable oils and oilseeds markets, resulting in exceptionally high prices. The Ufop Chart of the Week 17 2022 (see https://www.ufop.de/english/news/chart-week/#kw18_2022 and Chart 15 on vegetable oils prices) showed this recent evolution of soybean and rapeseed prices. UFOP commented "The main reason for the strong price surge over the past few weeks is the crisis in the Black Sea region, which was sparked

by the Russian invasion in February 2022. Reports about the war in Eastern Europe fueled prices at the international futures markets every minute at a time when prices were rising anyway due to tight supply to the market. Shortages in supply due to the absence of contractual delivery volumes from Ukrainian ports of export are now having a bearing on the entire global market. Concerns about global supply bottlenecks have also led to export restrictions or even bans, like the one the Indonesian government imposed on 28 April 2022. This situation caused rapeseed prices at the Paris stock exchange to explode. According to investigations conducted by Agrarmarkt Informations-Gesellschaft (mbH), price fluctuations, of up to EUR 68 per tonne in one day, were the order of the day in March 2022. Currently, stock exchange prices are driven by snow and cold spells in Canada, where rapeseed sowings should be underway. Prices exceeded the level of EUR 1,000 per tonne for the first time. More specifically, the May 2022 nearby closed at EUR 1,064.50 per tonne on 21 April 2022. The close compares to EUR 561.75 per tonne at the same time a year earlier and as little as EUR 366.75 per tonne in April 2020. This means that stock exchange prices almost tripled within two years."

Oilseed futures closing prices
and contracts concluded in Paris

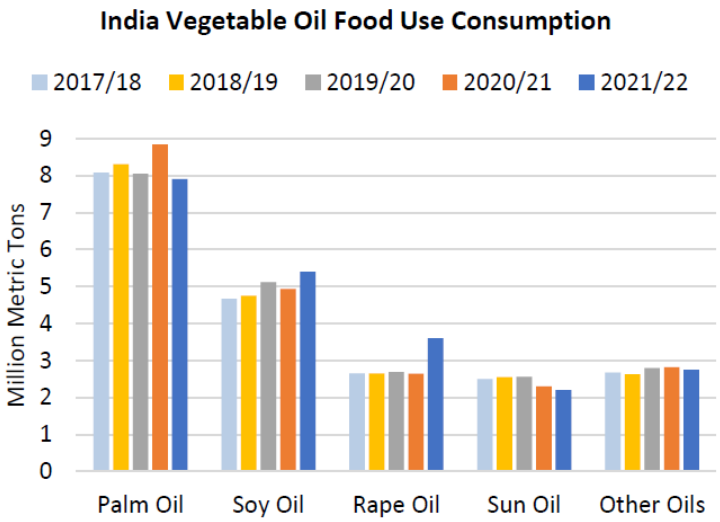


Source: CME, NYSE Liffe, AMI

Note: US prices converted to EUR

"Finding alternative vegetable oils will be a challenge in a market that has been facing tight supplies even before the events in Ukraine." USDA NIFA April report informed about India, which is turning to soybean and rapeseed oil to meet food use demand: "India is the world's second-largest consumer of vegetable oil for food and is forecast to consume 21.8 million tons in 2021/22 (…) and imported two-thirds of food use consumption over the past 5 years. In a typical year, palm oil (40%) and sunflower seed oil (11%) comprise more than half of India vegetable oil food consumption. However, over the past 4 months, the combined forecast for palm and sunflower seed oil imports have been cut nearly 1.5 million tons on high edible oil prices, gains in domestic rapeseed production, restrictive Indonesia palm oil trade policies, and disruptions to sunflower seed oil trade as a result of the Russian invasion of Ukraine.

In order to meet food use demand, India has been purchasing soybean oil at the highest rate since 2015/16 when a disappointing rapeseed crop the prior season drove higher imports.



In addition, India will likely rely more heavily on rapeseed oil in 2021/22 than in prior years. India has already begun to harvest a record rapeseed crop. Normally, the new crop is sold to domestic crushers in March and April and the resulting oil is consumed domestically almost entirely for food. As a result of the bumper crop, India is forecasted to produce an additional 800,000 tons of rapeseed oil which would help offset diminished imports of sunflower seed oil and palm oil. Soybean oil imports are likely to slow as rapeseed crush ramps up and the resulting rapeseed oil hits the shelves."

Australia: best results in 2021 and optimism for 2022 harvest

The last AOF crop report of May 2022 (see http://www.australianoilseeds.com/about_aof/news/another_strong_year_for_canola_ahead) confirms the excellent results of the 2021 harvest, not far from the January estimate : finally 6 329 000 tonnes compared to the 10 years average of 3 460 000 t.
For the 2022 campaign, « A strong start to new season plantings has been realised with timely rainfall across many districts in NSW, VIC, and WA in the first three months of 2022. SA is the exception with most canola growing regions still waiting for a general autumn break. Across the east coast, favourable seasonal conditions may continue into mid- to late- winter, with a weakening La Nina persisting longer than previously forecast. Optimism in growing conditions and continuing firm prices in the 2022-23 season is reflected in the estimated 12% aggregate increase in canola area planted on last year » reaching 3 320 000 ha compared to 2 970 000 in 2021.

Canada: Cargill set to build canola crushing plant after buying land at inland port in Saskatchewan

Canada implemented its canola development strategy explained during the 2021 Canola Week and reported in our last GCIRC newsletter. "Canada's Saskatchewan province has sold land at its inland port to global agribusiness giant Cargill for a canola crushing plant, the Saskatoon Star Phoenix reported. The Global Transportation Hub (GTH) authority in Regina, Saskatchewan – one of Canada's inland ports – sold the land to Cargill for US$38M, according to the 6 April report. Cargill announced plans for the new 1M tonnes/year canola plant last April saying it expected to begin construction this year with plans to become operational by early 2024 (…) Alongside plans for the US$350M Regina

canola plant, Cargill said it would also be updating its canola facilities in Camrose and Clavet to increase production."

Source: Oils & Fats international news 11th May 2022: https://www.ofimagazine.com/news/cargill-set-to-build-canola-crushing-plant-after-buying-land-at-inland-port-in-saskatchewan

Status and trends of oilseeds sector in India. Spatial Expansion of Rapeseed-Mustard over the Time: Growth Performance

*Dr PD Meena shares with us this short text by his colleagues **RK Yogi, AK Sharma, Vinod Kumar & PK Rai, of ICAR-Directorate of Rapeseed Mustard Research,** Bharatpur, Rajasthan India, on the evolution and performances of rapeseed-mustard in the context of the oil crops sector in India:*

"South Asia is the home to about one-fifth of the world's population and the countries in the region differ considerably in terms of size of population (24% of the world's population), geographical area (3.5% of the world's land surface area) and economic performance. India is the largest and fastest growing economy in the region with about 1.36 billion population and GDP of about US $ 2875.14 billion. However, India's per capita GDP ($2006) is lower than of Maldives ($10331), Sri Lanka ($4081) and Bhutan ($3243). Pakistan is the second largest economy in terms of GDP (US $ 224 billion) but is 5th in terms of GDP per capita ($1482) in the region followed by Nepal ($1039). India is also the largest agrarian economy with the highest gross value-added in agriculture (GDP) followed by Pakistan and Bangladesh.

Indian agriculture has undergone a radical transition from traditional to high-value agriculture during recent years. The economy has also witnessed shifting of consumption pattern from traditional cereals to a more holistic and nutritious diet of fruit and vegetables, milk, fish, meat, and poultry products due to rapid growth of the economy. According to Economic Survey of 2018-19, India continues to remain the fastest growing major economy in the world in 2018- 19, despite a slight moderation in its GDP growth from 7.2 % in 2017-18 to 6.8 % in 2018-19. On the other hand, the world output growth declined from 3.8 % in 2017 to 3.6 % in 2018. Real growth in 'Agriculture & allied' sector was lower in 2018- 19 at 2.9 %, after two years of good agriculture growth. Backed by good monsoon, India has attained a record food grain production of 305.44 million tons during 2020-21. The total oilseeds production is expected to be 36.57 million tons during 2020-21.

India is one of the major oilseeds' grower and importer of edible oils. India's vegetable oil economy is world's fourth largest after USA, China & Brazil. Rapeseed & Mustard is widely grown in majority of continents with largest area of 8 million ha in Canada followed by China (7 million ha) and India (6 million ha). Majority of the countries grow rapeseed, whereas India has largest area under mustard. The diverse agro-ecological conditions in the country are favorable for growing 9 annual oilseed crops, which include 7 edible oilseeds (groundnut, rapeseed & mustard, soybean, sunflower, sesame, safflower and niger) and two non-edible oilseeds (castor and linseed [1]). Oil Palm is comparatively a new crop in India and is the highest vegetable oil yielding perennial crop. With quality planting materials, irrigation and proper management, there is potential of achieving 20-30 MT Fresh Fruit Bunches (FFBs) per ha after attaining the age of 5 years.

[1] In several countries including EU and Canada, linseed is recognized as edible.

Oilseeds cultivation is undertaken across the country in about 27 million hectares mainly on marginal lands, of which 72% is confined to rainfed farming. The oilseed accounts for 13% of the Gross Cropped Area, 3% of the Gross National Product and 10% value of all agricultural commodities.

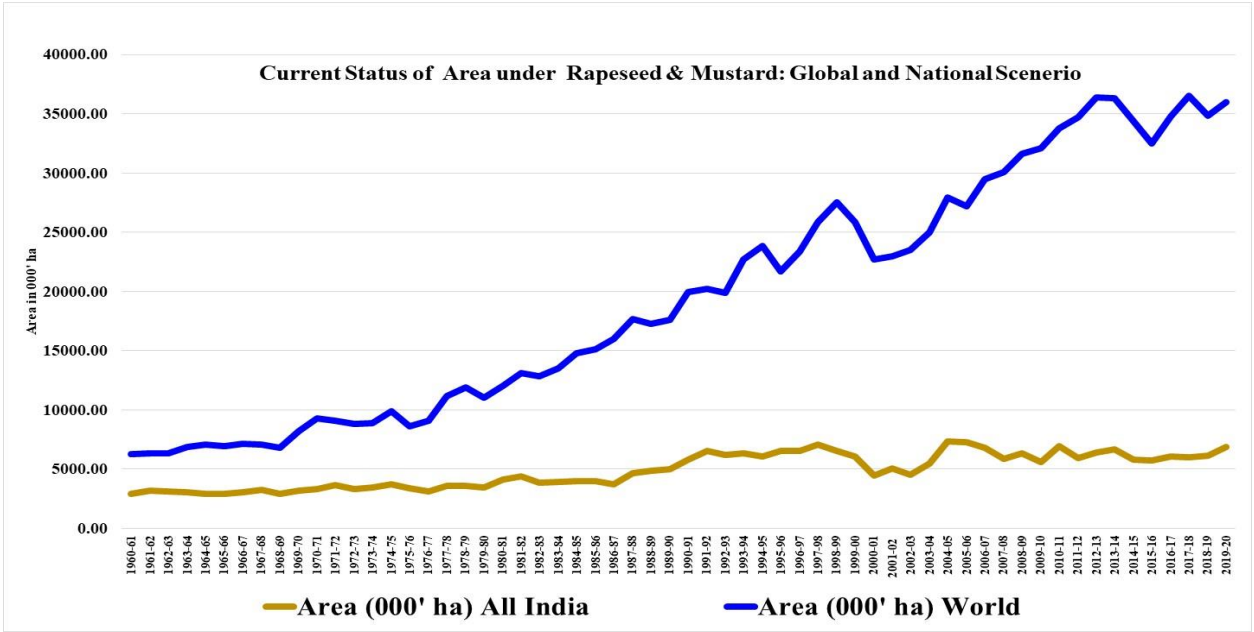
With per capita consumption of vegetable oils @16 kg/year/person for a projected population of 1.64 billion, the total vegetable oils demand is likely to touch 26.22 million tons by 2050 (UNO Report). But, during the last few years, the domestic consumption of edible oils has increased substantially and has touched the level of 24.07 million tons in 2019-20 and is likely to increase further. A substantial portion of our requirement of edible oil is met through import of palm oil from Indonesia and Malaysia (NMOOP, GOI).

Globally, Rapeseed & Mustard is processed into vegetable oil for human consumption and meal for livestock feed and few examples are also of industrial use. Rapeseed & Mustard has recorded annual growth rate of area, production, and yield @ 0.32%, 2.45% and 2.13% respectively during last decade (2009-10 to 2019-20). The productivity of India is the lowest among the major rapeseed mustard growing countries (Kumar *et al* 2019).

Table 1 Growth Performance of the Spatial expansion of rapeseed-mustard over the time

Year	All India (In 000' hectares)	World (In 000' hectares)	India's Share in Total Area (In %)
1960-61 to 1969-70	3034.24	6889.79	44.04
1970-71 to 1979-80	3445.88	9751.42	35.34
1980-81 to 1989-90	4231.62	14984.40	28.24
1990-91 to 1999-00	**6354.90**	**23089.07**	**27.52**
2000-01 to 2009-10	5861.63	27267.18	21.50
2010-11 to 2019-20	6237.81	35014.87	17.81

As against the World average of 2002 kg/ha, highest productivity of 4795 kg/ha of European Union, the Indian average yield was only 1161 kg/ha during 2010-11 to 2019-20. Longer crop duration and



high carbon content in the soil are the major factors attributing to high productivity of rapeseed in Western part of the World (Status Report R&M, 2017, NMOOP, GOI). Total area, production, and yield of rapeseed-mustard in world during 2019-20 was 35.95 million ha, 71.49 million tons (mt) and 1990 kg/ha, respectively.

Figure 1. Trends in the area under Rapeseed & Mustard at Global and National Level

There has been a considerable increase in production and productivity from 2013-14 to 2019-20. There was slight decrease in production and productivity from 2017-18 to 2018-19. However, there was slight increase in area, production, and productivity in 2019-20. The rapeseed-mustard acreage increased from 6.12 mha (2018-19) to 6.86 mha (2019-20). However, production slightly decreased from 9.26 mt (2018-19) to 9.12 mt (2019-20). The rapeseed-mustard yield slightly decreased during 2019-20 as compared to the previous years.

Table 2 Growth Performance of the Spatial expansion of rapeseed-mustard over the time

Plan	Plan Period	All India In 000' hectares)	World In 000' hectares)	India's Share in Total (In %)
Third Five Year Plan (1961 – 1966)	1961-62 to 19665-66	3034.00	6696.09	45.31
Annual Plan (1966 – 1969)	1966-67 to 1968-69	3039.93	6975.73	43.58
Fourth Five Year Plan (1969 – 1974)	1969-70 to 1973-74	3377.02	8833.88	38.23
Fifth Five Year Plan (1974 – 1979)	1974-75 to 1978-79	3455.16	10113.14	34.17
Rolling Plan (1978 – 1980)	1978-79 to 1979-80	3507.00	11431.51	30.68
Sixth Five Year Plan (1980 – 1985)	1980-81 to 1984-85	4039.86	13247.65	30.49
Seventh Five Year Plan (1985 – 1990)	1985-86 to 1989-90	4423.38	16721.15	26.45
Annual Plan (1990 – 1992)	**1990-91 to 1991-92**	**6167.75**	**20086.35**	**30.71**
Eighth Five Year Plan (1992 - 1997)	**1992-93 to 1996-97**	**6326.50**	**22292.44**	**28.38**
Ninth Five Year Plan (1997 – 2002)	1997-98 to 2001-02	5826.14	24992.69	23.31
Tenth Five Year Plan (2002 – 2007)	2002-03 to 2006-07	6271.00	26627.62	23.55
Eleventh Five Year Plan (2007 – 2012)	2007-08 to 20011-12	6101.12	32458.60	18.80
Twelfth Five Year Plan (2012 – 2017)	2012-13 to 2016-17	6125.35	34864.75	17.57
Annual Plan (2017 – 2020)	2017-18 to 2019-20	6319.12	35786.00	17.66

It is evident from the Fig 1 and Tables 1 2, that the average area under Rapeseed & Mustard at National level almost doubled from 30.34. lakh hectares during 1961-70 to 62.37 lakh hectare during 2011-20. However, it is doubled at global level in 20 years from 66.96 lakh hectares during 1961-70 to 149.84 lakh hectare during 1981-90. Further in next 40 years, it is crossed more than the double from149.84 lakh hectares during 1981-90 to 350.14 lakh hectare during 2011-20. Tabular analysis revealed the

technological or policy intervention in India during the period of 1991-2000 which resulted the highest increase *i.e.* 20.00 lakh hectare area under Rapeseed & Mustard in a decade. The Oilseed Mission coupled with other exogenous factors including liberalization boosted the Nation in big way by doubling the average area from 3.03 million hectares during 1961-66 to 6.32 million hectares during 2017-20. However, the inconsistency in the oilseed production system over the years is a cause of concern for all of us. It is, therefore, necessary to exploit alternative domestic resources like palm oil and Tree Borne Oilseeds (TBOs) including sal, mahua, simarouba, kokum, olive, karanja, jatropha, neem, jojoba, cheura, wild apricot, walnut, tung *etc*. to maximize production to ensure edible oil security for the country. These TBOs are cultivated/grown in the country under different agro-climatic conditions in a scattered form in forest and non-forest areas as well as in waste land /deserts/hilly areas and also good source of vegetable oil and therefore need to be supported for cultivation.

Against the total domestic demand of 25.88 million tons of vegetable oils, India is able to meet hardly 10.53 million tons (40%) through its domestic production. Rest amount 15.35 million tons (60%) is meet through imports. An expenditure of $ 75 billion (Rs 74996 Crore) was made on the import of vegetable oil during 2017-18. National Mission on Oilseeds and Oil Palm (NMOOP) is functional through its three pronged strategy including Mini Mission I (7 edible oilseeds including groundnut, rapeseed & mustard, soybean, sunflower, sesame, safflower, niger and two non-edible oilseeds including castor and linseed, Mini Mission II (Palm oil) and Mini Mission III (Tree Borne Oilseeds (TBOs) including sal, mahua, simarouba, kokum, olive, karanja, jatropha, neem, jojoba, cheura, wild apricot, walnut, tung etc.). There is an urgent need to intensify efforts for area expansion from the current area 6.3 million hectare to 10.00 million hectares under rapeseed-mustard to enhance production in the country by 2050. Availability, accessibility, and affordability of quality seeds of the suitable varieties among the farmers are very critical issues for food and nutritional security in India. Government policies regarding the development of irrigation facilities need to be revamped for addressing the major hurdle of rainfed farming system. Capacity building and skill development programs about the technical aspects including agronomic practices, nutrient and pest management among the farm households is essential for vertical as well as horizontal expansion of the sector."

Brazil: overview of the rapeseed cultivation

In Brazil, information on the management of the crop is scarce, especially in regions with a predominant tropical climate. However, agronomic research on rapeseed is active and pulication results are published in Portuguese.

"This work presents an overview of rapeseed cultivation, the result of the compilation of information on its cultivation in different regions of the country, especially the management technologies adopted, both in the field of experimentation and in commercial crops. It is evident that the canola crop has potential for cultivation in regions of the country with low latitudes, as a result of the development of genotypes less sensitive to photoperiod. In addition, it may be introduced as an out-of-season crop in continuous grain production systems, after the harvest of a first crop in summer. Despite the advances already achieved, it is necessary to continue with research, development and innovation that leverage the technical and scientific development of canola, to consolidate its tropicalization and ensure cultivation in much of Brazil".

See full report in Portuguese at by EMBRAPA: http://www.infoteca.cnptia.embrapa.br/infoteca/handle/doc/1140176

Scientific news

Publications:

BREEDING

He, Y., Yang, Z., Tang, M., Yang, Q. Y., Zhang, Y., & Liu, S. (2022). **Enhancing canola breeding** by editing a **glucosinolate** transporter gene lacking natural variation. Plant physiology, 188(4), 1848-1851. https://doi.org/10.1093/plphys/kiac021

Liu, H., Zhao, W., Hua, W. et al. A large-scale population based organelle pan-genomes construction and phylogeny analysis reveal the genetic diversity and the **evolutionary origins of chloroplast and mitochondrion** in *Brassica napus* L... BMC Genomics 23, 339 (2022). https://doi.org/10.1186/s12864-022-08573-x

Fernie, A. R. (2022). Asserting dominance: the **subgenome** networks underlying Canola seed development. The Plant Journal, 109(3), 475-476. https://doi.org/10.1111/tpj.15659

Guo, Y., Xu, Y., Yan, T., Jiang, L., Dong, J., Wu, D., & Kuang, L. (2021). Construction and Genetic Analysis of a **Worldwide Core Collection** of Rapeseed. (preprint) https://doi.org/10.21203/rs.3.rs-1059860/v1

Ferrie, A.M.R., Polowick, P.L. (2022). **Accelerated Breeding** for Brassica Crops. In: Gosal, S.S., Wani, S.H. (eds) Accelerated Plant Breeding, Volume 4. Springer, Cham. https://doi.org/10.1007/978-3-030-81107-5_5

Schuhmann, P., Engstler, C., Klöpfer, K., Gügel, I. L., Abbadi, A., Dreyer, F., ... & Carrie, C. (2022). Two wrongs make a right: **heat stress reversion of a male-sterile** *Brassica napus* line. Journal of Experimental Botany. https://doi.org/10.1093/jxb/erac082

Li, Z., Yuan, R., Wang, M., Hong, M., Zhu, L., Li, X., ... & Zeng, X. (2022). Development of the PARMS Marker of the **Dominant Genic Male Sterility** (DGMS) Line and Its Utilization in Rapeseed (*Brassica napus L.*) Breeding. Plants, 11(3), 421. https://doi.org/10.3390/plants11030421

Xing, M., Guan, C., & Guan, M. (2022). Comparative Cytological and Transcriptome Analyses of Anther Development in **Nsa Cytoplasmic Male Sterile** (1258A) and Maintainer Lines in *Brassica napus* Produced by Distant Hybridization. International journal of molecular sciences, 23(4), 2004. https://doi.org/10.3390/ijms23042004

Obermeier, C., Mason, A.S., Meiners, T. et al. Perspectives for integrated **insect pest protection in oilseed rape breeding**. Theor Appl Genet (2022). https://doi.org/10.1007/s00122-022-04074-3

Siddiqui, M. A., Aslam, M. M., Sial, M. A., Soomro, N. S., Khan, M. T., Yasmeen, S., ... & Khan, I. A. (2021). Surhan-2012: A Novel High Yielding, **Insect Resistant**, and High Oil Content Canola Variety Released for General Cultivation in the Sindh Province. Pakistan Journal of Agricultural Research, 34(4), 837-845. https://dx.doi.org/10.17582/journal.pjar/2021/34.4.837.845

Breit-McNally, C., Desveaux, D. & Guttman, D.S. The **Arabidopsis effector-triggered immunity** landscape is conserved in oilseed crops. Sci Rep 12, 6534 (2022). https://doi.org/10.1038/s41598-022-10410-w

Kaur G, Rajarammohan S, Kumar S, Verrma R, Kaur G, Kaur J, Gajbhiye S, Dixit S and Kaur J. 2022. Genomic designing for **biotic stress resistance** in rape and mustard. In: Kole C (ed) Genomic

Designing for biotic stress resistant oilseed crops. Springer Nature, Switzerland. https://doi.org/10.1007/978-3-030-91035-8_5

Rialch, I., Dhaliwal, I., Rana, K., Kaur, J., Kaur, G. (2022). Genomic Designing for **Biotic Stress Resistance** in Rapeseed. In: Kole, C. (eds) Genomic Designing for Biotic Stress Resistant Oilseed Crops. Springer, Cham. https://doi.org/10.1007/978-3-030-91035-8_2

Feng, W., Shi, H., Xu, W. et al. Heterologous expression and physicochemical characteristics identification of Kunitz **protease inhibitor** in *Brassica napus*. 3 Biotech 12, 81 (2022). https://doi.org/10.1007/s13205-022-03149-8

Van de Wouw, A. P., Zhang, Y., Mohd Saad, N. S., Yang, H., Sheedy, E., Elliott, C. E., & Batley, J. (2022). Molecular Markers for Identifying **Resistance Genes** in *Brassica napus*. Agronomy, 12(5), 985. https://doi.org/10.3390/agronomy12050985

Roy, J., Luis, E., Bandillo, N., McClean, P. E., & Rahman, M. (2021). Genetic Mapping and Genomic Prediction of **Sclerotinia Stem Rot Resistance** to Rapeseed/Canola (*Brassica Napus L.*) at Seedling Stage. (pre-print) https://doi.org/10.21203/rs.3.rs-1135987/v1

Roy, J., del Río Mendoza, L.E., Bandillo, N. et al. Genetic mapping and genomic prediction of **sclerotinia stem rot resistance** to rapeseed/canola (*Brassica napus L.)* at seedling stage. Theor Appl Genet (2022). https://doi.org/10.1007/s00122-022-04104-0

Zuo, R., Xie, M., Gao, F., Sumbal, W., Cheng, X., Liu, Y., ... & Liu, S. (2022). The Characterization of the Phloem Protein 2 Gene Family Associated with Resistance to ***Sclerotinia sclerotiorum*** in *Brassica napus*. International journal of molecular sciences, 23(7), 3934. https://doi.org/10.3390/ijms23073934

Guo, Y., Li, B., Li, M., Zhu, H., Yang, Q., Liu, X., ... & Wang, T. (2022). Efficient marker-assisted breeding for **clubroot resistance** in elite Pol-CMS rapeseed varieties by updating the PbBa8. 1 locus. (pre-print) https://doi.org/10.21203/rs.3.rs-1531391/v1

Fell, H., Ali, A. M., Wells, R., Mitrousia, G. K., Woolfenden, H., Schoonbeek, H. J., ... & Stotz, H. (2022). Novel gene loci associated with susceptibility or cryptic quantitative **resistance *to Pyrenopeziza brassicae*** in *Brassica napus*. (preprint) https://doi.org/10.21203/rs.3.rs-1327286/v1

Schilbert, H. M., & Glover, B. J. (2022). Analysis of **flavonol regulator evolution** in the Brassicaceae reveals MYB12, MYB111 and MYB21 duplications associated with MYB11 and MYB24 gene loss. bioRxiv. (Preprint) https://doi.org/10.1101/2022.04.06.487363

Hu, J., Chen, B., Zhao, J. et al. Genomic selection and genetic architecture of **agronomic traits** during modern rapeseed breeding. Nat Genet (2022). https://doi.org/10.1038/s41588-022-01055-6

Nelson, M., Barrero, J., Cmiel, M., Fletcher, A., Greaves, I., Hughes, T., ... & Rebetzke, G. Genetic improvement of **canola establishment**. REFERENCE

Yu, M., Zhang, R., Liu, Y., Gu, Y., Shang, G., Fan, Y., ... & Lu, K. (2022). Quantitative trait locus mapping and transcriptome analysis reveal candidate genes for a **stem bending mutant** in rapeseed (*Brassica napus*). Industrial Crops and Products, 177, 114456. https://doi.org/10.1016/j.indcrop.2021.114456

Lyu, J., Guo, Y., Du, C., Yu, H., Guo, L., Liu, L., ... & Hu, S. (2022). BnERF114. A1, a Rapeseed Gene Encoding APETALA2/ETHYLENE RESPONSE FACTOR, Regulates **Plant Architecture** through Auxin Accumulation in the Apex in Arabidopsis. International journal of molecular sciences, 23(4), 2210. https://doi.org/10.3390/ijms23042210

Ye, S., Yan, L., Ma, X., Chen, Y., Wu, L., Ma, T., ... & Wen, J. (2022). Combined BSA-Seq Based Mapping and RNA-Seq Profiling Reveal Candidate Genes Associated with **Plant Architecture** in *Brassica napus.* International journal of molecular sciences, 23(5), 2472. https://doi.org/10.3390/ijms23052472

Li, B., Wang, T., Guo, Y. et al. Fine mapping of qDB.A03, a QTL for **rapeseed branching**, and identification of the candidate gene. Mol Genet Genomics (2022). https://doi.org/10.1007/s00438-022-01881-7

Qin, M., Song, J., Guo, N., Zhang, M., Zhu, Y., Huang, Z., & Xu, A. (2022). Genome-Wide Association Analyses Reveal Candidate Genes Controlling **Harvest Index** and Related Agronomic Traits in *Brassica napus L.* Agronomy, 12(4), 814. https://doi.org/10.3390/agronomy12040814

Ren, R., Liu, W., Yao, M., Jia, Y., Huang, L., Li, W., ... & Qian, L. (2022). Regional association and transcriptome analysis revealed candidate genes controlling **plant height** in *Brassica napus*. https://doi.org/10.21203/rs.3.rs-1460223/v1

Kuang, L., Ahmad, N., Su, B., Huang, L., Li, K., Wang, H., ... & Dun, X. (2022). Discovery of Genomic Regions and Candidate Genes Controlling **Root Development** Using a Recombinant Inbred Line Population in Rapeseed (*Brassica napus L.).* International Journal of Molecular Sciences, 23(9), 4781. https://doi.org/10.3390/ijms23094781

Zhou, E., Zhang, Y., Wang, H., Jia, Z., Wang, X., Wen, J., ... & Yi, B. (2022). Identification and Characterization of the MIKC-Type MADS-Box Gene Family in *Brassica napus* and Its Role in **Floral Transition**. International journal of molecular sciences, 23(8), 4289. https://doi.org/10.3390/ijms23084289

Wang, Y., Shen, S., Yin, N., Liu, H., Du, D., & Li, J. (2022). Comparative analysis of the **orange versus yellow petal** of rapeseed (*Brassica napus*) using UPLC-HESI-MS/MS and transcriptome analysis. Plant Breeding, 141(1), 77-87. https://doi.org/10.1111/pbr.12991

Chao, H., Guo, L., Zhao, W., Li, H., & Li, M. (2022). A major **yellow-seed QTL** on chromosome A09 significantly increases the oil content and reduces the fiber content of seed in Brassica napus. Theoretical and Applied Genetics, 1-13. https://doi.org/10.1007/s00122-022-04031-0

Golova, A. A., & Gorlova, L. A. (2022, February). Study on the **inheritance of oleic acid content** in reciprocal F1 hybrids of winter rapeseed at VS Pustovoit All-Russian Research Institute of Oil Crops. In IOP Conference Series: Earth and Environmental Science (Vol. 979, No. 1, p. 012005). IOP Publishing. https://iopscience.iop.org/article/10.1088/1755-1315/979/1/012005/meta

Bilgrami, S., Liu, L., Farokhzadeh, S., Najafabadi, A. S., Ramandi, H. D., Nasiri, N., & Darwish, I. (2022). Meta-analysis of QTLs controlling **seed quality traits** based on QTL alignment in *Brassica napus.* Industrial Crops and Products, 176, 114307. https://doi.org/10.1016/j.indcrop.2021.114307

Yan, S., Li, H., Chao, H., He, J., Ding, Y., Zhao, W., ... & Li, M. (2022). Refinement of four major QTL for **oil content** *in Brassica napus* by integration of genome resequencing and transcriptomics. The Crop Journal. https://doi.org/10.1016/j.cj.2022.01.002

Tiwari, S., Gupta, S. K., Rai, S. K., Upadhyay, R. G., Kaur, J., & Jameel, F. (2021). **Fatty acid profiling** in gobhi sarson (*Brassica napus*). Environment Conservation Journal, 22(3), 409-414. https://doi.org/10.36953/ECJ.2021.22347

Jia, X., Xiong, X., Chen, H., Xiao, G., Cheng, Q., & Zhang, Z. (2022). Promising Novel Method of **Acetylation** Modification for Regulating **Fatty Acid Metabolism** in *Brassica napus* L. Biology, 11(4), 483. https://doi.org/10.3390/biology11040483

Tan, M., Niu, J., Peng, D.Z. et al. Clone and Function Verification of the OPR gene in *Brassica napus* Related to **Linoleic Acid Synthesis**. BMC Plant Biol 22, 192 (2022). https://doi.org/10.1186/s12870-022-03549-1

Chen, C., Chen, L., Li, S., Zhai, W., Li, D., & Chen, J. (2022). New insight into the roles of lipid transport protein and seed storage albumin gene families involved in **oil and protein accumulation** in rapeseed (*Brassica napus L.).* Botany, (ja). https://doi.org/10.1139/cjb-2021-0176

Stolte, N., Vettel, J., & Möllers, C. (2022). Genetic variation for **seed storage protein** composition in rapeseed (*Brassica napus*) and development of near-infrared reflectance spectroscopy calibration equations. Plant Breeding. https://doi.org/10.1111/pbr.13017

So, K. (2021). Breeding improvement of **cruciferin content** in the meal protein of spring Brassica napus L. PhD Thesis University of Manitoba. http://hdl.handle.net/1993/36263

Zhou, T., Wu, P., Yue, C., Huang, J., Zhang, Z., & Hua, Y. (2022). Transcriptomic Dissection of Allotetraploid Rapeseed (*Brassica napus L.)* in Responses to **Nitrate and Ammonium Regime**s and Functional Analysis of BnaA2. Gln1; 4 in Arabidopsis. Plant and Cell Physiology. https://doi.org/10.1093/pcp/pcac037

Kong, X. C., Yue, C. P., Zhang, T. Y., Zhou, T., Huang, J. Y., & Hua, Y. P. (2022). Genome-wide identification of 12 amino acid transporter families and molecular characterization of their transcriptional responses to various **nutrient stresses** in allotetraploid rapeseed. (pre-print) https://www.researchsquare.com/article/rs-1435140/latest.pdf

Dhaliwal, I., Rialch, I., Rana, K., Kaur, J., Kaur, G. (2022). Designing the Rapeseed Genome for **Abiotic Stress Tolerance**. In: Kole, C. (eds) Genomic Designing for Abiotic Stress Resistant Oilseed Crops. Springer, Cham. https://doi.org/10.1007/978-3-030-90044-1_2

Sharma, T., Gupta, A. (2022). Integrated OMICS Approaches to Ameliorate the **Abiotic Stress** in *Brassica Napus*. In: Roy, S., Mathur, P., Chakraborty, A.P., Saha, S.P. (eds) Plant Stress: Challenges and Management in the New Decade. Advances in Science, Technology & Innovation. Springer, Cham. https://doi.org/10.1007/978-3-030-95365-2_23

Sun, F., Chen, Z., Zhang, Q., Wan, Y., Hu, R., Shen, S., ... & Li, J. (2022). Genome-Wide Identification of the **TIFY Gene** Family in *Brassiceae* and Its Potential Association with **Heavy Metal Stress** in Rapeseed. Plants, 11(5), 667. https://doi.org/10.3390/plants11050667

Zhou, H., Xiao, X., Asjad, A. et al. Integration of GWAS and transcriptome analyses to identify SNPs and candidate genes for **aluminum tolerance** in rapeseed (*Brassica napus L.).* BMC Plant Biol 22, 130 (2022). https://doi.org/10.1186/s12870-022-03508-w

Zhu, J., Wang, W., Jiang, M., Yang, L., & Zhou, X. (2021). QTL mapping for **low temperature germination** in rapeseed. Scientific reports, 11(1), 1-9. https://doi.org/10.1038/s41598-021-02912-w

Niu, Z., Liu, L., Pu, Y., Ma, L., Wu, J., Hu, F., ... & Bai, C. (2021). iTRAQ-based quantitative proteome analysis insights into **cold stress** of Winter Rapeseed (*Brassica rapa L.*) grown in the field. Scientific reports, 11(1), 1-11. https://doi.org/10.1038/s41598-021-02707-z

Zhang, Y., Raza, A., Huang, H., Su, W., Luo, D., Zeng, L., ... & Zou, X. (2022). Analysis of Lhcb gene family in rapeseed (*Brassica napus L.*) identifies a novel member "BnLhcb3. 4" modulating **cold tolerance**. Environmental and Experimental Botany, 198, 104848. https://doi.org/10.1016/j.envexpbot.2022.104848

Jin, J., Sun, W., Wu, J., Fang, Y., Li, X., Ma, L., ... & Zeng, R. (2022). Hypocotyl elongation based on HY5 transcription factor in **cold resistant** winter rapeseed (*Brassica napus L.*). Oil Crop Science. https://doi.org/10.1016/j.ocsci.2022.02.005

Cao, B., Bai, J., Wang, X., Zhang, Y., Yu, X., Hu, S., & He, Y. (2022). BnA. JAZ5 Attenuates **Drought Tolerance** in Rapeseed through Mediation of ABA–JA Crosstalk. Horticulturae, 8(2), 131. https://doi.org/10.3390/horticulturae8020131

Lee, B. R., La, V. H., Park, S. H., Mamun, M. A., Bae, D. W., & Kim, T. H. (2022). H2O2-Responsive Hormonal Status Involves **Oxidative Burst** Signaling and Proline Metabolism in Rapeseed Leaves. Antioxidants, 11(3), 566. https://doi.org/10.3390/antiox11030566

Chen, S., Hayward, A., Dey, S. S., Choudhary, M., Witt Hmon, K. P., Inturrisi, F. C., ... & Cowling, W. A. (2022). Quantitative Trait Loci for **Heat Stress Tolerance** in *Brassica rapa L*. Are Distributed

across the Genome and Occur in Diverse Genetic Groups, Flowering Phenologies and Morphotypes. Genes, 13(2), 296. https://doi.org/10.3390/genes13020296

Wang, J., Zhou, Z., Tao, Q., Chen, X., Shui, C., Ren, X., ... & Liang, M. (2022). *Brassica napus* miR169 regulates BnaNF-YA in **salinity, drought, and ABA responses**. Environmental and Experimental Botany, 104882. https://doi.org/10.1016/j.envexpbot.2022.104882

Xu, Y., Tao, S., Zhang, Q., Wang, H., Li, P., Zhang, Y., ... & Huang, Z. (2022). Identification of **alkaline salt tolerance** genes in *Brassica napus L.* by transcriptome analysis. (Preprint) https://doi.org/10.21203/rs.3.rs-1576095/v1

Wang, W., Pang, J., Zhang, F. et al. Salt-responsive transcriptome analysis of canola roots reveals candidate genes involved in the key metabolic pathway in response to **salt stress**. Sci Rep 12, 1666 (2022). https://doi.org/10.1038/s41598-022-05700-2

Ahmadi, H., Abbasi, A., Taleei, A., Mohammadi, V., & Pueyo, J. J. (2022). Antioxidant Response and Calcium-Dependent Protein Kinases Involvement in Canola (*Brassica napus L.*) **Tolerance to Drought.** Agronomy, 12(1), 125. https://doi.org/10.3390/agronomy12010125

Rahman, M., Mendoza, L. E. R., Anderson, J. V., Berhow, M., Roy, J., Eriksmoen, E., ... & Hanson, B. (2022). NDOLA-2, a high-yielding, open-pollinated conventional spring type canola in North Dakota. Journal of Plant Registrations, 16(1), 124-131. https://doi.org/10.1002/plr2.20189

CROP PROTECTION

*Prof Bruce Fitt, from the University of Hertfordshire, UK, informed us of the publication of the **proceedings of the AFCP Forum on Management of diseases and pests of oilseed rape**, that took place as a hybrid event on 16 June 2021. A report on the event for 'Outlooks on Pest Management' by Ken Pallett, University of Hertfordshire, is available here.*

See here for a pdf of the Conference proceedings and a recording of this event is also available here. The Proceedings are now also available in paperback from Amazon Books, price £10 plus postage. Posters highlighting some of the extensive research area on this topic are available here.

Gao, F., Chen, Y., Lim, S., Xue, A., & Ma, B. L. (2021). Nitrogen management strategies on plant growth and severities of **Sclerotinia stem rot** of canola in eastern Canada. Canadian Journal of Plant Science, (ja). https://doi.org/10.1139/cjps-2021-0160

Shahoveisi, F., Riahi Manesh, M. & del Río Mendoza, L.E. Modeling risk of **Sclerotinia sclerotiorum**-induced disease development on canola and dry bean using machine learning algorithms. Sci Rep 12, 864 (2022). https://doi.org/10.1038/s41598-021-04743-1

Wytinck, N. (2022). The development of RNA interference-based technologies for the control of Sclerotinia sclerotiorum in Brassica napus. PhD Thesis. https://mspace.lib.umanitoba.ca/handle/1993/36417

Rafiei, V., Vélëz, H., & Tzelepis, G. (2022). The phospholipase VlsPLA2 from the plant pathogen ***Verticillium longisporum*** is a virulence factor targeting host nuclei and suppressing PTI-related hypersensitive response. bioRxiv. (preprint) https://doi.org/10.1101/2022.03.19.484916

Hafiz, F. B., Moradtalab, N., Goertz, S., Rietz, S., Dietel, K., Rozhon, W., ... & Schellenberg, I. (2022). Synergistic Effects of a Root-Endophytic Trichoderma Fungus and Bacillus on Early Root Colonization and Defense Activation Against ***Verticillium longisporum*** in Rapeseed. Molecular Plant-Microbe Interactions, MPMI-11. https://doi.org/10.1094/MPMI-11-21-0274-R

Hennig, B. C., Hwang, S. F., Manolii, V. P., Turnbull, G., Robinson, S. V., & Strelkov, S. E. (2022). Evaluation of Host Resistance, Hydrated Lime, and Weed Control to Manage **Clubroot** in Canola. Horticulturae, 8(3), 215. https://doi.org/10.3390/horticulturae8030215

Struck, C., Rüsch, S., & Strehlow, B. (2022). Control Strategies of **Clubroo**t Disease Caused by *Plasmodiophora brassicae*. Microorganisms, 10(3), 620. https://doi.org/10.3390/microorganisms10030620

Zahr, K., Yang, Y., Sarkes, A., Dijanovic, S., Fu, H., Harding, M. W., ... & Feng, J. (2022). ***Plasmodiophora brassicae*** infection threshold—how many resting spores are required for generating clubroot galls on canola (Brassica napus). Journal of Plant Diseases and Protection, 1-8. https://doi.org/10.1007/s41348-022-00565-z

Khalid, M., Kayani, S. I., Khan, A. A., Gul, H., & Hui, N. (2022). ***Plasmodiophora brassicae***–The causal agent of clubroot and its biological control/suppression with fungi–A review. South African Journal of Botany, 147, 325-331. https://doi.org/10.1016/j.sajb.2022.01.032

Huang, S., Zhai, C., Zou, Z., Liu, F., Parks, P., Mcgregor, L., ... & Peng, G. (2022). Effect of wounding and wound age on infection of canola cotyledons by ***Leptosphaeria maculans***, interacting with leaf wetness. Canadian Journal of Plant Pathology, (just accepted). https://doi.org/10.1080/07060661.2022.2059573

Padmathilake, K. R., & Fernando, W. G. D. (2022). ***Leptosphaeria maculans***-Brassica napus Battle: A Comparison of Incompatible vs. Compatible Interactions Using Dual RNASeq. International journal of molecular sciences, 23(7), 3964. https://doi.org/10.3390/ijms23073964

Padmathilake, K. R. E., & Fernando, W. G. D. (2022). Less Virulent ***Leptosphaeria biglobosa*** Immunizes the Canola Plant to Resist Highly Virulent ***L. maculans***, the **Blackleg** Pathogen. Plants, 11(7), 996. https://doi.org/10.3390/plants11070996

Rashid, M.H., Liban, S.H., Zhang, X. et al. Comparing the effectiveness of R genes in a 2-year canola–wheat rotation against *Leptosphaeria maculans*, the causal agent of blackleg disease in Brassica species. Eur J Plant Pathol (2022). https://doi.org/10.1007/s10658-022-02498-7

YADAV, M., KUMAR, A., CHATTOPADHYAY, C., & YADAVA, D. (2022). Epidemiological models based on meteorological variables to forewarn **Alternaria blight** of rapeseed-mustard. Journal of Agrometeorology, 24(1), 55-59. https://doi.org/10.54386/jam.v24i1.782

Dániel, M., Reeves, E., & Meadows, I. (2022). Practical and comprehensive diagnostic guide for **black rot** of brassicas. Plant Health Progress, (ja). https://doi.org/10.1094/PHP-08-21-0109-DG

Fornier, S. D., de Saint Germain, A., Retailleau, P., Pillot, J. P., Taulera, Q., Andna, L., ... & Boyer, F. D. (2022). Novel non-canonical **strigolactone analogs** highlight selectivity for stimulating germination in two ***Phelipanche ramosa*** populations. (pre-publication) https://hal.archives-ouvertes.fr/hal-03616875/

Ortega-Ramos, P., Cook, S. M., & Mauchline, A. L. (2022). How contradictory EU **policies** led to the development of a pest: the story of oilseed rape and the cabbage stem flea beetle. GCB Bioenergy. https://doi.org/10.1111/gcbb.12922

Sowa, G., Bednarska, A. J., Ziółkowska, E., & Laskowski, R. (2022). Homogeneity of agriculture landscape promotes **insecticide resistance** in the ground beetle *Poecilus cupreus*. PloS one, 17(4), e0266453. https://doi.org/10.1371/journal.pone.0266453

Obermeier, C., Mason, A.S., Meiners, T. et al. Perspectives for **integrated insect pest protection** in oilseed rape **breeding**. Theor Appl Genet (2022). https://doi.org/10.1007/s00122-022-04074-3

Armand T, Korn L, Pichon E, Souquet M, Barbet M, Martin J-L, Devavry M, Jacquot E. Efficiency and Persistence of Movento® Treatment against ***Myzus persicae*** and the Transmission of **Aphid-Borne Viruses**. Plants. 2021; 10(12):2747. https://doi.org/10.3390/plants10122747

Javed, M. W., Hasan, M. U., Sagheer, M., Sahi, S. T., & Mankin, R. W. (2022). Foliar and Soil Treatments of *Brassica napus* That Elicit Antibiosis in ***Brevicoryne brassicae***. Agronomy, 12(4), 882. https://doi.org/10.3390/agronomy12040882

Kavalappara, S. R., Milner, H., Riley, D. G., & Bag, S. (2022). First report of **turnip yellows virus** infecting cabbage (*Brassica oleracea var. capitata*) in the USA. Plant Disease, (ja). https://doi.org/10.1094/PDIS-10-21-2174-PDN

Sana, B., Murtaza, G., Mahmood, H., Bashir, M. A., Batool, M., Nisar, M. S., ... & Rehmani, M. I. A. (2022). Population dynamics of **aphids and its predator**s along with its management. Journal of King Saud University-Science, 102024. https://doi.org/10.1016/j.jksus.2022.102024

Shahrokhi, M., Yali, M. P., & Bozorg-Amirkalaee, M. (2022). Role of exogenous **elicitors** in canola plant defense against cabbage aphid by regulating physiological balance and secondary metabolite biosynthesis. (preprint) https://doi.org/10.21203/rs.3.rs-1575991/v1

Weber, D. C., Konstantinov, A. S., Khrimian, A., Bier, A. D., Lubenow, L. A., Knodel, J. J., ... & Kuhar, T. P. (2022). Trapping of Crucifer-Feeding **Flea Beetles** (*Phyllotreta spp.) (Coleoptera: Chrysomelidae)* With Pheromones and Plant Kairomones. Journal of Economic Entomology. https://doi.org/10.1093/jee/toac042

Binns, M. R., Macfadyen, S., & Umina, P. A. (2022). The dual role of **earwigs** (Dermaptera) in winter grain crops in Australia. Journal of Applied Entomology, 146(3), 272-283. https://doi.org/10.1111/jen.12959

Dehdari, M., Charehgani, H. & Fatemi, E. Evaluation of canola (*Brassica napus L.*) resistance to **sugar beet cyst nematode** (*Heterodera schachtii Schm.*) and its association with SSR molecular markers using parametric and non-parametric statistical methods. Indian Phytopathology (2022). https://doi.org/10.1007/s42360-022-00466-z

Cheng, X., Zhang, S., Shao, S., Zheng, R., Yu, Z., & Ye, Q. (2022). Translocation and **metabolism** of the chiral **neonicotinoid** cycloxaprid in oilseed rape (*Brassica napus L.).* Journal of Hazardous Materials, 426, 128125. https://doi.org/10.1016/j.jhazmat.2021.128125

Nash, M. (2022). **Cabbage-centre grub** (*Hellula hydralis Guenée*) (*Lepidoptera: Pyralidae*): a new pest challenge to long-season canola grown for forage and grain in southern Australia. Austral Entomology. https://doi.org/10.1111/aen.12591

Weeraddana, C. D. S., & Evenden, M. L. (2022). Oviposition by a Specialist Herbivore Increases Susceptibility of Canola to Herbivory by a Generalist Herbivore. Environmental Entomology. https://doi.org/10.1093/ee/nvac028

ECOLOGY AND POLLINATORS

Bugin, G., Lenzi, L., Ranzani, G., Barisan, L., Porrini, C., Zanella, A., & Bolzonella, C. (2022). **Agriculture and Pollinating Insect**s, No Longer a Choice but a Need: EU Agriculture's Dependence on Pollinators in the 2007–2019 Period. Sustainability, 14(6), 3644. https://doi.org/10.3390/su14063644

Elzay, S. D., & Baum, K. (2022). Data from: Canola supports **wild bee-plant mutualisms** across multiple spatial scales. https://hdl.handle.net/11244/334581

Younas, M., Ali, M., Matloob, A., Gul, H. T., & Saeed, S. (2022). Effect of **drought stress** on the **foraging behavior** of insect pollinators and the reproductive success of canola (Brassica napus L.). Emirates Journal of Food and Agriculture. REFERENCE

Sharma S, Kumar S, Kaur G and Banga SS. 2022. Floral volatiles may influence **honey bee** visitations in oilseed Brassica species. Journal of Crop Improvement. Https://doi.org/10.1080/15427528.2022.2059604

AGRONOMY

Leśny, J., Kuchar, L., Panfil, M., Vinogradov, D. V., & Dragańska, E. (2021). Characteristic Decrease in the Value of Rapeseed **Evapotranspiration** after Its Ripening. Agronomy, 11(12), 2523. https://doi.org/10.3390/agronomy11122523

Rajković, D., Marjanović Jeromela, A., Pezo, L., Lončar, B., Zanetti, F., Monti, A., & Kondić Špika, A. (2021). **Yield and Quality Prediction** of Winter Rapeseed—Artificial Neural Network and Random Forest Models. Agronomy, 12(1), 58. https://doi.org/10.3390/agronomy12010058

McGeary, K. D., de Koff, J., Pokharel, B., Link, R., Saini, P., & Gill, T. (2022). Effect of winter canola **cultivar on seed yield**, oil, and protein content. Agrosystems, Geosciences & Environment, 5(1), e20254. https://doi.org/10.1002/agg2.20254

Escuer-Gatius, J., Lõhmus, K., Shanskiy, M. et al. Critical points for closing the **carbon and nitrogen budgets** in a winter rapeseed field. Nutr Cycl Agroecosyst (2022). https://doi.org/10.1007/s10705-022-10202-8

Yahbi, M., Nabloussi, A., Maataoui, A., El Alami, N., Boutagayout, A., & Daoui, K. (2022). Effects of **nitrogen** rates on yield, yield components, and other related attributes of different rapeseed *(Brassica napus L.)* varieties. OCL, 29, 8. https://doi.org/10.1051/ocl/2022001

Zapletalová, A., Ducsay, L., Varga, L., Sitkey, J., Javoreková, S., & Hozlár, P. (2021). Influence **of Nitrogen** Nutrition on **Fatty Acids** in Oilseed Rape (*Brassica napus L.*). Plants, 11(1), 44. https://doi.org/10.3390/plants11010044

Wang, C., Li, Z., Zhang, L., Gao, Y., Cai, X., & Wu, W. (2022). Identifying Key Metabolites Associated with **Glucosinolate** Biosynthesis in Response to **Nitrogen** Management Strategies in Two Rapeseed *(Brassica napus)* Varieties. Journal of agricultural and food chemistry. https://doi.org/10.1021/acs.jafc.1c06472

Mozafari, H., Shirani Rad, A., Jalili, E. et al. Effect of Winter **Planting Date on Oil Yield and Fatty Acids** of New Spring Canola (*Brassica napus L.)* Cultivars Under Foliar Zinc Spray. Gesunde Pflanzen 74, 435–446 (2022). https://doi.org/10.1007/s10343-021-00620-z

Bucat, J. (2022). When to take advantage of **early seeding** opportunities for canola in WA. REFERENCE

Dhillon, G. S., Baarda, L., Gretzinger, M., & Coles, K. (2022). Effect of **precision planting and seeding rates** on canola plant density and seed yield in southern Alberta. Canadian Journal of Plant Science, 1-12. https://doi.org/10.1139/cjps-2020-0186

Zuo, Q., Zheng, J., You, J., Wang, L., Yang, G., & Leng, S. (2022). Effects of **nitrogen rate** on growth and quality of rapeseed blanket seedling for **mechanized transplanting**. Journal of Plant Nutrition, 1-8. https://doi.org/10.1080/01904167.2022.2063741

Nelson, M., Barrero, J., Cmiel, M., Fletcher, A., Greaves, I., Hughes, T., ... & Rebetzke, G. **Genetic improvement of canola establishment**. REFERENCE

Fan, H., Jia, S., Yu, M., Chen, X., Shen, A., & Su, Y. (2022). **Long-Term Straw Return** Increases Biological Nitrogen Fixation by Increasing Soil Organic Carbon and Decreasing Available Nitrogen in **Rice–Rapeseed Rotation**. (preprint) https://doi.org/10.21203/rs.3.rs-1253413/v1

Rigby, B. A., Nasrollahi, N., Celestina, C., Hunt, J. R., Kirkegaard, J. A., & Tang, C. (2021). **Nitrogen** Fertiliser Immobilisation and Uptake in the **Rhizospheres** of Wheat and Canola. Agronomy, 11(12), 2507. https://doi.org/10.3390/agronomy11122507

Bell, J. K., Mamet, S. D., Helgason, B., & Siciliano, S. D. (2022). *Brassica napus* **Bacterial Assembly** Processes Vary with Plant Compartment and Growth Stage but Not between Lines. Applied and Environmental Microbiology, e00273-22. https://doi.org/10.1128/aem.00273-22

de Aquino, G. S., Shahab, M., Moraes, L. A., & Moreira, A. (2022). Plant growth **promoting rhizobacteria** increased canola yield and root system. Journal of Plant Nutrition, 1-7. https://doi.org/10.1080/01904167.2022.2068441

Choudhary, V. K., & Meena, R. S. (2022). Assessment of diverse tillage system with mulching for water-cum-energy efficiency and soil carbon stabilization in **maize** (Zea mays L.)**-rapeseed** (B*rassica campestris L.)* **system.** Soil and Tillage Research, 219, 105326. https://doi.org/10.1016/j.still.2022.105326

Zhang, S., Lu, J., Zhu, Y., Fang, Y., Cong, R., Li, X., & Ren, T. (2022). **Rapeseed as a previous crop** reduces rice N fertilizer input by improving soil fertility. Field Crops Research, 281, 108487. https://doi.org/10.1016/j.fcr.2022.108487

Hemati, A., Alikhani, H. A., Ajdanian, L., Babaei, M., Asgari Lajayer, B., & van Hullebusch, E. D. (2022). Effect of Different Enriched Vermicomposts, Humic Acid Extract and Indole-3-Acetic Acid Amendments on the Growth of *Brassica napus*. Plants, 11(2), 227.https://doi.org/10.3390/plants11020227

Amy, C., Avice, J. C., Laval, K., & Bressan, M. (2022). Are native **phosphate** solubilizing bacteria a relevant alternative to mineral fertilizations for crops? Part I. when **rhizobacteria** meet plant P requirements. Rhizosphere, 100476. https://doi.org/10.1016/j.rhisph.2022.100476

Amy, C., Avice, J. C., Laval, K., & Bressan, M. (2022). Are native phosphate-solubilizing **bacteria** a relevant alternative to mineral fertilizations for crops? Part II: PSB inoculation enables a halving of P input and improves the microbial community in the rapeseed **rhizosphere**. Rhizosphere, 21, 100480. https://doi.org/10.1016/j.rhisph.2022.100480

Taye, Z.M., Noble, K., Siciliano, S.D. et al. Root Growth Dynamics, Dominant Rhizosphere Bacteria, and Correlation Between Dominant **Bacterial Genera and Root Traits** Through *Brassica napus* Development. Plant Soil 473, 441–456 (2022). https://doi.org/10.1007/s11104-022-05296-6

Rao, S. H., Baloch, A. W., Channa, S. A., Bhutto, L. A., & Bano, S. (2021). Uncovering the Genetic Potential of Rapeseed *(Brassica Napus L.)* Genotypes against **Water Deficit** Condition. Pak-Euro Journal of Medical and Life Sciences, 4(4), 188-196. https://www.readersinsight.net/PJMLS/article/view/2176/1452

Mabudi Bilasvar, H., Ghassemi-Golezani, K. & Mohammadi Nassab, A.D. Seed Development, Oil Accumulation and Fatty Acid Composition of **Drought Stressed** Rapeseed Plants Affected by Salicylic Acid and Putrescine. Gesunde Pflanzen (2022). https://doi.org/10.1007/s10343-021-00612-z

Batool, M., El-Badri, A.M., Hassan, M.U. et al. **Drought Stress** in *Brassica napus*: Effects, Tolerance Mechanisms, and Management Strategies. J Plant Growth Regul (2022). https://doi.org/10.1007/s00344-021-10542-9

Batool, M., El-Badri, A. M., Wang, Z., Mohamed, I. A., Yang, H., Ai, X., ... & Zhou, G. (2022). Rapeseed Morpho-Physio-Biochemical Responses to **Drought Stress** Induced by PEG-6000. Agronomy, 12(3), 579. https://doi.org/10.3390/agronomy12030579

Aslam MM, Farhat F, Siddiqui MA, Yasmeen S, Khan MT, Sial MA, et al. (2021) Exploration of physiological and biochemical processes of canola with exogenously applied fertilizers and plant

growth regulators under **drought stress.** PLoS ONE 16(12): e0260960. https://doi.org/10.1371/journal.pone.0260960

Moghadam, M.S.K., Rad, A.H.S., Khodabin, G. et al. Application of Silicon for Improving Some Physiological Characteristics, Seed Yield, and Oil Quality of Rapeseed Genotypes Under Late-Season **Drought Stress.** J Soil Sci Plant Nutr (2022). https://doi.org/10.1007/s42729-022-00852-6

Ahmad, Z., Barutçular, C., Zia Ur Rehman, M., Sabir Tariq, R. M., Afzal, M., Waraich, E. A., ... & Nawaz, H. (2022). **Pod shattering** in canola reduced by mitigating **drought stress** through silicon application and molecular approaches-A review. Journal of Plant Nutrition, 1-28. https://doi.org/10.1080/01904167.2022.2027972

Eyni-Nargeseh, H., Shirani Rad, A.H. & Shiranirad, S. Does **Potassium Silicate** Improve Physiological and Agronomic Traits and Oil Compositions of Rapeseed Genotypes Under Well-Watered and Water-Limited Conditions?. Gesunde Pflanzen (2022). https://doi.org/10.1007/s10343-022-00652-z

Poursattari, R., Hadi, H. **Lead Phytoremediation**, Distribution, and Toxicity in Rapeseed (*Brassica napus L.*): the Role of Single and Combined Use of Plant Growth Regulators and Chelators. J Soil Sci Plant Nutr (2022). https://doi.org/10.1007/s42729-022-00765-4

Bian, J. L., Cao, W., Guo, J. M., Yang, J. X., Wang, X. D., Wang, J., ... & Xia, C. Y. (2022). Water-soluble chitosan and phytoremediation efficiency of two *Brassica napus L.* cultivars in **cadmium-contaminated** farmland soils. International Journal of Phytoremediation, 1-10. https://doi.org/10.1080/15226514.2022.2049693

Zaheer, I. E., Ali, S., Saleem, M. H., Yousaf, H. S., Malik, A., Abbas, Z., ... & Wang, X. (2022). Combined application of zinc and iron-lysine and its effects on morpho-physiological traits, antioxidant capacity and chromium uptake in rapeseed *(Brassica napus L.).* PloS one, 17(1), e0262140. https://doi.org/10.1371/journal.pone.0262140

Quan, W., Wu, M., Dai, Z., Luo, H., & Shi, F. (2022). Design and Testing of Reverse-Rotating Soil-Taking-Type Hole-Forming Device of Pot Seedling **Transplanting Machine** for Rapeseed. Agriculture, 12(3), 319. https://doi.org/10.3390/agriculture12030319

Lei, X., Wu, W., Chang, C., Li, T., Zhou, Z., Guo, J., ... & Ren, W. (2022). Seeding Performance Caused by Inclination Angle in a Centralized Seed-Metering Device for Rapeseed. Agriculture, 12(5), 590. https://doi.org/10.3390/agriculture12050590

Zhan, G., Zong, W., Ma, L., Wei, J., & Liu, W. (2022). Biomechanical properties of ready-to-harvest rapeseed plants: Measurement and analysis. Information Processing in Agriculture. https://doi.org/10.1016/j.inpa.2022.04.002

Nishime, T. M., Werner, J., Wannicke, N., Mui, T. S., Kostov, K. G., Weltmann, K. D., & Brust, H. (2022). Characterization and Optimization of a Conical Corona Reactor for **Seed Treatment** of Rapeseed. Applied Sciences, 12(7), 3292. https://doi.org/10.3390/app12073292

Kirkegaard, J. (2022). Transformational impacts of **dual-purpose canola** in mixed farming systems. REFERENCE

Ndulue, E., & Sri Ranjan, R. (2022). DRAINMOD simulation of **drain spacing impact** on canola yield in heavy clay soils in the Canadian prairies. Irrigation and Drainage. https://doi.org/10.1002/ird.2683

Afroz, S. (2022). Effect of **Climate Change on Crop Productivity**: Evidence from Saskatchewan (Doctoral dissertation, University of Victoria). REFERENCE

Schauberger, B., Kato, H., Kato, T. et al. French crop yield, area and production data for ten staple crops from 1900 to 2018 at county resolution. Sci Data 9, 38 (2022). https://doi.org/10.1038/s41597-022-01145-4

Khodabin, G., Lightburn, K., Hashemi, S.M. et al. Evaluation of nitrate leaching, fatty acids, physiological traits and yield of rapeseed *(Brassica napus)* in response to tillage, irrigation and fertilizer management. Plant Soil 473, 423–440 (2022). https://doi.org/10.1007/s11104-021-05294-0

Alizadeh, S., Roozbahani, A., Rad, A.H.S. et al. Foliar Application of Humic Acids Improves Seed Yield and Oil Quality of Rapeseed *(Brassica napus L.)* Genotypes at Well-Time and Late Planting Dates. J Soil Sci Plant Nutr 22, 549–559 (2022). https://doi.org/10.1007/s42729-021-00670-2

Sohn, S. I., Pandian, S., Oh, Y. J., Kang, H. J., Ryu, T. H., Cho, W. S., ... & Shin, K. S. (2021). A Review of the Unintentional Release of Feral **Genetically Modified Rapeseed into the Environment**. Biology, 10(12), 1264. https://doi.org/10.3390/biology10121264

Wang X, Ma H, Guan C, Guan M. **Germplasm** Screening of **Green Manure** Rapeseed through the Effects of Short-Term Decomposition on **Soil** Nutrients and Microorganisms. Agriculture. 2021; 11(12):1219. https://doi.org/10.3390/agriculture11121219

Gurusinghe, S.; Haque, K.M.S.; Weston, P.A.; Brown, W.B.; Weston, L.A. Impact of Rotational Sequence Selection on **Weed Seedban**k Composition in Australian Broadacre Crops. Agronomy 2022, 12, 375. https://doi.org/10.3390/agronomy12020375

PHYSIOLOGY

He Zhu, Z., Sami, A., Peng Chen, Z., Fatima, M., Yin Zheng, W., Xu, Q. Q., ... & Zhou, K. J. (2021). Effects of microscopic testa color and morphology on the water uptake ability and **drought tolerance of germination-stage** rapeseed (*Brassica napus L.*). Bioengineered, 12(2), 9341-9355. https://doi.org/10.1080/21655979.2021.2000789

Malek, M., Ghaderi-Far, F., Torabi, B., & Sadeghipour, H. R. (2022). Dynamics of **seed dormancy and germination** at high temperature stress is affected by priming and phytohormones in rapeseed *(Brassica napus L.).* Journal of Plant Physiology, 269, 153614. https://doi.org/10.1016/j.jplph.2021.153614

Xu, Q. Q., Sami, A., Zhang, H., Jin, X. Z., Zheng, W. Y., Zhu, Z. Y., ... & Zhu, Z. H. (2022). Combine influence of **low temperature and drought** on different varieties of rapeseed *(Brassica napus L.).* South African Journal of Botany, 147, 400-414. https://doi.org/10.1016/j.sajb.2022.02.003

ElSayed, A. I., Mohamed, A. H., Rafudeen, M. S., Omar, A. A., Awad, M. F., & Mansour, E. (2022). Polyamines mitigate the destructive impacts of **salinity stress** by enhancing photosynthetic capacity, antioxidant defense system and upregulation of calvin cycle-related genes in rapeseed (Brassica napus L.). Saudi Journal of Biological Sciences, 29(5), 3675-3686. https://doi.org/10.1016/j.sjbs.2022.02.053

Wang, Z., Han, Y., Luo, S., Rong, X., Song, H., Jiang, N., & Yang, L. (2022). Calcium Peroxide Alleviates the **Waterlogging Stress** of Rapeseed by Improving the Rhizosphere Oxygen Environment in a Rice-rape Rotation Field. https://doi.org/10.21203/rs.3.rs-1373782/v1

Mi, C., Wang, Q., Zhao, Y.N. et al. Changes in the Differentially Expressed Proteins and Total Fatty Acid Contents in Winter Rapeseed *(Brassica rapa L.)* Leaves under **Drought Stress.** Russ J Plant Physiol 69, 31 (2022). https://doi.org/10.1134/S1021443722020133

Neshat, M., Abbasi, A., Hosseinzadeh, A. et al. **Plant growth promoting bacteria** (PGPR) induce antioxidant tolerance against **salinity stress** through biochemical and physiological mechanisms. Physiol Mol Biol Plants 28, 347–361 (2022). https://doi.org/10.1007/s12298-022-01128-0

Tian, H., Song, H., Wu, X., & Zhang, Z. (2022). Responses of Cell Wall Components to **Low Nitrogen** in Rapeseed Roots. Agronomy, 12(5), 1044. https://doi.org/10.3390/agronomy12051044

Zahoor, A., Ahmed, M., ul Hassan, F. et al. Ontogeny Growth and Radiation Use Efficiency of Canola *(Brassica napus L.)* Under Various **Nitrogen** Management Strategies and Contrasting Environments. Int. J. Plant Prod. 16, 195–208 (2022). https://doi.org/10.1007/s42106-022-00183-7

Jégo, G., Sansoulet, J., Pattey, E., Beaudoin, N., Bélanger, G., Ziadi, N., ... & Justes, E. (2022). Determination **of nitrogen dilution curves** of corn, canola, and spring wheat in Canada using classical and Bayesian approaches. European Journal of Agronomy, 135, 126481. https://doi.org/10.1016/j.eja.2022.126481

Tian, H., Zhu, Z., Song, H., & Wu, X. (2021). Iminodisuccinic Acid Relieved **Cadmium Stress** in Rapeseed Leaf by Affecting Cadmium Distribution and Cadmium Chelation With Pectin. (preprint) https://doi.org/10.21203/rs.3.rs-1098394/v1

Gu, D., Zhou, X., Yin, X., Wu, M., Chen, W., Xu, E., ... & Chen, X. (2022). **Metal tolerance protei**n family members are involved in **Mn** homeostasis through internal compartmentation and exocytosis in *Brassica napus*. Environmental and Experimental Botany, 104785. https://doi.org/10.1016/j.envexpbot.2022.104785

PhD Thesis:

Amy, C. (2021). Optimiser la nutrition azotée et phosphorée du colza pour une production durable via l'utilisation de biointrants améliorant le fonctionnement du phytobiome (Doctoral dissertation, Normandie Université). (In French: *Optimising **nitrogen and phosphorus nutrition** in oilseed rape for sustainable production through the use of bioinputs that improve the functioning of the phytobiome*) https://tel.archives-ouvertes.fr/tel-03609145/

Taghvaei, M. M., Lahiji, H. S., & Golfazani, M. M. (2022). Evaluation of expression changes, proteins interaction network, and microRNAs targeting catalase and superoxide dismutase genes under **cold stress** in rapeseed (*Brassica napus L.).* OCL, 29, 3. https://doi.org/10.1051/ocl/2021051

Liu, M. (2021). Role of Aquaporins in *Brassica napus* Responses to **Root Hypoxia** and Re-aeration.. University of Alberta. https://doi.org/10.7939/r3-zf8k-5477

PROCESSING and USES

Refi, Ö. Z. L. Ü., & GÜNER, M. Determination of **Pneumatic Conveying Characteristics of Canola**. Journal of Agricultural Sciences, 38-38. https://doi.org/10.15832/ankutbd.794097

Vidal, N. P., Roman, L., Swaraj, V. S., Ragavan, K. V., Simsek, S., Rahimi, J., ... & Martinez, M. M. (2022). Enhancing the nutritional value of **cold-pressed** oilseed cakes through **extrusion cooking.** Innovative Food Science & Emerging Technologies, 77, 102956. https://doi.org/10.1016/j.ifset.2022.102956

Alhomodi, A. F., Berhow, M., Gibbons, W. R., Monono, E., & Karki, B. Meal Nutritional Characteristics and Oil Profile of **Sprouted, Dehulled, and Solvent-Extracted Canola**. Journal of the Science of Food and Agriculture. https://doi.org/10.1002/jsfa.11794

Flakelar, C. L., Adjonu, R., Doran, G., Howitt, J. A., Luckett, D. J., & Prenzler, P. D. (2022). **Phytosterol, Tocopherol and Carotenoid Retention** during Commercial Processing of *Brassica napus* (Canola) Oil. Processes, 10(3), 580. https://doi.org/10.3390/pr10030580

Zhou, L., Shen, J., Timothy, J. T., Chicilo, F., Purdy, S. K., Meda, V., & Reaney, M. J. (2022). Electrostatic field treatment as a novel and efficient method in crude canola **oil refining**. Journal of Cleaner Production, 131905. https://doi.org/10.1016/j.jclepro.2022.131905

He, M., Nian, B., Shi, J., Sun, X., Du, R., Tan, C. P., ... & Liu, Y. (2022). Influence of **extraction technology** on rapeseed oil functional quality: a study on rapeseed **polyphenols**. Food & function, 13(1), 270-279. https://doi.org/10.1039/D1FO01507A

Tian, Y., Kriisa, M., Föste, M., Kütt, M. L., Zhou, Y., Laaksonen, O., & Yang, B. (2022). Impact of **enzymatic pre-treatment** on composition of nutrients and phytochemicals of canola (*Brassica napus*) oil press residues. Food Chemistry, 132911. https://doi.org/10.1016/j.foodchem.2022.132911

Dygas, D., Janicka, P., Berłowska, J., & Kręgiel, D. (2022). Conventional and Unconventional **Yeasts** Able to Grow on **Rapeseed Meal Hydrolysates**. BioResources, 17(2). REFERENCE

Beaubier, S., Defaix, C., Albe-Slabi, S., Aymes, A., Galet, O., Fournier, F., & Kapel, R. (2022). Multiobjective decision making strategy for **selective albumin extraction** from a rapeseed cold-pressed meal based on Rough Set approach. Food and Bioproducts Processing, 133, 34-44. https://doi.org/10.1016/j.fbp.2022.02.005

Nehmeh, M., Rodriguez-Donis, I., Cavaco-Soares, A., Evon, P., Gerbaud, V., & Thiebaud-Roux, S. (2022). Bio-Refinery of Oilseeds: Oil Extraction, Secondary Metabolites Separation towards Protein Meal Valorisation—A Review. Processes, 10(5), 841. https://doi.org/10.3390/pr10050841

Ahlström, C., Thuvander, J., Rayner, M., Mayer Labba, I. C., Sandberg, A. S., & Östbring, K. (2022). Pilot-Scale **Protein Recovery** from Cold-Pressed Rapeseed Press Cake: Influence of Solids Recirculation. Processes, 10(3), 557. https://doi.org/10.3390/pr10030557

Baker, P. W., Višnjevec, A. M., Krienke, D., Preskett, D., Schwarzkopf, M., & Charlton, A. (2022). Pilot scale **extraction of protein** from cold and hot-pressed rapeseed cake: Preliminary studies on the effect of upstream mechanical processing. Food and Bioproducts Processing. https://doi.org/10.1016/j.fbp.2022.03.007

Xiong, Z., Fu, Y., Yao, J., Zhang, N., He, R., Ju, X., & Wang, Z. (2022). Removal of anti-nutritional factors **of rapeseed protein isolate** (RPI) and toxicity assessment of RPI. Food & function, 13(2), 664-674. https://doi.org/10.1039/D1FO03217H

Georgiev, R., Kalaydzhiev, H., Ivanova, P., Silva, C. L., & Chalova, V. I. (2022). Multifunctionality of Rapeseed Meal **Protein Isolates** Prepared by Sequential Isoelectric Precipitation. Foods, 11(4), 541. https://doi.org/10.3390/foods11040541

Jafarian Asl P., Niazmand R. (2022) Bioactive **Phytochemicals** from Rapeseed (*Brassica napus*) Oil Processing By-products. In: Ramadan Hassanien M.F. (eds) Bioactive Phytochemicals from Vegetable Oil and Oilseed Processing By-products. Reference Series in Phytochemistry. Springer, Cham. https://doi.org/10.1007/978-3-030-63961-7_3-1

Zhang, L., Akhymetkan, S., Chen, J., Dong, Y., Gao, Y., & Yu, X. (2022). Convenient method for the simultaneous production of high-quality fragrant rapeseed oil and recovery of **phospholipids** via **electrolyte degumming**. *LWT*, *155*, 112947. https://doi.org/10.1016/j.lwt.2021.112947

Wawrzyniak, J., Rudzińska, M., Gawrysiak-Witulska, M., & Przybył, K. (2022). Predictive Models of **Phytosterol Degradation** in Rapeseeds Stored in Bulk Based on Artificial Neural Networks and Response Surface Regression. Molecules, 27(8), 2445. https://doi.org/10.3390/molecules27082445

Margellou, A.G., Koutsouki, A.A., Petrakis, D.E. et al. Catalysis and Inhibition of **Transesterification** of Rapeseed Oil over MgO–CaO. Bioenerg. Res. (2022). https://doi.org/10.1007/s12155-022-10430-4

Yang, X., Liu, Y., Bezama, A., & Thrän, D. (2022). Two birds with one stone: A combined environmental and economic performance **assessment** of rapeseed-based **biodiesel** production. GCB Bioenergy, 14(2), 215-241. https://doi.org/10.1111/gcbb.12913

Cipolletta, M., D'Ambrosio, M., Moreno, V. C., & Cozzani, V. (2022). Enhancing the sustainability of **biodiesel** fuels by inherently safer **production processes**. Journal of Cleaner Production, 344, 131075. https://doi.org/10.1016/j.jclepro.2022.131075

Liu, H., He, A., Li, S., Xu, L., Xu, N., Liu, S., ... & Jiang, M. (2022). Efficient production of **acidic sophorolipid** from rapeseed oil by *Candida bombicola*. Biofuels, Bioproducts and Biorefining. https://doi.org/10.1002/bbb.2357

Elsayed, M., Li, W., Abdalla, N. S., Ai, P., Zhang, Y., & Abomohra, A. E. F. (2022). Innovative approach for **rapeseed straw recycling** using black solider fly larvae: Towards enhanced energy recovery. Renewable Energy, 188, 211-222. https://doi.org/10.1016/j.renene.2022.02.029

Carré, P., & Loison, J. P. (2021). A new method for **rapeseed hulls** purification–Proof of concept. OCL, 28, 56. https://doi.org/10.1051/ocl/2021046

Tang, C., Wan, Z., Chen, Y., Tang, Y., Fan, W., Cao, Y., ... & Tang, Z. (2022). Structure and Properties of **Organogels** Prepared from Rapeseed Oil with Stigmasterol. Foods, 11(7), 939. https://doi.org/10.3390/foods11070939

FitzPatrick, S. E., Deb-Choudhury, S., Ranford, S., & Staiger, M. P. (2022). **Canola protein aerogels** via salt-induced gelation and supercritical carbon dioxide drying. European Polymer Journal, 168, 111126. https://doi.org/10.1016/j.eurpolymj.2022.111126

Nastac, S., Nechita, P., Debeleac, C., Simionescu, C., & Seciureanu, M. (2021). The Acoustic Performance of Expanded Perlite **Composites** Reinforced with Rapeseed Waste and Natural Polymers. Sustainability, 14(1), 103. https://doi.org/10.3390/su14010103

Dissanayake, T., Chang, B. P., Mekonnen, T. H., Ranadheera, C. S., Narvaez-Bravo, C., & Bandara, N. (2022). Reinforcing canola protein matrix with chemically tailored nanocrystalline cellulose improves the functionality of **canola protein-based packaging materials**. Food Chemistry, 383, 132618. https://doi.org/10.1016/j.foodchem.2022.132618

Alam, M., Altaf, M., & Ahmad, N. (2022). Rapeseed oil gallate-amide-urethane **coating material**: Synthesis and evaluation of coating properties. e-Polymers, 22(1), 190-202. https://doi.org/10.1515/epoly-2022-0021

Subramani, S., Nantha Muthu, S. and Gajbhiye, N.L. (2022), "A numerical study on the influence of minimum quantity lubrication parameters on spray characteristics of rapeseed oil as **cutting fluid**", Industrial Lubrication and Tribology, Vol. 74 No. 2, pp. 197-204. https://doi.org/10.1108/ILT-08-2021-0305

Wongsirichot, P., Gonzalez-Miquel, M., & Winterburn, J. (2022). Recent advances in rapeseed meal as alternative feedstock for **industrial biotechnology**. Biochemical Engineering Journal, 108373. https://doi.org/10.1016/j.bej.2022.108373

Zhang, H., Zhang, H., Qin, X. et al. **Biodegradation of nitriles** derived from glucosinolates in rapeseed meal by BnNIT2: a nitrilase from *Brassica napus* with wide substrate specificity. Appl Microbiol Biotechnol 106, 2445–2454 (2022). https://doi.org/10.1007/s00253-022-11844-y

Tan, Q., Wang, J. P., Zeng, Q. F., Ding, X. M., Bai, S. P., Peng, H. W., ... & Zhang, K. Y. (2022). Effects of rapeseed meal on laying performance and egg quality in **laying ducks**. Poultry Science, 101(3), 101678. https://doi.org/10.1016/j.psj.2021.101678

Engelsmann, M. N., Jensen, L. D., van der Heide, M. E., Hedemann, M. S., Nielsen, T. S., & Nørgaard, J. V. (2022). Age-dependent development in **protein digestibility** and intestinal morphology in **weaned pigs** fed different protein sources. Animal, 16(1), 100439. https://doi.org/10.1016/j.animal.2021.100439

Lannuzel, C., Smith, A., Mary, A. L., Della Pia, E. A., Kabel, M. A., & de Vries, S. (2022). Improving fiber utilization from rapeseed and sunflower seed meals to substitute soybean meal in **pig and**

chicken diets: A review. Animal Feed Science and Technology, 115213. https://doi.org/10.1016/j.anifeedsci.2022.115213

Miao, L. H., Remø, S. C., Espe, M., Philip, A. J. P., Hamre, K., Fjelldal, P. G., ... & Sissener, N. H. (2022). Dietary plant oil supplemented with arachidonic acid and eicosapentaenoic acid affects the fatty acid composition and eicosanoid metabolism of **Atlantic salmon** *(Salmo salar L.)* during smoltification. Fish & Shellfish Immunology, 123, 194-206.https://doi.org/10.1016/j.fsi.2022.02.049

Kaiser, F., Harbach, H., & Schulz, C. (2022). **Rapeseed proteins as fishmeal alternatives:** A review. Reviews in Aquaculture. https://doi.org/10.1111/raq.12678

Razmaitė, V., Šiukščius, A., & Šarauskas, G. (2022). Effects of **Dietary Rapeseed and Camelina Seed Cakes** on Physical–Technological Properties of **Goose Meat**. Animals, 12(5), 632. https://doi.org/10.3390/ani12050632

Correa, L. B., Netto, A. S., da Silva, J. S., Cônsolo, N. R. B., Pugine, S. M. P., de Melo, M. P., ... & Zanetti, M. A. (2022). Changes on meat fatty acid profile, cholesterol and hepatic metabolism associated with antioxidants and canola oil supplementation for **Nellore cattle**. Livestock Science, 257, 104850. https://doi.org/10.1016/j.livsci.2022.104850

Bibat, M. A. D., Ang, M. J., & Eun, J. B. (2022). Impact of replacing pork backfat with rapeseed oleosomes–Natural pre-emulsified oil–On technological properties of meat model systems. Meat Science, 108732 https://doi.org/10.1016/j.meatsci.2021.108732

Oliveira, A. M. D., & Yu, P. (2022). Research progress and future study on physicochemical, nutritional, and structural characteristics of canola and rapeseed feedstocks and co-products from bio-oil processing and nutrient modeling evaluation methods. Critical Reviews in Food Science and Nutrition, 1-7. https://doi.org/10.1080/10408398.2022.2033686

Zhang, Y., Lv, H., Yang, B., Zheng, P., Zhang, H., Wang, X., ... & Jin, Q. (2022). Characterization of Thermally Induced Flavor Compounds from the Glucosinolate Progoitrin in Different Matrices via GC-TOF-MS. Journal of agricultural and food chemistry. https://doi.org/10.1021/acs.jafc.1c04415

Multescu, M., Marinas, I. C., Susman, I. E., & Belc, N. (2022). Byproducts (Flour, Meals, and Groats) from the Vegetable Oil Industry as a Potential **Source of Antioxidants**. Foods, 11(3), 253. https://doi.org/10.3390/foods11030253

Xie, C., Li, W., Gao, R., Yan, L., Wang, P., Gu, Z., & Yang, R. (2022). Determination of glucosinolates in rapeseed meal and their degradation by myrosinase from rapeseed sprouts. Food Chemistry, 382, 132316. https://doi.org/10.1016/j.foodchem.2022.132316

Cao, X., Pan, Y., Qiao, M., & Yuan, Y. (2022). Synthesis of **human milk fat substitutes** based on enzymatic preparation of low erucic acid acyl-donors from rapeseed oil. Food Chemistry, 132907. https://doi.org/10.1016/j.foodchem.2022.132907

Coughlan, R., Moane, S., & Larkin, T. (2022). Variability of Essential and Nonessential Fatty Acids of Irish Rapeseed Oils as an Indicator of **Nutritional Quality.** International Journal of Food Science, 2022. https://doi.org/10.1155/2022/7934565

Tang, X., Zheng, Y., Liu, T. C., Liu, J., Wang, J., Lu, Y., ... & Zhou, P. (2022). Fragrant **rapeseed oil consumption** prevents blood cholesterol accumulation via promoting fecal bile excretion and reducing oxidative stress in high **cholesterol diet** fed rats. Journal of Functional Foods, 88, 104893. https://doi.org/10.1016/j.jff.2021.104893

Nishikawa, M., Ohara, N., Naito, Y., Saito, Y., Amma, C., Tatematsu, K., ... & Okuyama, H. (2022). Rapeseed (canola) oil aggravates metabolic syndrome-like conditions in male but not in female stroke-prone spontaneously hypertensive rats (SHRSP). Toxicology Reports, 9, 256-268. https://doi.org/10.1016/j.toxrep.2022.01.011

Nicol, K., Mansoorian, B., Latosinska, A. et al. No evidence of differential impact of sunflower and rapeseed oil on biomarkers of **coronary artery disease or chronic kidney disease** in healthy adults with overweight and obesity: result from a randomised control trial. Eur J Nutr (2022). https://doi.org/10.1007/s00394-022-02810-5

Hussain, S., Rehman, A. U., Obied, H. K., Luckett, D. J., & Blanchard, C. L. (2022). Extraction, Chemical Characterization, In Vitro Antioxidant, and **Antidiabetic Activity** of Canola (**Brassica napus L**.) Meal. Separations, 9(2), 38. https://doi.org/10.3390/separations9020038

You, H., Zhang, Y., Wu, T., Li, J., Wang, L., Yu, Z., ... & Ding, L. (2022). Identification of **dipeptidyl peptidase IV inhibitory peptide**s from rapeseed proteins. LWT, 160, 113255. https://doi.org/10.1016/j.lwt.2022.113255

Xu, F., Xu, B., Chen, H., Ju, X., & de Mejia, E. G. (2022). Enhancement of DPP-IV Inhibitory Activity and Capacity of Enabling GLP-1 Secretion Through RADA16-assisted Molecular Designed **Rapeseed Peptide Nanogels**. Food & Function. https://doi.org/10.1039/D1FO04367F

ANALYTICS

Zhou, E., Song, N., Xiao, Q., Farooq, Z., Jia, Z., Wen, J., ... & Yi, B. (2022). Construction **of transgenic detection** system of *Brassica napus L*. based on single nucleotide polymorphism chip. 3 Biotech, 12(1), 1-15. https://doi.org/10.1007/s13205-021-03062-6

Sohn, S. I., Pandian, S., Zaukuu, J. L. Z., Oh, Y. J., Park, S. Y., Na, C. S., ... & Cho, Y. S. (2021). Discrimination of transgenic canola (*Brassica napus L*.) and their hybrids with *B. rapa* using Vis-NIR spectroscopy and machine learning methods. International Journal of Molecular Sciences, 23(1), 220. https://doi.org/10.3390/ijms23010220

Demeke, T., Lee, S. J., & Eng, M. (2022). Increasing the Efficiency of **Canola and Soybean GMO Detection** and Quantification Using Multiplex Droplet Digital PCR. Biology, 11(2), 201. https://doi.org/10.3390/biology11020201

Peeters, K., & Tamayo Tenorio, A. (2022). Comparing Analytical Methods for **Erucic Acid Determination** in Rapeseed Protein Products. Foods, 11(6), 815. https://doi.org/10.3390/foods11060815

West, B. (2022). Hyperspectral imagery combined with machine learning to differentiate Genetically Modified (GM) and non-GM canola (Doctoral dissertation, Murdoch University). http://researchrepository.murdoch.edu.au/id/eprint/64579

PhD thesis, books:

Yadav, S. INFLUENCE OF BRASSICA SPP. (CARINATA, RAPESEED, CANOLA) AND ITS METABOLITES ON GROW TH AND INTESTINAL HEALTH IN SALMONELLA AND EIMERIA-INFECTED CHICKENS (Doctoral dissertation, University of Georgia). REFERENCE

Wani, I. A., ul Ashraf, Z., & Muzzaffar, S. (2022). **Erucic Acid**. In Handbook of Plant and Animal Toxins in Food (pp. 169-176). CRC Press.

ECONOMY and MARKET

Delzeit, R., Heimann, T., Schünemann, F., & Söder, M. (2021). Who benefits really from phasing out palmoil-based biodiesel in the EU? (No. 2203). Kiel Working Paper. https://www.econstor.eu/handle/10419/247707

Bełdycka-Bórawska, A., Jankowski, K. J., Rokicki, T., & Gostkowski, M. (2021). Area under Rapeseed Cultivation as a Factor Differentiating the Economic Performance of Biodiesel Producers. Energies 2021, 14, 8568. https://doi.org/10.3390/en14248568

Schaefer, K., Myers, R., Johnson, S., Helmar, M., & Radich, T. (2022). Biodiesel feedstock and crude oil price relationships – The effects of policy and shale oil expansion. Agricultural and Resource Economics Review, 1-18. https://doi.org/10.1017/age.2022.6

Xuan, Y., Hu, Y. & Wang, H. Social and economic analysis on the price spillover effect of agricultural products from the perspective of financialization: evidence from China's oil and oilseeds industrial chain. Appl Nanosci (2022). https://doi.org/10.1007/s13204-021-02094-x

NOVKOVIĆ, N., MUTAVDŽIĆ, B., DRINIĆ, L., JOVANOVIĆ, S., & TEKIĆ, D. TENDENCIES AND PREDICTION OF PRICES OF INDUSTRIAL CROPS IN SERBIA. AGROFOR, 6(3). https://doisrpska.nub.rs/index.php/AGR/article/view/8406

MUSTARD and Other Brassicae

Yadav, P., Yadav, S., Mishra, A., Chaudhary, R., Kumar, A., Meena, H. S., & Rai, P. K. (2022). Molecular distinction and **population structure of Indian mustard** [***Brassica juncea*** *(L.)* Czern.]. Genetic Resources and Crop Evolution, 1-12. https://doi.org/10.1007/s10722-022-01346-1

Singh, V.V., Balbeer, Sharma, H.K. et al. Heterosis and gene action studies for agro-physiological traits in Indian mustard (*Brassica juncea L.*). Vegetos (2022). https://doi.org/10.1007/s42535-022-00346-x

Kaur, G., Sharma, S., Langyan, S., Kaur, J., Yadava, P., Banga, S.S. (2022). **Advanced Breeding** for Oil and Oil Cake Quality in ***Brassica juncea***. In: Kole, C., Mohapatra, T. (eds) The Brassica juncea Genome. Compendium of Plant Genomes. Springer, Cham. https://doi.org/10.1007/978-3-030-91507-0_23

Kugashiya, K. G., Patel, H. S., Chaudhari, P. R., Desai, T. A., & Vaghela, P. O. (2022). **Breeding for CGMS** system in mustard (*Brassica juncea L*. Czern & Coss): A review. REFERENCE

Khan, R., Ashraf, M., Abbas, S., Mehmood, A., & Begum, S. (2022). **Genetic diversity** of ***Brassica rapa*** germplasm of Azad Jammu and Kashmir, Pakistan revealed by molecular markers. Acta Scientiarum Polonorum Hortorum Cultus, 21(2), 123–131. https://doi.org/10.24326/asphc.2022.2.11

Sharma, S., Bala, M., Kaur, G., Tayyab, S., Feroz, S.R. (2022). Chemical **Composition of Oil and Cake** of ***Brassica juncea***: Implications on Human and Animal Health. In: Kole, C., Mohapatra, T. (eds) The Brassica juncea Genome. Compendium of Plant Genomes. Springer, Cham. https://doi.org/10.1007/978-3-030-91507-0_3

Mahapatra, S., Chakraborty, S., Samanta, M., & Das, S. (2022). Impacts of Integrated Nutrient Management on Epidemiology, Seed Yield and Severity of **Alternaria blight** Disease in Indian Mustard (***Brassica juncea L.***). International Journal of Bio-Resource & Stress Management, 13(3). REFERENCE

Singh, M., Singh, V.V., Singh, N., Monika (2022). **Drought Tolerance** in Rapeseed-Mustard: Conventional and Molecular Approaches. In: Kole, C. (eds) Genomic Designing for Abiotic Stress Resistant Oilseed Crops. Springer, Cham. https://doi.org/10.1007/978-3-030-90044-1_5

van Herwaarden, A. (2022). The Performance and Feasibility of **Carinata** in Australia. REFERENCE

Book chapters:

Rai, P.K., Yadav, P., Kumar, A., Sharma, A., Kumar, V., Rai, P. (2022). ***Brassica juncea***: A Crop for Food and Health. In: Kole, C., Mohapatra, T. (eds) The Brassica juncea Genome. Compendium of Plant Genomes. Springer, Cham. https://doi.org/10.1007/978-3-030-91507-0_1

Kaur, G. et al. (2022). Classical Genetics and Traditional Breeding in ***Brassica juncea***. In: Kole, C., Mohapatra, T. (eds) The Brassica juncea Genome. Compendium of Plant Genomes. Springer, Cham. https://doi.org/10.1007/978-3-030-91507-0_6

Miscellaneous

Uses of teledection

Bojanowski JS, Sikora S, Musiał JP, Woźniak E, Dąbrowska-Zielińska K, Slesiński P, Milewski T, Łączyński A. Integration of **Sentinel-3** and MODIS Vegetation Indices with ERA-5 Agro-Meteorological Indicators for Operational **Crop Yield Forecasting**. Remote Sensing. 2022; 14(5):1238. https://doi.org/10.3390/rs14051238

Zhang, H., Liu, W., & Zhang, L. (2022). Seamless and automated rapeseed mapping for large cloudy regions using time-series optical satellite imagery. ISPRS Journal of Photogrammetry and Remote Sensing, 184, 45-62. https://doi.org/10.1016/j.isprsjprs.2021.12.001

Allies, A., Roumiguie, A., Fieuzal, R., Dejoux, J. F., Jacquin, A., Veloso, A., ... & Baup, F. (2021). Assimilation of multisensor optical and multiorbital SAR satellite data in a simplified agro-meteorological model for rapeseed crops monitoring. IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing. https://doi.org/10.1109/JSTARS.2021.3136289

Luo, Y., Zhang, Z., Zhang, L., Han, J., Cao, J., & Zhang, J. (2022). Developing High-Resolution Crop Maps for Major Crops in the European Union Based on Transductive Transfer Learning and Limited Ground Data. Remote Sensing, 14(8), 1809. https://doi.org/10.3390/rs14081809

Mirahmadi, A., Yazdanpanah, H., & Momeni Shahraki, M. (2022). Evaluation of smoothing methods for the reconstruction of Greenness Index time series and estimation of Rapeseed phenology from Landsat 8 satellite data (Case study: Farokhshahar Region). Physical Geography Research Quarterly. https://dx.doi.org/10.22059/jphgr.2022.327272.1007633

Zhang, C., Xie, Z., Liu, J., Dong, T., Tang, M., Feng, S., & Cai, H. (2022). Detecting winter canola (*Brassica napus*) phenological stages using an improved shape-model method based on time-series UAV spectral data. The Crop Journal. https://doi.org/10.1016/j.cj.2022.03.001

Xiao, Z., Pan, Y., Wang, C., Li, X., Lu, Y., Tian, Z., ... & Wang, H. (2022). Multi-Functional Development and Utilization of Rapeseed: Comprehensive Analysis of the Nutritional Value of Rapeseed Sprouts. Foods, 11(6), 778. https://doi.org/10.3390/foods11060778

Upcoming international and national events

15-17 June 2022, Perugia (Italy) CONGRESS SISSG 2022 "Edible oils and fats: innovation and sustainability in production and control."

https://www.sissg.it/en/congresso-di-perugia-2022/

26-29 June, 2022, 15th International Conference on Precision Agriculture Minneapolis, USA
https://www.ispag.org/icpa

10-15 July, 2022, Grenoble, France: The 25th International Symposium on Plant Lipids (ISPL2022)
https://ispl2020.sciencesconf.org/

August 29 – September 2, 2022, European Society o Agronomy Congress; Potsdam, Germany
https://esa-congress-potsdam2022.de/frontend/index.php?folder_id=4191&page_id=

27-30 September, 2022 in Wageningen: 7th International Plant Phenotyping Symposium
https://www.plant-phenotyping.org/ipps7

24-27 September, 2023, 16th International Rapeseed Congress, Sydney, Australia
For further info go to www.irc2023sydney.com

irc 2023 SYDNEY
16th INTERNATIONAL RAPESEED CONGRESS
24 - 27 September 2023
GLOBAL CROP - GOLDEN OPPORTUNITIES

We invite you to share information with the rapeseed/canola community: let us know the scientific projects, events organized in your country, crop performances or any information of interest in rapeseed/canola R&D.

Contact GCIRC News:

Etienne Pilorgé, GCIRC Secretary-Treasurer: e.pilorge@terresinovia.fr

Contact GCIRC: contact@gcirc.org