ALS-inhibitors tolerance in sugar beets -

an innovative concept of weed control




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ALS-inhibitors tolerance in sugar beet

- The concept of ALS-inhibitor tolerance in sugar beet
- Basics about the ALS-inhibitors tolerance
  - How it was found
  - How it was integrated into high yielding hybrids
- What do we expect from this new technology?
- Timeline
- Comparison with other herbicide tolerance concepts, e.g. Clearfield & RR
- Resistance management

What should we understand by ALS-inhibitors tolerance in sugar beets?

Modern Sugar Beet Hybrids*

+

Dedicated Herbicide based on ALS-inhibition**

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**varieties completely tolerant to ALS-inhibitor herbicide*

*** broad efficacy against all major weeds*

Basics of ALS-inhibitor herbicide tolerance

- The concept is based on changes in the gene for acetolactate synthase, which happen naturally, but rarely, during cell division

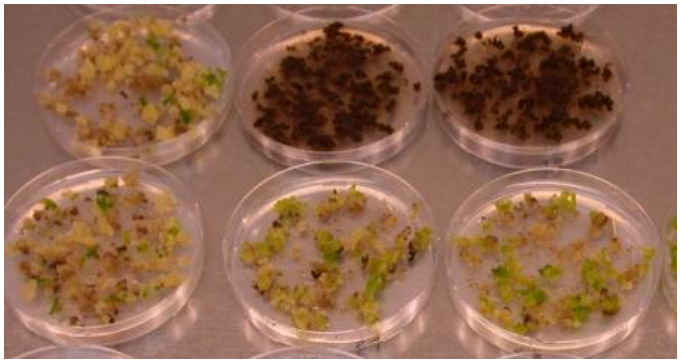
- The tolerance was not created, but occurred spontaneously in cultivated sugar beet cell cultures

- Out of 1.5 billion cells one single herbicide-tolerant cell was detected, which formed the basis for the development of the new system.
  This is equivalent to one single sugar beet plant out of 15.000 ha beet production

- In ALS-inhibitor tolerant sugar beets the ALS-inhibiting herbicide can’t bind with ALS enzyme responsible for production of essential amino acids, production of proteins is not blocked therefore sugar beet continues growing normally

Basics of ALS-inhibitor herbicide tolerance

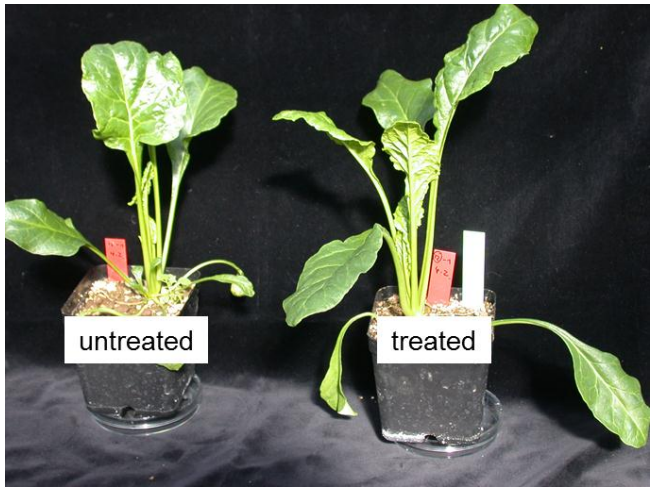
- The resistant sugar beet cell cultures were selected in cell and tissue cultures and subsequently regenerated to sugar beet plants



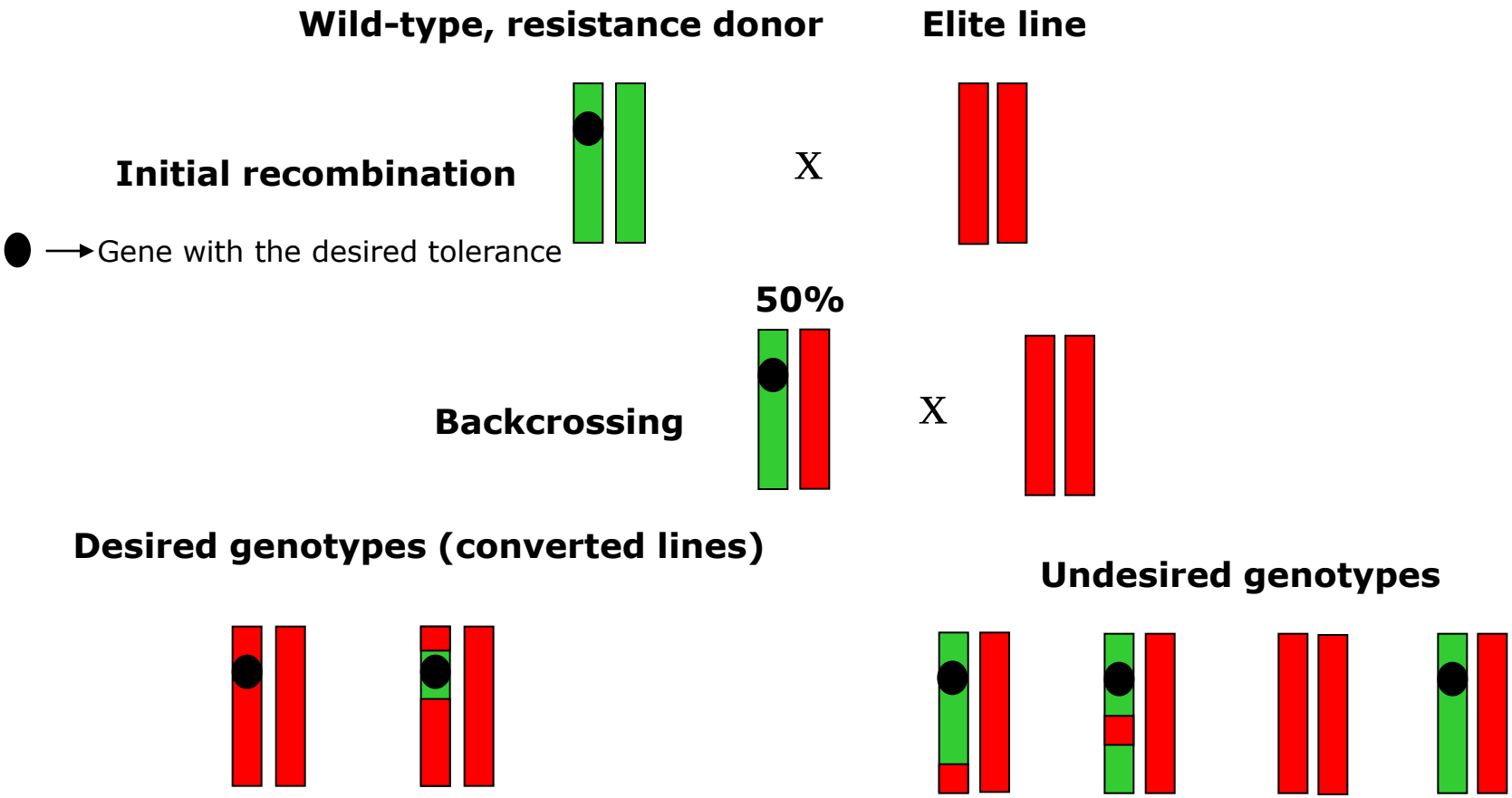
- This new plant is the "donor" in the back crossing method, to transmit the characteristic in the existing gene pool

Susceptible conventional line

Tolerant "donor" plant

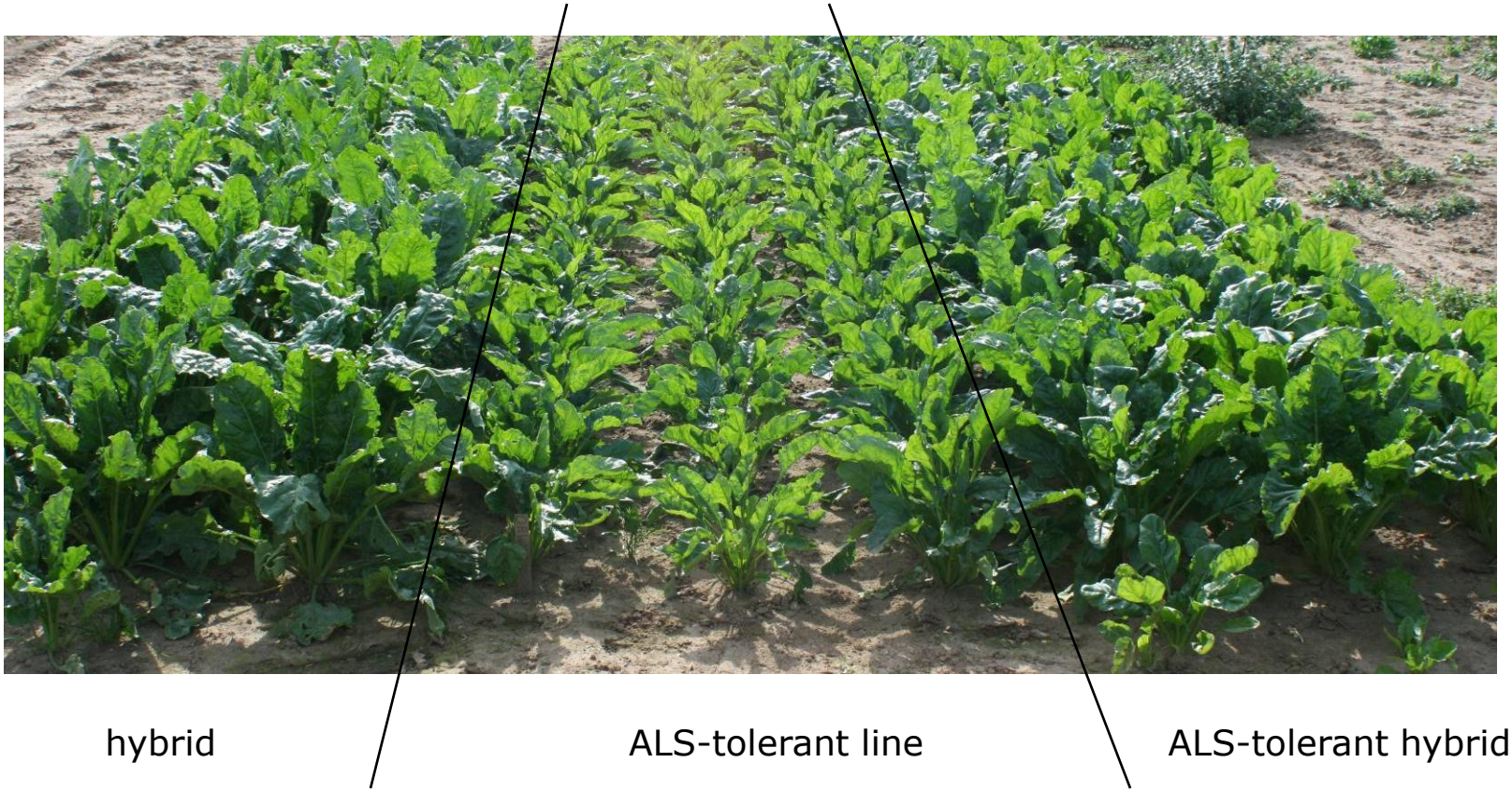


Principle of marker assisted backcrossing



- With the use of special markers desired genotypes are selected: Backcrossing continues until the new line is identical to the Elite line, but with the desired gene which provides the tolerance

2011: First ALS-inhibitors tolerant hybrid



hybrid | ALS-tolerant line | ALS-tolerant hybrid

Experimental ALS-inhibitor tolerant hybrid: Weed control performance

Model trial:
ALS-tolerant hybrid untreated

Model trial:
ALS-tolerant hybrid treated with ALS-herbicide

What do we expect from this new technology?

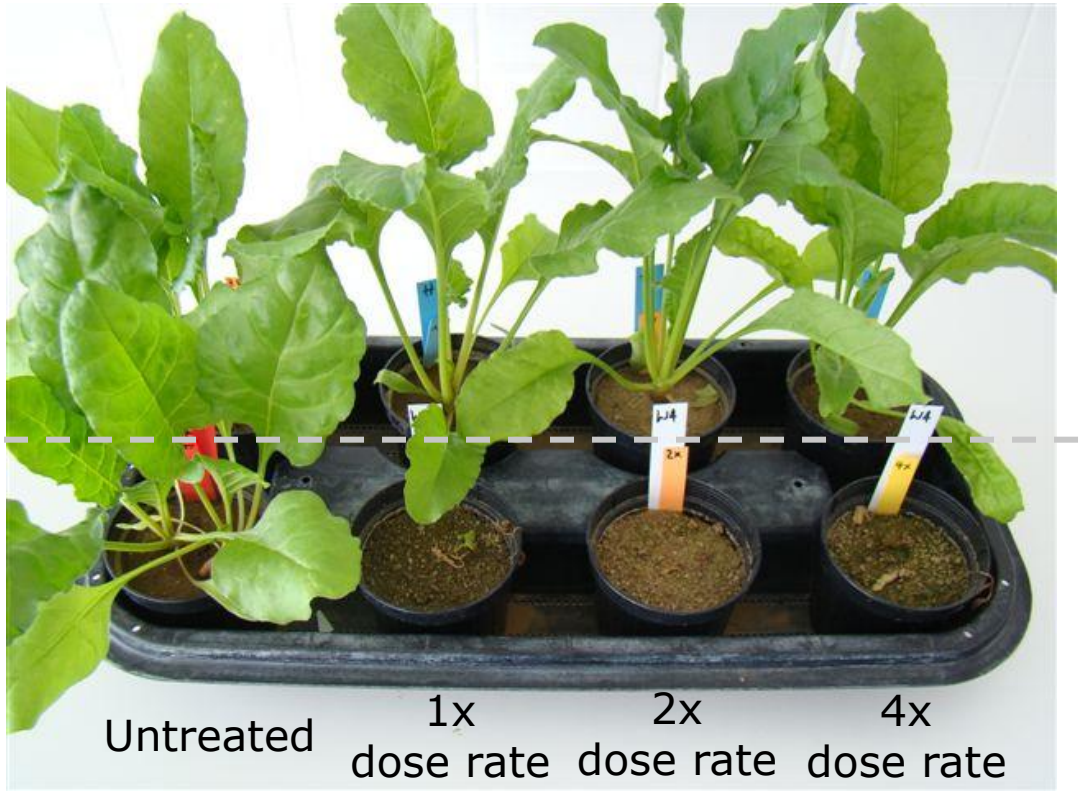
- Broad and reliable efficacy against all major weeds
- Fewer herbicide applications compared to conventional methods: season-long control based on only 1-2 applications
- Lower application rate, less release of herbicidal active substances into the environment
- Wide and flexible window for herbicide applications
- Leaf -active and residual control components
- Full product, no need for tank mixtures, simple spray solution preparation
- Unique opportunity to eliminate weed-beets (Volunteer plants of none ALSI tolerant sugar beet)

Most important weeds species in European sugar beet under control

- ✓ Agropyron repens
- ✓ Alopecurus myosuroides
- ✓ Apera spica-venti
- ✓ Cereals
- ✓ Echinocloa crus-galli
- ✓ Poa annua
- ✓ Aethusa cynapium
- ✓ Amaranthus retroflexus
- ✓ Anthemis sp.
- ✓ Atriplex patula
- ✓ Capsella bursa-pastoris
- ✓ Chenopodium album
- ✓ Cirsium arvense
- ✓ Convolvulus arvensis
- ✓ Galium aparine
- ✓ Lamium purpureum
- ✓ Matricaria chamomilla
- ✓ Mercurialis annua
- ✓ Polygonum aviculare
- ✓ Polygonum convolvulus
- ✓ Polygonum lapatifolium
- ✓ Polygonum persicaria
- ✓ Raphanus raphanistrum
- ✓ Senecio vulgaris
- ✓ Sinapis arvensis
- ✓ Solanum nigrum
- ✓ Sonchus arvensis
- ✓ Stellaria media
- ✓ Thlaspi arvense
- ✓ Viola arvensis

What do we expect from this new technology?

- Crop safety:
  - No impact on crop development since 100%-tolerance to corresponding herbicide
  - Full utilization of yield potential



ALSI tolerant hybrid

Susceptible standard hybrid

When new system should be available in the Market?

- The system will be made available to local crop institutes and consulting partners in the next years to jointly verify ways to further optimize cultivation practices in sugar beet
- The authorization procedure of both components, varieties and herbicide, will be synchronized
- It is intended to develop the technology in all relevant sugar beet markets

Start basic research — **2001**

Patent & Press-release — **2012**

Development & Evaluation trials

Approval & Market launch — **2017-2020**

Is this the same system as Clearfield?

- **The basic idea is similar:**
  - What is involved is the use of an ALS inhibitor herbicide in a non-genetically modified crop.

- **But the result is different:**

  - Due to the nature of the crop, in sugar beet the harvest takes place before plants enter the flowering stage. This means there is no pollen flow and no seed production; therefore little risk of presence of volunteer beet plants

  - Complete herbicide product, under normal conditions no need for a mixing partner or sequence application with other herbicides

  - Herbicide product with well-balanced foliar and residual activity ensures continuous weed control independently on soil moisture status

What if we compare this technology with Round-up?

- It is a non-GMO solution, it corresponds to a natural selection and conventional breeding
- By the combination of foliar activity and residual activity components in the soil, fewer sprayings should be necessary, which will eventually lead to savings on energy and CO_2 reductions
- Lower release of herbicidal active substances into the environment
- No risk of damage by residues of ALS herbicides commonly used in other crops

Resistance management

- Permanent utilization of herbicides with the same mode of action in all crops during crop rotation produces a higher selection pressure.

- This is also the case for herbicides inhibiting the ALS, therefore principles of integrated weed management should be followed:
  - Well-ordered crop rotation
  - Use of different herbicidal mode of actions across crop rotation
  - Change of active substance or tank mixture ALS inhibitors with other mode of action
  - Adequate soil cultivation and cropping records

- Weed species, which can develop resistance rapidly, should be observed considering several aspects:, e.g.:
  - Genetic variability within the species
  - Emergence and growth properties
  - Population size
  - Seed production and persistence of the seeds

Conclusion

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Modern Sugar Beet Hybrids + **Dedicated Herbicide based on ALS-inhibition**

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Thanks for your attention!