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Increasing the efficiency and competitiveness of organic crop breeding

PRACTICE ABSTRACT No. 12

Does technology allow us to bridge the high throughput phenotyping and genotyping gap in crops?

THE PROBLEM:

For any breeding strategies there are essentially three resources needed. A large population, dense maps of the population and evaluated traits which can be linked with those genetic resources (Fig. 1). Advancements in development of genetic resources and genomics over the last couple of decades have radically altered the density of these genetic/physical maps, providing a landscape for conducting high-throughput genotyping and genomic analyses. However, developments in plant phenotyping have been slow to materialise especially for physiological traits, limiting advancements in crop improvement.

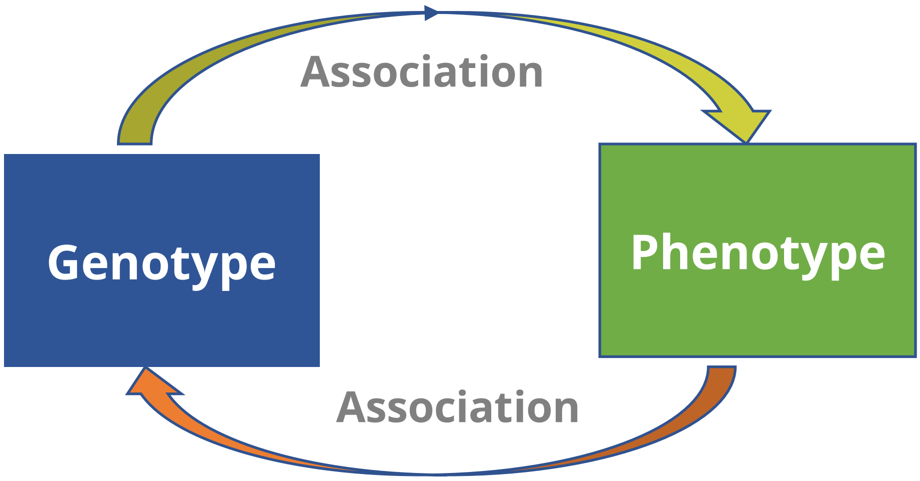

Fig. 1: The relationship between Genotype and Phenotype.

SOLUTIONS:

With the advent of climatic change and changing scenarios of both biotic and abiotic stresses and plant adaptability, physiologists and breeders are looking at alternative ways of increasing yield. The need is to understand traits which are directly or indirectly linked to yield, e.g. physiological traits and also provide a high throughput way of stress detection and quantification in order to understand how plants adapt and tolerate stress.

The availability of different technologies involving remote sensing, information and imaging techniques have allowed real-time image analysis of physiological changes in plants. Data extraction from these resources combined with systems integration allows morpho-physiological traits to be assessed non-destructively and as a time-series approach across whole populations and throughout development. These tools and techniques also allow pre-symtomatic monitoring of plant stress and pre-detection something which is a struggle using traditional assessment approach, i.e. visual assessment.

Some of these imaging resources include:

- **RGB sensing**: Plant phenotyping and monitoring approaches using RGB digital cameras which with subsequent analysis enables determination of canopy morphological characteristics with improved speed and precision.
- **Spectral sensing**: Stress in plants, e.g. diseases, result in physiological and morphological changes that potentially affect crop quality and final yield. Spectral sensing assesses the spectral information or characteristics of the vegetation, canopy or plant by measuring reflectance at different wavelengths of the spectrum.
- **Thermal sensing**: Infra-red thermography (IRT) is a viable alternative for the indirect estimation of stomatal conductance as studies have shown that the leaf/canopy temperature is an indicator of transpiration rate. IRT is a good resource to understand the biotic and abiotic stress responses in plants through variation in canopy temperature, e.g. water stress, stress pertaining to root diseases.

The above resources cover the broad spectrum but there are other systems, e.g. fluorescence imaging, Laser imaging, Magnetic resonance imaging etc. which also add to the phenotyping tools available for crop sensing.

PRACTICAL RECOMMENDATIONS:

The question of how and why about crop genomics has been investigated in depth over the last couple of decades, and now remote sensing applications and technological advances will allow us to answer the same questions about measuring whole-plant phenotypes in the coming decades.

The Ecobreed Phenotyping team is using integrated sensing platforms covering different spatial and spectral resolutions to monitor and phenotype both wheat and potato crops in this project.

FURTHER INFORMATION:

de Jesus Colwell F, Souter J, Bryan GJ, Compton LJ, Boonham N, Prashar A. Development and Validation of Methodology for Estimating Potato Canopy Structure for Field Crop Phenotyping and Improved Breeding. *Front Plant Sci.* 2021 Feb 10; 12:612843. doi: 10.3389/fpls.2021.612843. PMID: 33643346

Susič, N., Žibrat, U., Širca, S, Strajnar, P., Razinger, J., Knapič, M., Vončina, A., Urek, G. & Gerič Stare, B. 2018. Discrimination between abiotic and biotic drought stress in tomatoes using hyperspectral imaging. *Sensors and Actuators B: Chemical,* 273**,** 842-852.

Prashar A, Colwell FJ, Hornyik C, Bryan GJ. Advances in development of potato varieties resistant to abiotic stress. *In:* Gefu Wang-Pruski, ed. *Achieving Sustainable Cultivation of Potatoes*. Burleigh Dodds Science Publishing, 2018, pp.125-142.

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PRACTICE ABSTRACT No. 13

Resistance of potato cultivars to *Phytophthora infestans*

PROBLEMS:

- Late blight, caused by *Phytophthora infestans* is commonly thought to be the important factor limiting yield in both conventional and organic farming (Fig. 1).
- Applying fungicides is the prevailing method for controlling late blight.
- Limited effective biological means to control late blight in organic farming.
- Scarcity of data available on yield loss caused by late blight in organic farming.

Fig.1. Damage caused by late blight development.

SOLUTIONS:

- Breeding for resistance is the most important strategy to combat late blight in organic potato production.
- Blight resistant varieties are available e.g. Sarpo mira but these tend to have poor organoleptic properties when cooked.
- Marker assisted selection (MAS) enables breeding and selection for improved and durable resistance to *P. infestans* by pyramiding and combining multiple race-specific R genes.
- Further efforts for improving tuber resistance against *P. infestans* are necessary since foliage and tuber resistance is not always correlated.

PRACTICAL RECOMMENDATIONS:

- More breeding efforts aimed at producing new potato cultivars suitable for organic conditions.
- Cultivation of potato varieties suited to local conditions.
- An increase in the share of resistant cultivars in the area of cultivation.

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Increasing the efficiency and competitiveness of organic crop breeding

PRACTICE ABSTRACT No. 14

Identifying cover crops for soybean organic production?

PROBLEMS:

With the increasing popularity of sustainable and organic production systems, maintaining and preserving soil fertility and health are key priorities. A major challenge in organic production is to enable optimal plant nutrition, based on the efficient use of soil nutrients (Manojlović, 2008). Ubavić and Bogdanović (2008) suggest selecting species with a well-developed root system that can use nutrients from less soluble compounds from deeper in the soil profile, with rapid growth and a short vegetation period and with the ability to fix atmospheric nitrogen e.g. legumes. Cover crops are increasingly being used as a tool to support agro-ecosystem services. Selected cover crop species differ in the traits by which they capture resources and influence the local ecosystem.

Fig.1. Soybean after winter cover crop. Photo credit: Institute of Field and Vegetable Crops Novi Sad.

SOLUTIONS:

Integration of cover crops can have significant ecological impacts on the farming system with numerous on-farm benefits. In organic production, cover crops play an essential role in improving the physical, chemical and biological properties of soils.

COVER CROP CHALLENGES:

- Selection of the most appropriate cover crop species and mixture.
- Competiveness for moisture and nutrients with the main crop (e.g. moisture use).
- Cost of cover crop seed, establishment and destruction.
- Termination time/practice of the cover crop.

BENEFITS AFTER THE INTRODUCTION OF COVER CROPS:

- Increased sustainability of production systems.
- Contribution to soil quality, via improved physical and chemical soil characteristics.
- If a legume is included, then N fixation is ensured thereby increasing the yield and quality of the following crop.
- Nitrogen release to the following cash crop.
- Decreased erosion.
- Decreased soil compaction.
- Conservation of soil moisture.
- Organic matter conservation.
- Weed control.
- Increased biodiversity.
- Attraction of beneficial insects.

CONSIDERATIONS:

- Agro-ecological conditions, location, soil type.
- Type of farm (plant or livestock production),
- Selection of cover crop species and mixture (in line with selection of the main crop, e.g. avoid brassica species where oilseed rape is grown).
- Time of planting and termination of the cover crop and the systems/approaches used.

Rye as cover crop

- Positive effect on soil structure.
- Good soil cover.
- Rye has deep root that helps in prevention of soil compaction in annually tilled field.
- Great in cover crop mixtures with legumes (winter pea, vetch, faba bean).

Fig. 2. Rye as winter cover crop.

- Previous crop for legumes (soybean), maize, sunflower.
- Rye has root exudates that can inhibit germination and growth of weed seeds which is very important supporting weed control in organic production.
- More disease resistant compared to barley or oat.
- Life-cycle of pests is broken.

Pea and oat as cover crop

- Oats provide support to the pea and have a positive effect on weed control, while the pea provides nitrogen.
- Adjust the sowing density to limit competition.
- Can be grazed by livestock.
- Forage peas can be grown alone or in combination with other species, especially with small grains (oats, rye).

Fig. 3. Pea and oat as cover crop.

- Mixtures provide more options for use as forage. Generally, single species cannot deliver all of these benefits, and hence planting mixtures is gaining increasing attention.
- Easy to terminate.
- Attract a wider range of beneficial insects and pollinators.

FURTHER INFORMATION:

Đorđević V, Malidža G, Vidić M, Milovac Ž, Šeremešić S (2016) Best practice manual for soya bean cultivation in the Danube region, Donau Soja, Headquarter, Vienna, Austria

Mikić A, Ćupina B, Rubiales D, Mihailović V, Šarūnaitė L, Fustec J, Antanasović S, Krstić Đ, Bedoussac L, Zorić L, Đorđević V, Perić V Srebrić M (2015) Models, developments, and perspectives of mutual legume intercropping. Adv Agron 130: 337-419. doi: 10.1016/bs.agron.2014.10.004

Sharma P, Singh A, Kahlon CS, Brar AS, Grover KK, Dia M, Steiner RL (2018): The Role of Cover Crops towards Sustainable Soil Health and Agriculture - A Review Paper. American Journal of Plant Sciences, Vol. 9, No. 9.

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PRACTICE ABSTRACT No. 15

Production of organic seeds: problems, challenges and requirements

PROBLEMS:

Synthetic fungicide and insecticide seed dressing treatments against pests and pathogens are not permitted in organic agriculture.

Organic seeds often show a lower germination in the field than from official seed testing especially under cool weather conditions. The problem appears both on certified untreated seeds and home-saved seeds.

Fig. 1. Good seed quality gives you good germination

SOLUTIONS:

Official seed testing is carried out at a temperature of 20°C in many countries. But soil temperatures can be 10 °C or lower when sowing crops such as winter wheat. As a result, a much more realistic germination result is achieved when you test seed germination at 10 °C. At 10 °C, many seed lots have a much lower germination which can be due to diseases like fusarium and Septoria, on and inside the seeds. The germination in "cold test" should achieve 80%.

The highest coincidence results of field results and lab results is achieved when soil is used as a substrate even though soil is naturally heterogeneous. Some labs offer the test in sand or other substrates which have a tendency for better germination results when compared with the field.

PRACTICAL RECOMMENDATIONS:

To maximise germination of the seed, care should be taken in processing the seed. Harvesting should be done at the optimum time to minimise grain sprouting in the head. The grain should not be dried at > 70 °C if lower than 20 % moisture (and >65 °C if higher moisture). The grain should be cooled on storage, ideally to around 12 °C for short-term storage, thus limiting insect and potential mould damage.

It is key to test home-saved seed for crop-specific diseases and germination. By knowing the germination and the thousand grain weight of the seed, an appropriate sowing rate can be calculated.

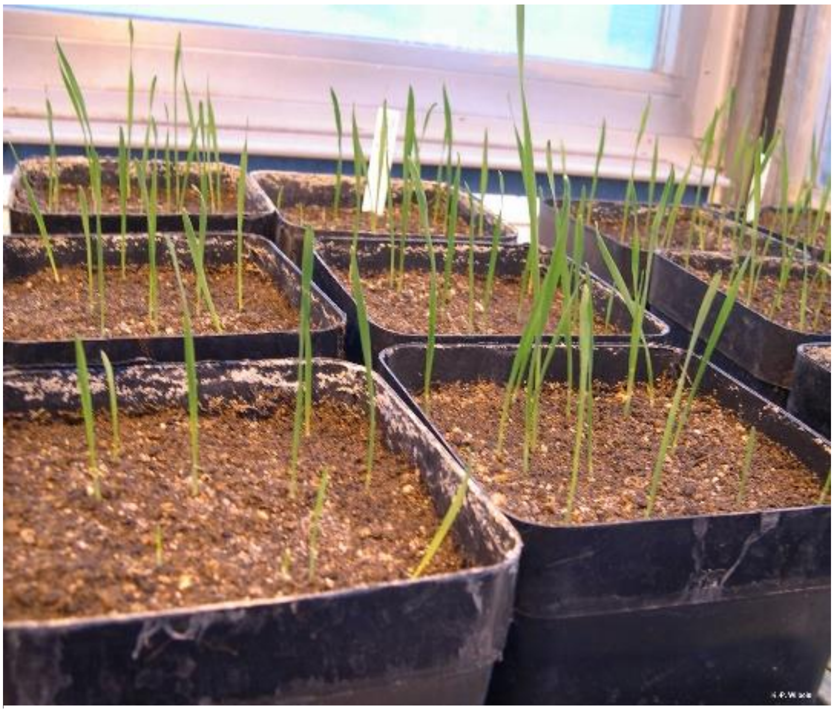

Fig. 2: Germination test in a trial.

As seedling blights are more of an issue at colder soil temperatures, it can often be more prevalent in winter crops. With spring sown crops, the soil is heating up. Seedling blight diseases are often more common when there has been significant rainfall at flowering time.

A good seed cleaner should be used both for certified and for home-saved seed. The quality of seed can significantly improve with the use of a seed dresser. 2.0 mm and 2.25 mm slotted sieves are often used to remove a lot of the small weed seeds and small grains from seed samples.

For wheat, spelt, emmer and einkorn seeds always check the amount of bunt spores. Bunt is a soil-borne disease; therefore, it is important to minimise the transfer and multiplication of spores in your soil.

FURTHER INFORMATION:

S. Groot. S. Klaedtke, M. Messmer and F. Rey (2020): Organic seed health. An inventory of issues and a report on case studies. In: https://www.liveseed.eu/wp-content/uploads/2021/02/LIVESEED_D2.5-Inventory-of-scientific-legal-and-technical-measures-to-improve-seed-quality-in-organic.pdf

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PRACTICE ABSTRACT No. 16

Soybean chilling stress

PROBLEMS:

Fig. 1: NARDI Fundulea Organic Research Center – Volunteer soybean plants in winter wheat. 2019.

- Chilling stress can damage seeds which can ultimately result in death.
- Chilling stress affects early sown soybeans, when the seeds imbibe water under cold conditions (4 – 10°C).
- Early sowing of soybeans has other associated risks e.g. induced dormancy and plant damage from late frosts.
- Fluctuations in regional climatic conditions have major impacts on soybean yield. For example, in Romania the cold weather in March 2018 killed all winter and spring legumes, whereas in 2019 soybean volunteers in a winter wheat crop at NARDI Fundulea (Fig. 1) survived due to a dry and mild winter.

SOLUTIONS:

- Early sowing of soybeans can help deliver higher yields.
- The wide range of available soybean cultivars may have different levels of tolerance to cold soil temperatures.

PRACTICAL RECOMMENDATIONS:

- Evaluation of variation in soybean cultivar tolerance to chilling stress (Fig. 2) by cold germination test (6°C).
- Selection of soybean cultivars suited to cold soil conditions together with consideration of other traits, e.g. maturity group, time of flowering and maturity, adaptability to local climate and soil characteristics etc.

Fig. 2: NARDI Fundulea Organic Research Center – Soybean cold test (6 C°), 2019

➢Sowing of soybean according to local forecast of air temperature, rainfall, soil conditions, etc. and adapt planting date, seed inoculation, seed rate, sowing depth, row spacing etc. accordingly.

FURTHER INFORMATION:

Alsajri FA, Singh B, Wijewardana C, Irby JT, Gao W, Reddy KR (2019). Evaluating soybean cultivars for low- and high-temperature tolerance during the seedling growth stage. Agronomy 9: 13. DOI: 10.3390/agronomy9010013

Davidson D (2017). Cold stress in soybeans at seeding. ILSoyAdvisor, 22 May. Illinois Soybean Association, Bloomington, IL. https://www.ilsoyadvisor.com/on-farm/ilsoyadvisor/cold-stress-soybeans-seeding

Hyojin Lee, Jong A. Chun, Hyun-Hee Han,and Sung Kim, 2016. Prediction of Frost Occurrences Using Statistical Modeling Approaches, Research Article: ID 2075186. DOI: https://doi.org/10.1155/2016/2075186

Jeschke M, Gaspar A, Van Roekel R (2020). Effects of cold temperature following soybean planting. https://www.pioneer.com/us/agronomy/Effects-Cold-Temperatures-Following-Soybean-Planting.html

Mourtzinis S, Specht JE, Conley SP (2019). Defining optimal soybean sowing dates across the US. Sci Rep 9: 2800. DOI: 10.1038/s41598-019-38971-3

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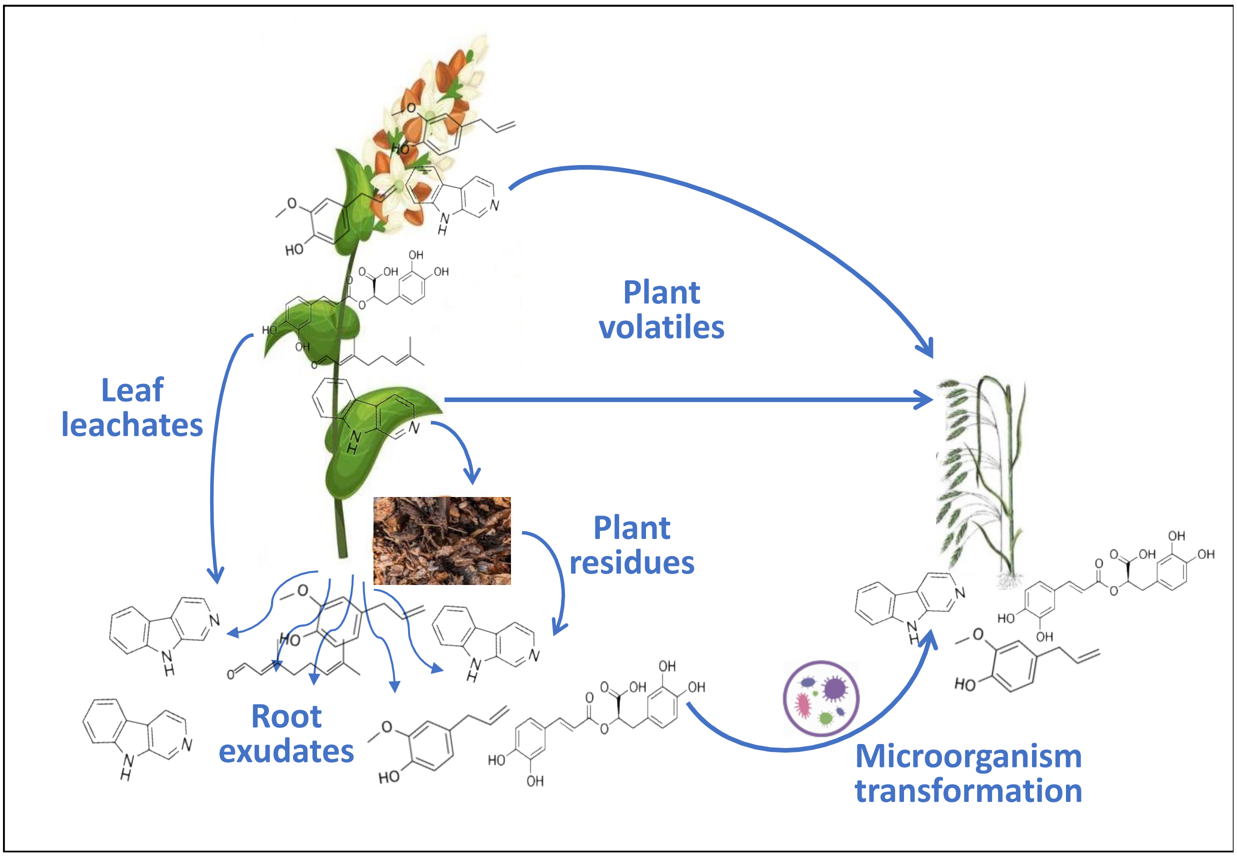
PRACTICE ABSTRACT No. 17

Allelopathy for weed management

PROBLEMS:

- ➢ Weed management is a major problem in organic production systems where synthetic herbicides are not permitted.
- ➢ Organic agriculture relies heavily on cultural control options for weed control i.e. crop rotation, sowing date, plough based cultivation etc.



SOLUTIONS:

➢ Plants naturally produce and release to the environment thousands of compounds, which can control the germination and/or growth of other plants. This phenomenon is known as allelopathy and can be found in natural as well as agricultural ecosystems.

➢ Some crops e.g. wheat, sorghum, rye, buckwheat and oats produce and store a variety of allelopathic substances that can serve as a natural source of weed-controlling compounds. These allelochemicals can be found in living organs or arise from residues after decay. Wheat is one of the crops with the strongest phytotoxic properties, most likely due to the presence of hydroxamic acids and phenolic compounds.

➢ The allelopathic properties of plants can be used in different ways: living crops releasing or exuding allelochemicals, allelopathic mulching or cover crops, allelopathic interactions in multiple cropping systems and ultimately, the application of allelopathic aqueous extracts as natural herbicides.

PRACTICAL RECOMMENDATIONS:

➢ Allelopathy seems to work better against single rather than a range of weed species but has clear potential to contribute to sustainable weed control.

➢ Further research is needed to screen crop cultivars for variation in allelochemical production and release, together with field studies to evaluate the most appropriate application methods (mulching, cover crop, etc.) and crop rotations for sustainable weed management.

FURTHER INFORMATION:

Cheng F, Cheng Z (2015) Research progress on the use of plant allelopathy in agriculture and the physiological and ecological mechanisms of allelopathy. Frontiers in Plant Science 6: 1020. https://doi.org/10.3389/fpls.2015.01020

Farooq N, Abbas T, Tanveer A, Jabran K (2020) Allelopathy for weed management. In: Mérillon JM, Ramawat K (eds), Co-evolution of secondary metabolites, pp 505-519. Springer, Cham. https://doi.org/10.1007/978-3-319-96397-6_16

Jabran K, Mahajan G, Sardana V, Chauhan BS (2015) Allelopathy for weed control in agricultural systems. Crop Protection 72: 57-65. https://doi.org/10.1016/j.cropro.2015.03.004

Jabran K (2017) Wheat allelopathy for weed control. In: Jabran K (ed), Manipulation of allelopathic crops for weed control, pp 13-20. Springer, Cham. https://doi.org/10.1007/978-3-319-53186-1_2.

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PRACTICE ABSTRACT No. 18

Protein yield – criteria and metrics for choice of varieties

PROBLEMS:

- Yield, protein and gluten content are important criteria for choice of varieties in bread-making wheat. In some countries protein is the relevant criteria, in others gluten.
- Yield and protein/gluten content have a negative correlation to yield that makes variety choice difficult. Protein content is not relevant for animal feed.
- Organic farmers have limited access to data from organic variety testing.

SOLUTIONS:

- Breeders with a focus on organic farming have successfully started to select for protein/gluten yield. Protein and gluten content have a high positive correlation.
- A high nitrogen efficiency in wheat improves protein yield of organic farming systems.

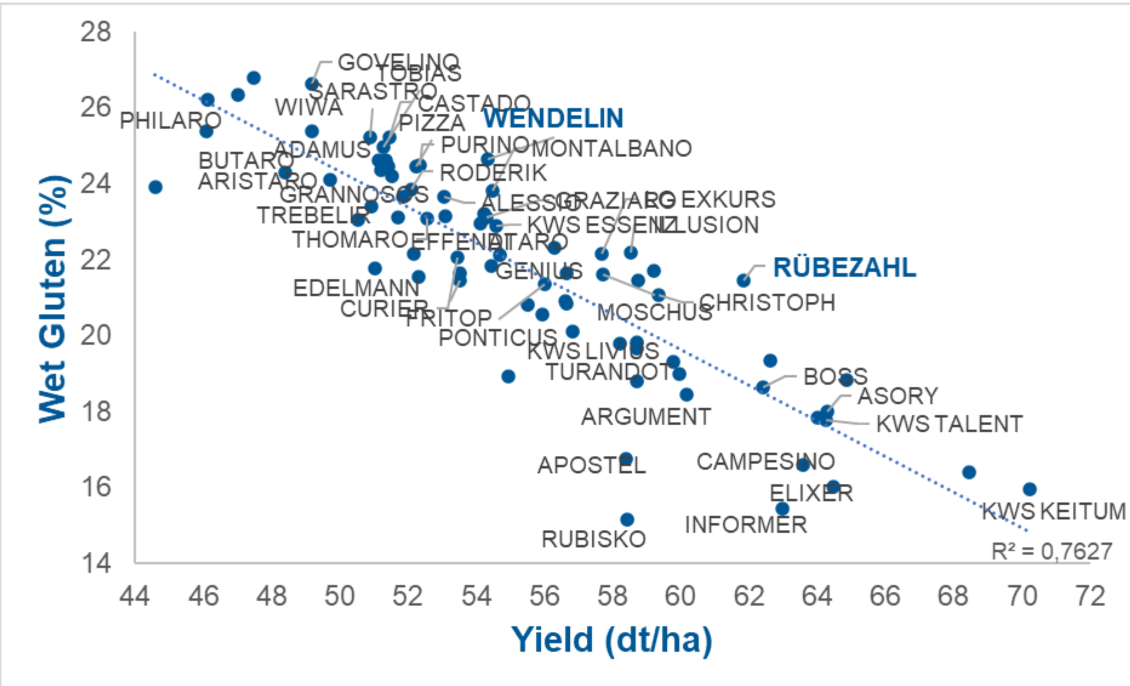

Fig. 1: Bundessortenamt, organic VCU winter wheat, organic trials of German federal states. All varieties mentioned have organic multiplication in Germany.

PRACTICAL RECOMMENDATIONS:

- To select varieties for high protein and gluten yield use results from organic variety trials. If not available, then use results of trials carried out under low-input conditions.
- Location of the trials are comparable with your farm concerning soil quality and climate. Often official trials have the tendency to be grown on soils with good quality.
- Some conventional breeders focus on development of varieties with reduced protein content but improved gluten content. These varieties have not shown good results under organic farming conditions to date in most cases.

FURTHER INFORMATION:

W. Vogt-Kaute (2006): Baking quality of variety mixtures of organic wheat and acknowledgement by farmers and millers in Germany, in: SUSVAR proceedings La Besse 2006, https://orgprints.org/id/eprint/10337/1/10337.pdf

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PRACTICE ABSTRACT No. 19

Buckwheat and how to grow it

PROBLEM:

Even though buckwheat is a traditional crop in some European countries, there are still a lot of farmers not familiar with its production.

SOLUTION:

Buckwheat is a flowering plant from the knotweed family (Polygonaceae), which can be used both as a grain and as a cover crop. The grain is a very nutritious food, a source of high-quality protein with a high content of essential amino acids, vitamins and minerals and is even considered by some as a superfood. Buckwheat is a natural source of the bioflavonoid rutin, which reduces the risk of cardiovascular disease and atherosclerosis.

Buckwheat is quick to establish and can be useful as a component of a cover crop mixture following harvest in late summer, as a second crop in a season or where an autumn or early spring drilled spring crop fails. This quick growing nature also means that it is good at suppressing weeds through shading and via the release of allelochemicals which can inhibit the growth and germination of weeds. It is worth noting though, that in fields with high weed pressure, buckwheat may not be able to out compete the weeds.

Buckwheat is not frost resistant and therefore can be killed by sub-zero temperatures. As a result, it should not be drilled until the risk of frost has passed. The lack of frost-hardiness is an advantage when grown as a winter cover crop as the buckwheat is generally killed before it sets seed. Buckwheat is a great source of pollen and nectar for bees and other insects with buckwheat honey being high in antioxidants. Buckwheat is able to take up soil phosphorous more efficiently than other plants. Once the crop is incorporated into the soil, this soluble P is then available to the next crop.

PRACTICAL RECOMMENDATIONS:

- Buckwheat thrives in a wide range of conditions but is susceptible to climatic extremes. The optimum temperature for growth is 20°C while the minimum germination temperature is 7–8 °C. Mature plants die at 2 °C and young seedlings die at -2 °C.
- High yields can be achieved on suitably fertile, not too acidic soils and as the root system is poor, buckwheat thrives best on medium to light soils that are not compacted and well cultivated.
- Manure and slurry should never be applied directly to buckwheat, but it is best to apply to the soil prior to drilling. When applying potassium fertiliser, the use of potassium sulphate is preferable as buckwheat is sensitive to chloride in potassium salts.

Fig. 1: TGW difference in buckwheat. Photo: Adam Brezáni

- Buckwheat is susceptible to boron deficiency; seen in leaf mottling, stunted growth and brittleness. If the B content is < 0.4 mg B/kg of soil, fertilisation with borax (3-4 kg/ha) or other fertilisers containing boron is advisable.
- Buckwheat should be drilled quite shallow – about 2 cm and with large variation in buckwheat TGW it is advisable to drill a plant stand i.e. 200 – 350 seeds/m^2 Rather than by seed weight kg/ha. TGW is also important factor when considering whether to grow the buckwheat for grain or as a cover crop. Mills usually prefer higher TGW of > 27 g since the groat yield is higher.
- Buckwheat can be grown in conventional narrow spacing rows (e.g. 12.5 cm) or in wider rows to enable inter-row cultivation. Wider rows encourage branching of the buckwheat plant and the plant is more robust, which can decrease lodging. Weeds can be a problem in wider rows, it is recommended to have an inter-row cultivator to maintain the rows clean of weeds.
- The vegetation period can differ from 80-150 days, depending on variety.
- It is important to consider whether there are any beehives nearby. It is recommended to have 2-5 bee colonies per hectare to encourage pollination. The addition of nomadic bee colonies can increase the yield of buckwheat by 30-40 %.

- Harvest is the most difficult part of growing buckwheat. The basic premise for success is to minimise losses and to prevent the achenes (or grains) from becoming scorched and mouldy.

Fig. 2: Buckwheat trials established in 33 cm wide rows, an inter-row cultivator was used. Right picture - 45th day of the vegetation. Photo: Adam Brezáni

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ECOBREED CONSORTIUM

ABOUT ECOBREED:

ECOBREED is a 5-year (2018-2023) project funded by European Union's Horizon 2020 research and innovation programme that will improve the availability of varieties and seed suitable for organic and low-input production. Activities will focus on four crop species i.e. wheat, potato, soybean and common buckwheat, selected for their potential contribution to increasing the competitiveness of the organic sector.

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PRACTICE ABSTRACT No. 20

Harvesting and storage of buckwheat

PROBLEM:

As buckwheat's popularity increases, so does its acreage. It is used as a cover crop and for grain production. In the case of grain production, the most difficult part of cultivation is determining the right time for harvesting.

SOLUTION:

Determining the harvest date can be very problematic. When the autumn is dry, the plants die off naturally. However, when there is more abundant rainfall, the buckwheat continues to flower, so the mature achenes may have fallen off on the lower branches and are still flowering on the upper branches. The level of asynchronous flowering depends on the variety as some varieties are more determinate than others, please refer to our buckwheat farmers' bulletin. In a wet autumn, therefore, there is a large fallout loss. Harvesting is optimally started when 75 % of the achenes on the plants have turned brown (or typical seed colour, e.g. grey), the achenes on the terminal branches are ripe and coloured and the achenes on the middle branches are ripening. If harvested prematurely, the achenes are unfilled and therefore lighter. If a dry season is forecast, harvesting may be delayed.


Fig. 1: Direct harvest of mature buckwheat in October, 2021. Photo: Adam Brezáni

Since buckwheat ripens gradually as it flowers and desiccation of the crop is not allowed in organic agriculture, it is possible to use the first autumn frosts to defoliate the crop; this is particularly suitable for late-sown crops. However, after this, the crop must be harvested within three days at the latest, otherwise the crop will quickly become infected with fungi and losses due to fallout increase.

Fig. 2: Perforated floor active drying with ambient air at EKOFARMA PROBIO s.r.o. (URL: https://rb.gy/703v)

Buckwheat can be harvested directly with a combine harvester. The disadvantage of this method is greater contamination of the harvested grain with green biomass from buckwheat plants and weeds. This leads to higher moisture of the harvested material and additional drying is often required. It is recommended that the threshing drum speed be set at 500 to 600 rpm with a typical moisture content of 20 - 30%. If crop moisture is higher, it is recommended that the threshing drum speed be set at 700 rpm. A lower threshing drum speed ensures that mainly ripe achenes are harvested, and immature ones remain on the plant. The stubble should be kept taller, i.e. 150 - 200 mm, but this depends on variety and the degree of lodging. The goal is not to harvest the green parts of the buckwheat, because the greener material gets into the combine harvester, the slower it will run thereby decreasing efficiency. An option is to use a pre-treatment, i.e. swathing where the stand is cut about 20 cm from the ground with a disc mower or swather and laid onto the stubble. Then it is harvested using a combine harvester with a special pick-up adapter. This harvesting method could result in a higher yield because the immature achenes can dry more uniformly, But the negative is that the over ripe achenes will be lost via the cutting movement. However special equipment is required (swather), and an additional pass is needed during harvesting compared to direct harvesting.

Harvest moisture can vary between 20-30%. Optimal long-term storage occurs at 14%. If drying is carried out with hot air, the maximum temperature is 40 °C, but the temperature of the achenes should not exceed 25-30 °C. If the temperature is too high, the achenes might become brittle to dehusk and the net yield of groats may decrease. The grain can be dried with cold air through perforated floors at a maximum height of 150–200 mm to ensure good aeration. Once the mass is partially dried, the height can be increased to 300 mm to make room for another batch. If the floor ventilation has a high capacity. It is possible to increase the height to about 600 mm.

FURTHER INFORMATION:

Vogt-Kaute W., Grausgruber H., Bernhart M., Billsborrow P., Smales A., Kolmanič A., Champailler M., Dolničar P., Tatarowska B., Plich J., Janovská D., Brezáni A., Haupvogel P., Janovicková K., Toncea I., Mikó P., Megyeri M., Polgár Z., Jocković B., Vasiljević M., Đorđević V., Pagnotta M. (2022) ECOBREED Farmers Participatory Field Trials 2021. Kmetijski inštitut Slovenije, Ljubljana, pp. 102. https://doi.org/10.5281/zenodo.7334377

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Increasing the efficiency and competitiveness of organic crop breeding

PRACTICE ABSTRACT No. 21

Seed dressings against seed-borne diseases in organic farming

PROBLEMS:

Synthetic fungicide and insecticide seed dressing treatments against pests and pathogens are not permitted in organic agriculture if seed-borne diseases appear. Most important seed- borne diseases are common bunt (*Tilletia caries*), loose smut (*Ustilago nuda*), fusarium, Septoria, net blotch (*Drechslera teres*), barley stripe (*Drechslera graminea* and *colletotrichum*).

Therefore, good seed quality is important for organic farming.

A seed dressing for organic farming needs to have permission under the organic regulations and the national standards for plant protection.

SOLUTIONS:

There are a few seed dressings available for organic seeds.

Tillecur is made from mustard and has a good efficiency against common bunt. It can be used in liquid formulation with 3 to 4 litres of water per 100 kg of seeds or as a dry powder. Tillecur does not work against bunt spores which originate in soil.

Seed disinfectants which combat pathogens on the seed surface. Usually these are products like acetic acid or alcohol. They only work on the surface of seed against diseases like Common bunt but partially also against diseases that are partially on the surface like *Fusarium* spp. Too high a concentration causes damage of germination.

Fig. 1: Loose smut in oats.

These treatments also do not protect the seed against bunt spores originating in the soil.

Cedomon and **Cerall** (*Pseudomonas chlororapis*) products contain contain the same bacteria but have a different formulation. Cedomon is effective against net blotch and stripe disease in barley, and Cerall against Fusarium, Septoria and Common bunt in wheat.

PRACTICAL RECOMMENDATIONS:

- Always test your seed for seed-borne diseases and use seed of good quality.
- Disease levels should be kept at a low level in breeding and seed multiplication.
- Always check National laws to see if a seed treatment is permitted as there are differences within Europe.
- There are no treatments available against loose smut in barley.

FURTHER INFORMATION:

S. Groot et al (2020): Organic seed health. An inventory of issues and a report on case studies. In: https://www.liveseed.eu/wp-content/uploads/2021/02/LIVESEED_D2.5-Inventory-of-scientific-legal-and-technical-measures-to-improve-seed-quality-in-organic.pdf

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