Increasing the efficiency and competitiveness of organic crop breeding (ECOBREED)

WP 3 – Potato

Peter Dolničar, WP leader

Ljubljana, 15-16 June, 2020

Partner institutions:

- Kmetijski inštitut Slovenije (KIS)
- Newcastle University (UNEW)
- Plant Breeding and Acclimatization Institute (IHAR)
- University of Pannonia (UNIPAN)

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WP 3 – Objectives

- Perform a detailed phenotypic analysis of the potato core collection identifying traits suited to organic potato production systems.

- Improve the quality of organic ware and seed potato production.

- Production of new potato cultivars and breeding materials suitable for organic production.

- Produce superior elite breeding line(s) with durable field resistance to multiple *P. infestans* races.

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WP 3 – Y2 overwiev

Year 2019

- Planting in Slovenia and in Hungary done in May
- Crop husbandry
- Evaluations during growing season 2019
- Harvest
- Tuber phenotyping and quality analyses
- Late blight experiments
- Crossings and breednig progamme during the year
- Data and report preparation

Year 2020 – unitil April

Planting done at different tasks of WP3

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WP 3: Tasks

Task 3.1: Screening of genetic resources and breeding material (months 13-52)

Task 3.2: AMF-compatibility screening: start in 2020 (months 13-36)

Task 3.3: Improving seed tuber quality and vigour via the use of cover crops (months 25-54)

Task 3.4: Colorado potato beetle and wireworm control strategies (months 25-54)

Task 3.5: Marker assisted selection in organic breeding (months 13-60)

Task 3.6: Production of elite varieties and advanced breeding lines (months 19-60)

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Task 3.1 Screening of genetic resources and breeding material

- Working collection of 65 potato varieties and clones grown in phenotyping trials in 4 countries in 2019: SLO, UK, POL, and HU (trial failed)
- Additional clones and varieties planted: SLO (3), UK (2) and POL (8)
- Separate late blight field trials performed in SLO and POL
- Separate late blight laboratory tests (detached leaflet tests and tuber slice test) performed in POL

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Task 3.1 Screening of genetic resources and breeding material 2019

- Phenotyping trial Background data recorded

- Evaluation during main vegetative stages
  - Potato Phenological growth stages (BBCH-identification keys)
  - Plant and canopy growth assesment
  - Diseases, Pests and Viruses

- Potato harvest and evaluation of tuber quality
  - Assesment of morphological characters of potato tubers
  - Assesment of tuber disorders and diseases
  - Assesment of cooking quality of potato

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Task 3.1 Screening of genetic resources and breeding material

- Average yields differed bretwen the countries: the highest in POL (average 40,4 t/ha), the lowest in SLO (12,13 t/ha – early variety trial, the highest yield 25t/ha KIS Savinja)

- Big differences in tuber yields between varieties (in UK at some varieties no yield – rotten tubers due to LB infection)

- Different best performing varieties in different countries

- The top varieties for tuber sizes and tuber numbers were similar across the countries

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Task 3.1 Screening of genetic resources and breeding material

Late blight field trials (Slovenia):

- The most resistant varieties from WC: Alouette, Bionta, Caprice, Carolus, Delila, Gardena, Kelly, KIS Kokra, Levante, Nofy, Otolia, Sarpo Mira, Sarpo Shona, Tajfun, Tinca, Twister, Twinner, Yona and 12-LHI-6 and *KIS 07-136/164-11*.
- Some varieties graded as resistant in the cathalogues and by the breeders were highly infected with late blight.
- Many resistant varieties were susceptible to early blight (Alouette, Twister…).

Laboratory test – detached leaflets assays (Poland):

- The most resistant varieties were: Alouette, Carolus, Delila, Gardena, Kelly, KIS Kokra, Levante, Nofy, Otolia, Sarpo Mira, Sarpo Shona, Tinca, Twister, Twinner and Valor, and the group of 8 breeding lines: 12-LHI-6, *PL 18-IX-238, PL 18-IX-182, PL 18-VI-104, PL 18-VII-16, PL 18-VII-62, PL 18-VII-73* and *PL 18-VII-79.*

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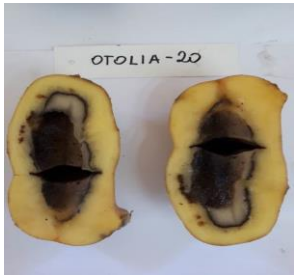
Task 3.1 Screening of genetic resources and breeding material

- Presence of disorders: some varieties produced tuber disorders



- Cooking quality differs among countries due to different growing conditions.

- Dry matter content differed among countries as well.

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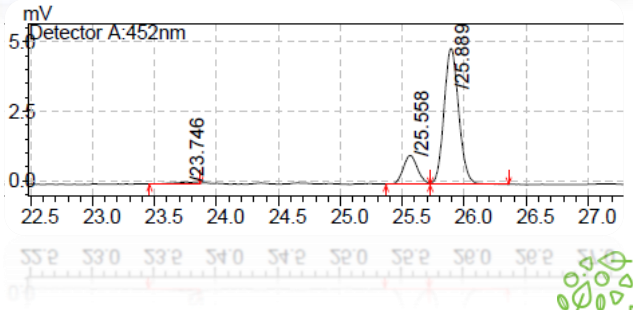
Additional screening WC in Poland :

- total carotenoids (TC)
- individual carotenoids (lutein and zeaxanthin)



Preparation of samples for analyses of quality compounds

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Task 3.1 Screening of genetic resources and breeding material in 2020

- Phenotyping experiments planted in all four partner countries (all experiments emerged and are in good conditions in May, evaluation starts)
- Conventioanal phenotyping of potato
- Late blight experiments planted in Poland and in Slovenia
- Preparations for preliminary Advanced Phenotyping at UNEW and KIS

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Task 3.2: AMF-compatibility screening

AMF Evaluation of potato

Newcastle University

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Variety Name	Classification P. Infestans	Classification PVY	Maturity	Classification Maturity	2019 Tuber Yield	2019 AUDPC L.Blight	2019 AUDPC E.Blight
SARPO MIRA	very high	ER	Late	very late	35.5	0	1098
AGRIA	low	high	late	late	30.5	2250	0
OSPREY	low	high	Medium	second early	27.2	0	0
TINCA			na		35.6	0	0
12-LHI-6			na		50.7	0	0
LEVANTE	high		na		34.0	0	0
TWISTER	high		early	early	48.1	0	0
SARPO SHONA	high		late	late	22.6	0	0
COLLEEN	low	moderate	early	very early	36.3	750	0
CASABLANCA	moderate	low	early	very early	17.4	0	0
GATSBY	low	moderate	Medium	second early	35.7	1500	0
AMBO			early	early	30.3	1500	0
CARA	high	high	late	late	30.0	525	0
CHARLOTTE	low	moderate	Medium	second early	26.3	0	0
VALOR	moderate	low	late	late	28.6	525	0
LILLY			Medium	second early	13.9	2250	0
TAYFUN	moderate		Medium	second early	43.5	0	0
INCA BELLA	moderate	low	late	late	16.8	0	0
CAPRICE	high	high	Medium	second early	9.6	0	0
SALOME	high	high	early	very early	25.0	0	0

20 potato varieties selected on the basis of maturity, blight levels etc from the 2019 field trial at UNEW

Commercial AMF inoculant INOQ Advantage (*Rhizoglomurus irregulare*, *Funneliformis mosseae*, *Funneliformis caledonium*)

10 week inoculation from 10th Mach – 18th May 2020

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TASK 3.3 Improving seed tuber quality and vigor via the use of cover crops

- Test plots for seed multiplication (organic certified) with selected potato genotypes (from Task 3.1) and a range of cover crops will be established (6 selected species/mixtures) in the UK and Slovenia

- Cover crops will be planted in August 2020

- Potatoes varieties will be planted across in 2021

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TASK 3.4 Colorado potato beetle control strategies

- Aim: to evaluate some innovative CPB control strategies in potato fields
- Two experiments will be set: at KIS and at UP
- Both are based on complete randomized block design

Experiment UP

1. Unsprayed control
2. Conventional chemical control
3. – 6. Different organically allowed compounds

Experiment KIS

1. Unsprayed control
2. RNAi,
3. Beauveria bassiana (KIS isolate),
4. Beauveria bassiana + spinosad
5. Spinosad (Laser Plus*)

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TASK 3.4 Wireworm control strategies

- Aim: to evaluate some innovative wireworm control strategies in potato fields
- We set up two experiments (23.4.2020 and 27.5.2020)
- Both are based on complete randomized block design

Zaščita 1 vrsta							
4	1	2	2	6	3	5	3
1	4	1	4	5	1	2	2
5	6	3	6	4	2	1	5
3	5	4	1	2	4	3	6
2	3	5	3	1	5	6	4
6	2	6	5	3	6	4	1
Zaščita 1 vrsta							

Experiment 1

Zaščita 1 vrsta					
4	1	2	2	6	3
1	4	1	4	5	1
5	6	3	6	4	2
3	5	4	1	2	4
2	3	5	3	1	5
6	2	6	5	3	6
Zaščita 1 vrsta					

Experiment 2

1. Attracap (30 kg/ha)
2. Attracap (15 kg/ha)
3. KIS entomopathogenic fungi
4. KIS entomopathogenic fungi + rice formulation
5. Force
6. Negative control

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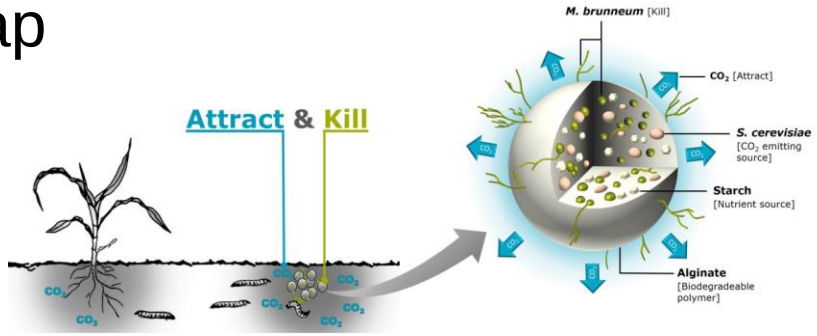
- We had 6 treatments in the experiment, namely:
- **Force** - <u>chemical insecticide</u>
- **Attracap** - <u>granular biological insecticide</u>
  - »attract and kill« principle
  - wireworms are known to be attracted by sources of CO2. In the granules of Attracap we have yeast, starch and entomopathogenic fungus *Metarhizium brunneum*.
  - granules are placed in moist soil -> yeast start to produce CO2 (“attract” part) -> wireworms get closer to the granules -> contact with the entomopathogenic fungi, (“kill” part) -> spores attach to the cuticula of the larvae and invade their body -> wireworms die
- In the experiment we used full dose and half dose of Attracap



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- At the institute we also have our own isolates of entomopathogenic fungi that have proven to be quite effective
- We prepared spore suspension and soaked the potato tubers in this suspension
- spores would attach to the surface of the potato, then we dried the potatoes and plant them the next day

Healthy wireworm

Mycosed wireworm

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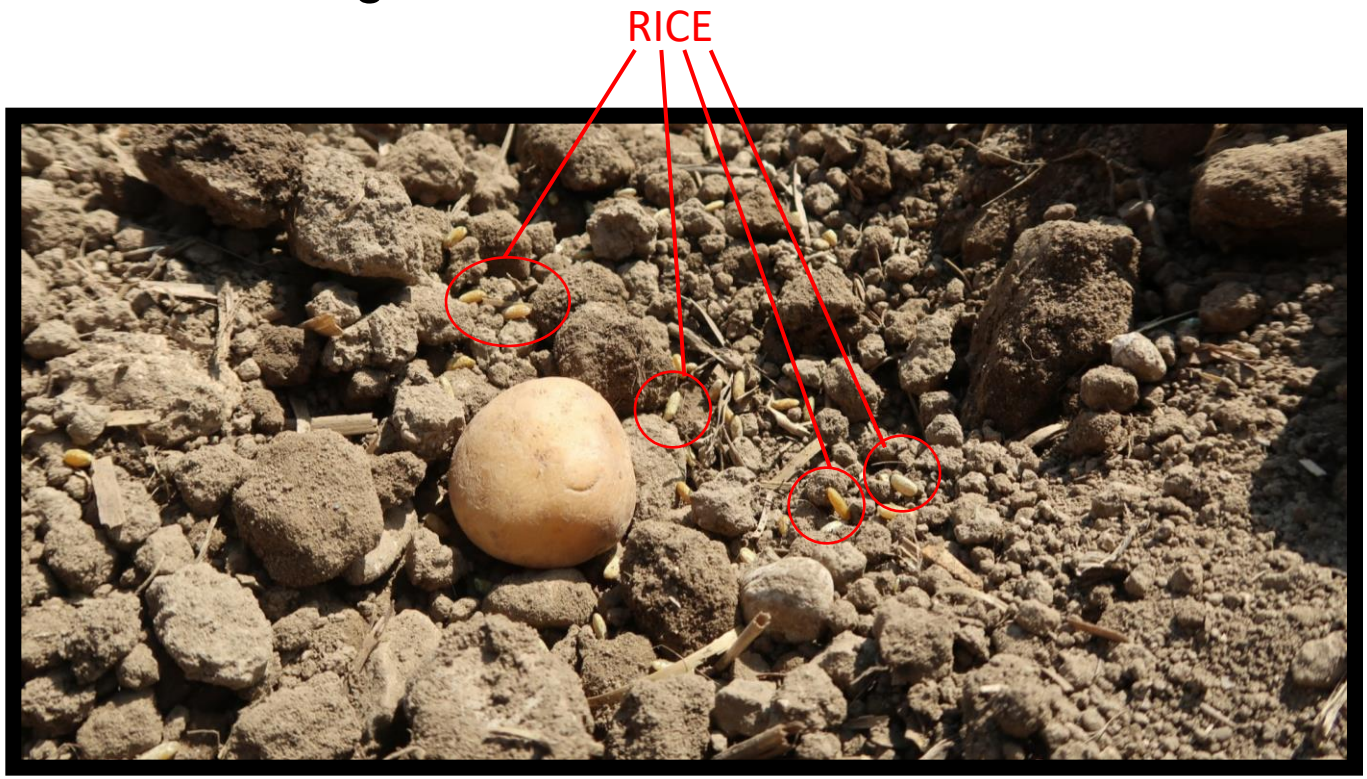
- In the last treatment we also used tubers soaked in spore suspension, however when we planted the potatoes we also added the same fungal isolates that were multiplied on the rice. Just to have in mind: <u>rice is here just a carrier for mass production of the fungi</u>



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Task 3.5 Marker assisted selection in organic breeding

Successful new crosses with resistant progenies in 2019:

Crosses Slovenia	Number of berries
Twister x KIS Slavnik	8
Edony x Carolus	7
Cvetnik x Carolus	3
Meireska x Twister	3
Edony x Twinner	8
Meireska x Sarpo Mira	6
Manitou x Sarpo Mira	7
Sum	**42**

Crosses Hungary	Number of seeds
White Lady x S440	2,700
White Lady x Red Scarlet	300
Sárvári borostyán x Belena	50
Agria x FH97.029.02	200
10.165 x Denar	50
95.392 x Denar	400
Sum	**3,700**

- Potatoes grown on the brick for new crosses between resistant parents at KIS, preparations for crossings at IHAR and UP in 2020.

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Task 3.5 Marker assisted selection in organic breeding

Planting populations from previous years:

Slovenia:

- Breeding populations combaining *R8* and other res. genes from previous years was planted and evaluated in the field in single hills from the crossing year 2017 and four hills plots form the crossing year 2016 in the year, 2019 and selected genotypes replanted in 2020 as four and ten hills plots and single hills from crossing year 2018.

- Molecular markers for PVY and LB resistant genes will be used for exploiting the progeny populations and advanced clones.

Poland:

- In 2019 two unselected populations (15-V-271 x 15-V-54 and 15-V-255 x 15-V-54) combining the genes *Rpi-phu1* and *R8* were planted in field conditions.

- Molecular markers for PVY and LB resistant genes will be used for exploiting the established progeny populations and advanced clones

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Task 3.6 Production of elite varieties and advanced breeding lines - Slovenia

- New crosses with resistant parents at KIS in 2019

Crosses	Number of berries
Alouette x Sarpo Mira	8
Twinner x Sarpo Mira	22
Sum	30

- Potatoes grown on the brick at KIS for new crosses between resistant parents in 2020 preparations for crossings at IHAR and UP in 2020
- Selected families are grown in greenhouse and in the field in 2020.

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Task 3.6 Production of elite varieties and advanced breeding lines - Poland

Planting populations from previous years:

Slovenia:

- Breeding populations combaining *R8* and other res. genes from previous years was planted and evaluated in the field in single hills from the crossing year 2017 and four hills plots form the crossing year 2016 in the year, 2019 and selected genotypes replanted in 2020 as four and ten hills plots and single hills from crossing year 2018.
- Molecular markers for PVY and LB resistant genes will be used for exploiting the established progeny populations and advanced clones.

Poland:

- In 2019 fourteen outstanding advanced breeding lines combining optimal agronomical traits and high level of LB resistance from the 15-V-255 x 15-V-54 progeny were planted and assessed in term of LB resistance.

- In 2020 ~180 advanced breeding clones combining optimal agronomical traits and high level of LB resistance were planted in the field.

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Milestones

- MS 9 - Phenotypic data management system produced for partners: done in D3.1

- MS 10 – AM-mycorrhizal soil inocula strains received for partners: UNEW is the only partner involved with implementation of the Task 3.2, so they already had the inocula to work with

- MS 11 – Selection of suitable markers for screening, sharing of protocols between partners, allocation of traits between partners: partneres working on Tasks 3.5 and 3.6 KIS, IHAR and UP exchanged the informations about the molecular markers for LB and PVY resistance used in their breeding programmes

- MS 18 – Order of cover crop seed for seed multiplication evaluation

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Problems encountered – general problems in 2019

Rather late seed delivery (the last seed delivery in the middle of April.
In Slovenia and Hungary late planting of phenotyping trial as a result of that.
Bad weather in central eastern Europe in 2019 (Slovenia and Hungary):

- very cold and wet May (the coldest and wettest May in the last 40 years in Slovenia),
- Extreme high temperatures in the second half of June, July and August (up to 35 degrees).

Late emergence and poor vegetative growth (low yields) in Slovenia.
Brexit – ongoing problem

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