

PUBLIC-PRIVATE PARTNERSHIP INVESTIGATING EUROPEAN CARROT GENETIC RESOURCES IN EVA CARROT



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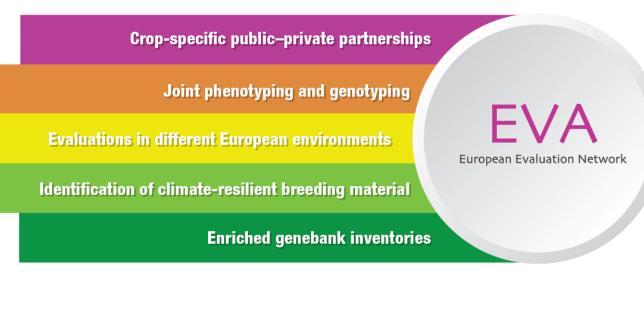
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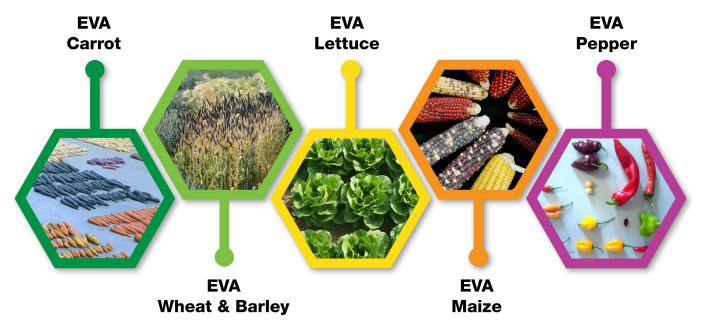
European Evaluation networks – an ECPGR initiative to increase use of genetic resources in Europe

The ECPGR European Evaluation Network (EVA) for Plant Genetic Resources for Food and Agriculture is an international project aimed at increasing the use of crop genetic diversity and the diversity of stakeholders in plant breeding.

EVA is of strategic importance for Europe and provides an opportunity to promote sustainable use of PGRFA to facilitate the adaptation of European agriculture to climate change and to contribute toward Sustainable achieving related Development Goals (SDGs). In collaborative projects involving public and private sector partners, EVA is generating standardized evaluation data (both phenotypic and genotypic data) for crop accessions and numerous available in European landraces genebanks. EVA is implemented through crop-specific networks, covering both

cereal and vegetable crops.





The EVA Carrot network

The EVA Carrot network is one of three vegetable networks currently functional within EVA.

The EVA Carrot network has 14 partners from 8 European countries, including 8 breeding companies, genebanks, universities and research institutes. Network partners provide their complementary expertise and capacity and together generate extensive datasets that will help identify interesting materials among the evaluated accessions to be included in future breeding activities. Regeneration of carrot landraces is an important aspect of the EVA carrot network, to ensure availability of materials for breeding and research.

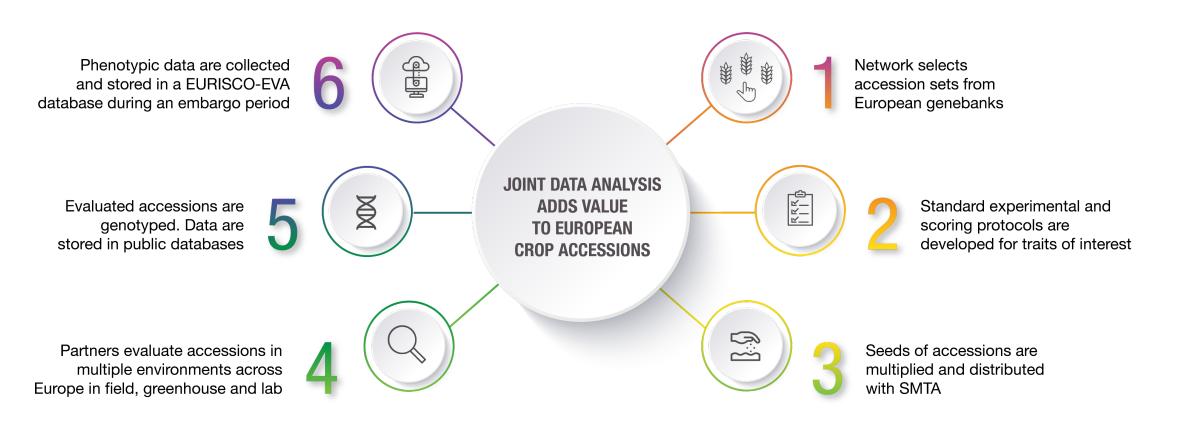
2020	2	021	2022	2023	
regeneration	Field evaluations	genotypin	g Field evaluations	Data analysis: GxE, GxP	



Countries participating in EVA Carrot

The EVA Carrot workplan for 2020–2023 foresees regeneration activities, genotyping, phenotypic evaluation and data analyses exploring the genetic and environmental effects on the observed phenotypes.

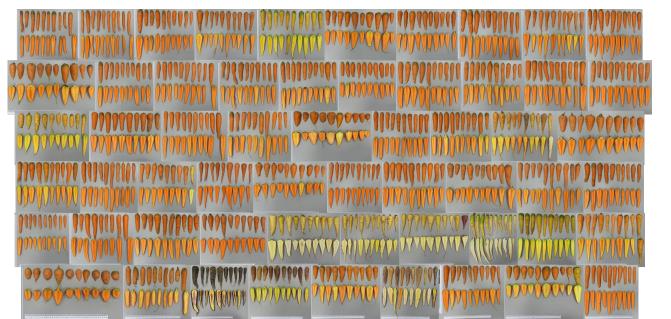
How the EVA crop networks operate



https://www.ecpgr.cgiar.org/european-evaluation-network-eva

Preliminary phenotypic data

Sixty carrot accessions from four European genebanks have been extensively evaluated during two field seasons. Preliminary results show phenotypic variation that can be attributed to genetic and environmental effects. More detailed analysis of all datasets is ongoing.



Bolting behaviour

Most accessions did not bolt whatever the trial or the country of origin (A). Seven accessions from Spain showed high bolting percentages, except in southern trials in Italy and Spain. The latitude around 42° seems to be a limit for sensitivity to bolting for these accessions. Interestingly, the sensitivity to bolting of carrot accessions followed the same pattern whatever the trial (B). This trait appears to be stable depending on the accession.



root position at soil Meloidogyne incognita Cavity spot brix degree on juice Meloidogyne hapla Sclerotinia foliage width/volume General root quality root branching germination root length leaf blight root shape root surface Alternaria radicina root fip/end shape nematode damages Mycocentrospora acerina ca root cracking Alternaria dauci root fly damages seedling vigour leaf type Meloidogyne javanica percentage of bolters red leaves leaf growth habit black spot damages Cercosporina outer core pigmentation bolting tendency Powdery mildew root diameter Iternaria alternata

EVA-Carrot trial locations

Phenotypic evaluations were conducted over two years in ~30 laboratory and field trials. Traits of interest for carrot breeding included agronomic and quality characteristics as well as resistance or tolerance to important pests affecting carrot production.

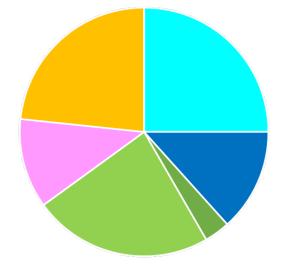
Diversity of carrot genetic resources in Europe

Genotyping of the 60 EVA Carrot accessions from 16 countries used an approach combining genotyping by sequencing (GBS), whole genome resequencing and a novel SNP-array under development.

Preliminary clustering and principal component analysis of SNP array data from 60 EVA accessions and six cultivars (including genome reference DH1) show a connection between material origin and genetic structure. Spanish accessions group together as do old cultivars with white and yellow root colouring.

Array

Origin of 60 EVA carrot accessions



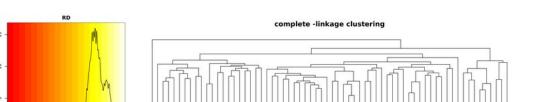
Provider	SGS TraitGenetics (Gatersleben, DEU)	Plateforme d'Analyses Génomiques (IBIS/ULAVAL) Quebec (CA)	GenomeCentre (IPK Gatersleben, DEU)
Technology	Axiom platform (40K)	GBS Library, Pstl/Nsil/Mspl for Illumina660	Nextera DNA Flex, Illumina66- S1XP300cycle (~500GB)
EVA samples	66	10 x 66 = 660	66
SNPs generated	41.971	36.284	Exp. > 3 Mio.
Informative SNPs	24.879	16.717	Exp. > 100.000
	59%	46%	

GBS

WGS

Northwest Europe Northeast Europe Central Europe South Europe East and Southeast Europe Southwest Europe

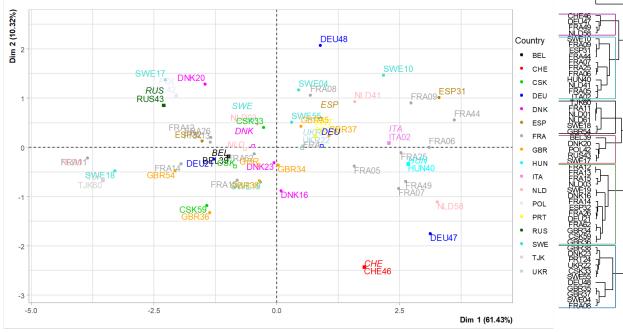
Origin countries of EVA accessions: Northeast Europe (GBR, SWE, DNK); Northwest Europe (BEL, NLD, DEU); South Europe (ITA); Central Europe (FRA); East and Southeast Europe (CSK, CHE, HUN, POL, RUS, TJK); Southwest Europe (ESP, PRT).



Phenotypic diversity of 60 accessions evaluated in EVA-Carrot in 2020-2021. © E. Geoffriau

Foliage width and volume

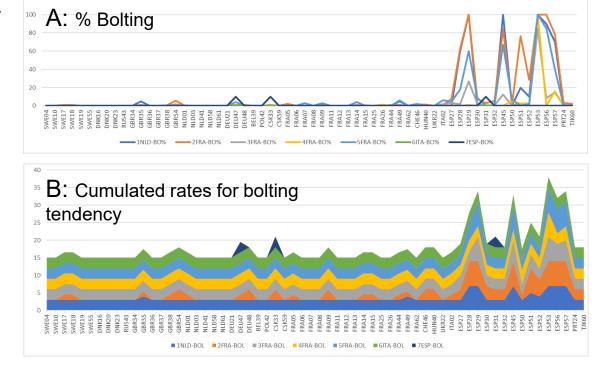
A large diversity was observed for the importance of the foliar development given by the rating of the width-volume of the foliage, from low to high following the axis 1 of the principal component analysis over 7 trials in Europe. A relative convergence between location was noted. The variation for these traits depends more on the carrot type than on the country of origin. In particular, the clustering shows some Nantes type accessions grouped together, as well as some white/yellow rooted accession from France, Switzerland and Germany, exhibiting a close genetic background. Logically, early types tend to be in the same cluster. Unkown type of some accessions may be inferred.



Distribution and hierarchical classification of EVA carrot accessions for foliage width-volume (2020 data, 115 days after sowing, bolting accessions excluded, data from 7 trials in Europe, distribution from low to high volume on axis 1 from left to right).

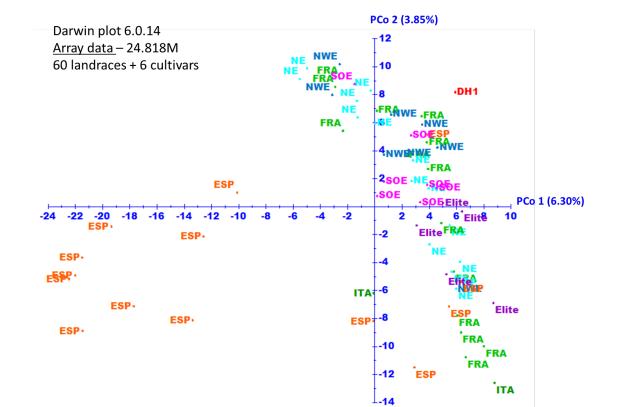


Bolting accessions in field trial in Southern France 2020. © Takii



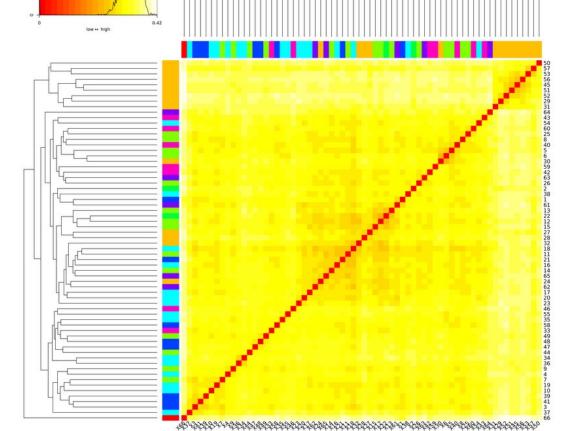
Evolution of bolting percentage (A) and bolting tendency (B) depending on the trial latitude and country of origin of EVA carrot accessions (2020 data, 115 days after sowing, rates cumulated from northern to southern trials, accessions sorted by the latitude of country of origin)

V cita



Principal component analysis of EVA carrot accessions based on ~24k markers of SNP array.

RIJK ZWAAN



Dendrogram of genetic diversity of EVA Carrot accessions based on genotyping with novel SNP array.

Conclusions

These first observations on two traits of interest for the valorization of carrot accessions give an appreciation of the variability among a European collection depending on the accession and the interaction with the environment. This study gives indication on the behaviour of original genetic material. More than 30 morphological and evaluation traits have been observed over 2 years and 10 trials. Besides the level of variation, the descriptors more sensitive of the environment or accession dependant will be identified for a better genetic resources management and a facilitated use in carrot breeding.

Building on experiences of collaborative projects such as the French Daucus network and CarrotDiverse and the expertise of the ECPGR Umbellifer Crops Working Group and participating partners, the EVA Carrot Network established itself as a valuable initiative to promote the conservation and sustainable use of carrot genetic resources.

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