Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources

ISSN 1742-3694 (Online)

www.farmerspride.eu

Crop wild relative

Issue 12 September 2020

Conserving plant genetic resources for use now and in the future

Farmer's Pride - EU Horizon 2020 Framework Programme - Project 774271

Crop wild relative

Issue 12 September 2020

Editor:
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Design by:
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Layout by:
rjpdesign.co.uk

Front cover:
Pyrus syriaca (Wild pear)
in the Southern Palestinian
Territories

Photo:
Nigel Maxted

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Introgression breeding from crop wild relatives in eggplant landraces for adaptation to climate change

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Eggplant (*Solanum melongena* L.) is an important vegetable in many tropical and subtropical areas of the world. Many of these areas are already suffering dramatic modifications in the current agricultural environment due to climate change (Rosenzweig *et al*., 2014). Eggplant crop wild relatives (CWR) grow in a wide range of environmental conditions, including desertic areas and other highly stressful environments (Syfert *et al*., 2016). Some of these wild relatives have been found to be resistant or tolerant to some prevailing diseases and insect pests (Daunay and Hazra, 2012) that might have increased incidence as a result of higher temperatures.

Thanks to the initiative "Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives" (Dempewolf *et al*., 2014), we have used eggplant wild relatives for the improvement of eggplant landraces from areas vulnerable to climate change, such as Southeast Asia and West Africa.

Approach used

The approach used in these projects has been the so-called "introgressiomics" (Prohens *et al*., 2017), which calls for a broad use of CWR for developing multiple introgression breeding materials that can be easily integrated in breeding pipelines. Partners from Côte d'Ivoire, Egypt, Japan, Spain, Sri Lanka, and Taiwan have joined forces to develop and evaluate pre-breeding materials for resistance to biotic and abiotic stress and agronomic, fruit yield and quality traits. Also, several international and local breeding companies from different regions of the world have participated in the evaluation of pre-bred materials with introgressions from wild species.

Development of interspecific hybrids

In a first stage, multiple crosses were performed between six eggplant landraces (three from Côte d'Ivoire and three from Sri Lanka) with 35 wild accessions from 15 wild relatives from the primary (one species), secondary (11 species) and tertiary (three species) genepools (Figure 1). A total of 90 hybrid combinations between the six landraces and 14 wild species (all except the tertiary genepool species *S. sisymbriifolium*) were obtained (Figure 2). For the two other wild species from the tertiary genepool (*S. elaeagnifolium* and *S. torvum*) embryo rescue was used to obtain the hybrids, which were viable, but completely sterile in the case of the hybrids with *S. torvum*.

Development of backcrosses and introgression lines

As a result of backcrossing of the hybrids to the recurrent cultivated landraces, we developed 48 first backcross (BC1) ; Figure 3 and 36 second backcross (BC2) generations towards the respective *S. melongena* parents involving the primary genepool species *S. insanum* and eight secondary genepool species (*S. anguivi*, *S. dasyphyllum*, *S. incanum*, *S. lichtensteinii*, *S. lidii*, *S. linnaeanum*, *S. pyracanthos*, and *S. tomentosum*), as well as the tertiary genepool species *S. elaeagnifolium*.

A total of 87 progenies of second generations of selfing obtained by single seed descent from individually selected plants for tolerance to drought coming from 14 BC2 generations involving six wild species (*S. anguivi*, *S. dasyphyllum*, *S. incanum*, *S. insanum*, *S. lichtensteinii* and *S. lidii*) were also obtained. These materials are morphologically highly variable (Figure 4) and are potentially of interest for the development of drought-tolerant materials of eggplant.

Marker-assisted selection programmes have been undertaken for the development of introgression lines (ILs) sets with four wild species (*S. elaeagnifolium*, *S. dasyphyllum*, *S. incanum* and *S. insanum*). After several generations of backcross and marker-assisted selection, the first set of fixed introgression lines containing single introgressions of *S. incanum* has been developed (Gramazio *et al.,* 2017). This first set has been

Figure 1 **Fruits of eggplant CWR and landraces (large fruits in the center) used for introgression breeding.** **(Photo: Mariola Plazas).**

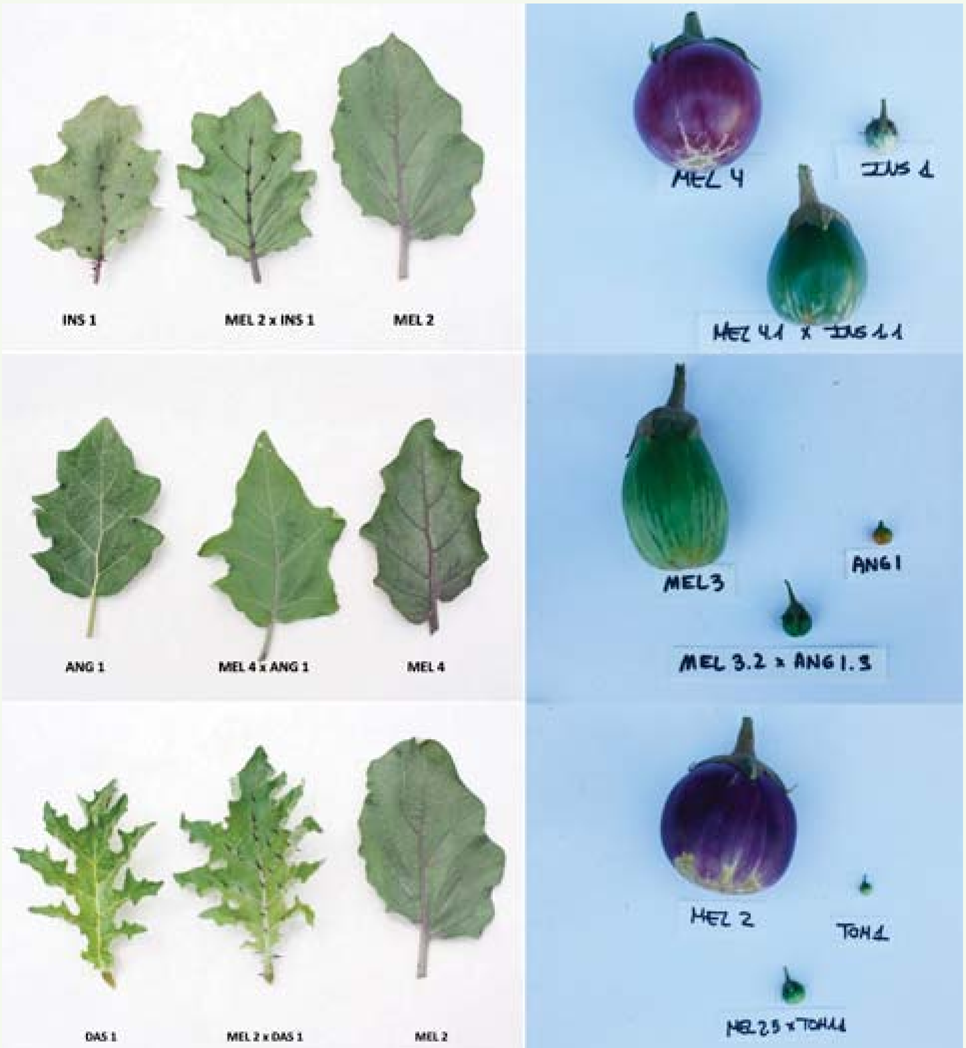
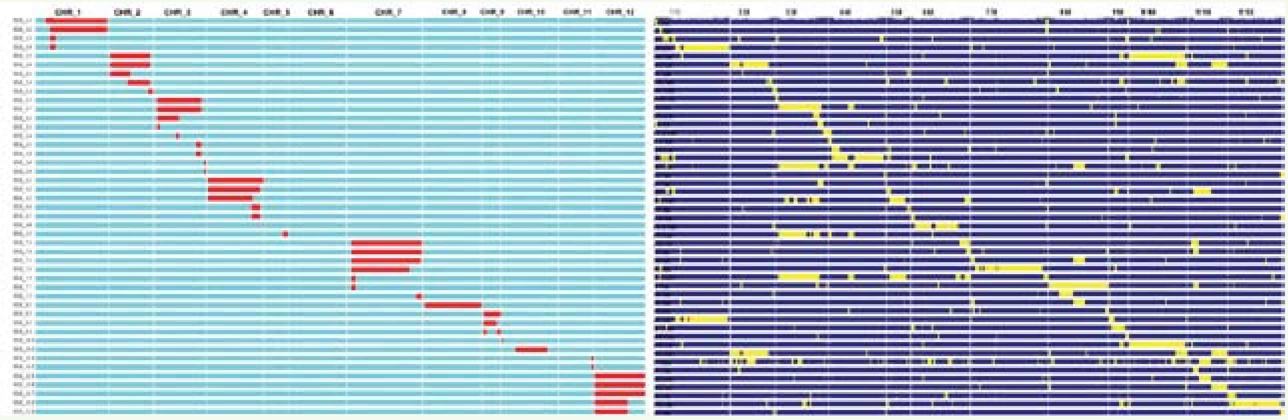


Figure 2 Leaves and fruits **of interspecific hybrids** between eggplant and CWR and their respective parents. The left part of the **figure displays the leaves of interspecific hybrids** between *S. melongena* and *S. insanum* **(above),** *S. anguivi* **(center) and** *S. dasyphyllum* **(below).** The right part of the **figure displays the leaves of interspecific hybrids** between *S. melongena* and *S. insanum* **(above),** *S. anguivi* **(center) and** *S. tomentosum* **(below). For** both leaves and fruits, the respective parents of **interspecific hybrids are** included. **(Photos: Jaime Prohens).**

Figure 3 **Fruits of four different plants of the first backcross (BC1) of the interspecific** **(Photo: Mariola Plazas).**

Figure 4 Sample of fruits from different BC2S2 progenies between eggplant and accessions of six eggplant CWR
(Photo: Jaime Prohens).

Figure 5 **Graphical genotypes of fixed introgression lines of** *S. incanum* **(left) and of the BC4 generation of** *S. insanum* **(right). Introgressions of** *S. incanum* and *S. insanum* are in red and yellow colors, respectively.



completed and at present 51 ILs with *S. incanum*, covering over 70% of the *S. incanum* genome, are available (Figure 5). New crosses and selfings are being performed to complete this set of ILs with *S. incanum*. The programmes with *S. dasyphyllum*, *S. elaeagnifolium* and *S. insanum* are advanced, and BC3 and BC4 generations have been selfed and/or backcrossed again to the *S. melongena* parents to finalize the selection of plants to be selfed for the development of fixed ILs (Figure 5).

Evaluation of materials

Throughout the process of development of eggplant materials with introgressions from CWR, different evaluations have been performed for biotic and abiotic stresses. Drought tolerance was found in several accessions in the CWR *S. anguivi*, *S. dasyphyllum*, *S. insanum*, *S. incanum* and *S. sisymbriifolium* as well as in interspecific hybrids of the three former species with *S. melongena* under different environments (Figure 6). High levels of resistance to different strains of bacterial wilt have been found in *S. sisymbriifolium* and *S. torvum*, while moderate levels of tolerance have been found in accessions of *S. anguivi* and *S. incanum*. Regarding tolerance to insect pests, high levels of resistance to sweet potato whitefly have been found in *S. campylacanthum*, *S. dasyphyllum* and *S. pyracanthos* and *S. tomentosum*, while for two-spotted spider mite the highest levels of resistance have been found in *S. dasyphyllum*, *S. sisymbriifolium* and *S. torvum*. In addition, resistance to spider mite was detected in *S. macrocarpon* and moderate resistance in *S. aethiopicum*.

Some interspecific hybrids were found to be very vigorous and displayed a powerful root system (Figure 7), which may account for increased tolerance to drought, as well as for enhanced vigour of the scion when eggplant is grafted onto vigorous interspecific hybrids of eggplant. Therefore, direct use of interspecific hybrids of eggplant with wild relatives as rootstocks is promising.

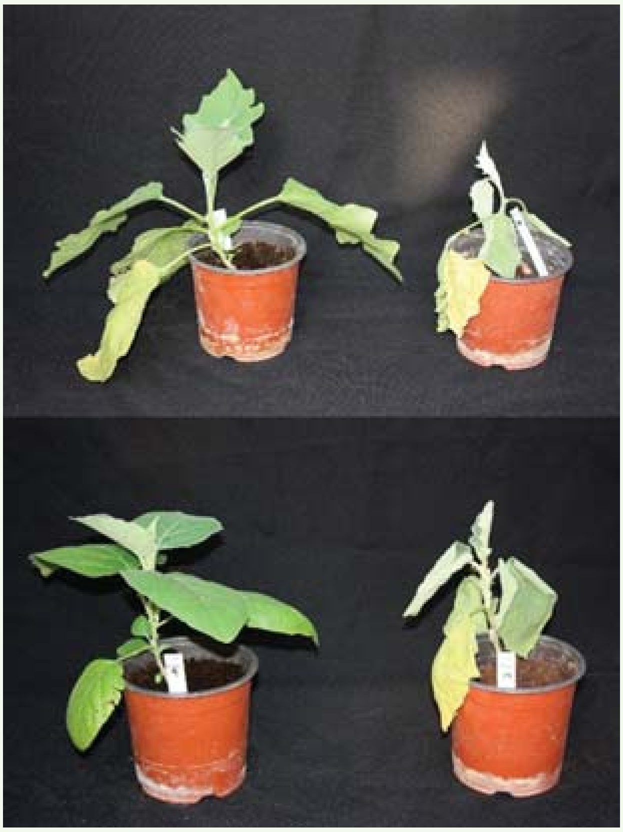


Figure 6 Comparison of the tolerance to water stress of **cultivated eggplant (above) and of the eggplant CWR** *S. incanum* **(right). The plants of the left are the irrigated** controls and the plants to the right the non-irrigated ones **(Photo: Mariola Plazas).**

Conclusions

Introgression breeding in eggplant landraces from areas particularly susceptible to climate change using a broad range of eggplant CWR could contribute to mitigate the impact of climate change in the production of this vegetable. The interspecific hybrids obtained, advanced backcross materials and introgression lines with multiple eggplant CWR are highly promising for broadening the genepool of eggplant and for adapting this crop to climate change. The evaluations performed up to now for tolerance to biotic and abiotic stresses and for other agronomic and quality traits indicate that the development of a new generation of eggplant cultivars with enhanced

Figure 7 Increased vigour for plant vegetative traits and **root system in an interspecific hybrid of** *S. melongena* with *S. tomentosum* **(Photo: Jaime Prohens).**

performance under the new environmental conditions resulting from climate change is feasible.

Acknowledgements

This work was undertaken as part of the initiative "Adapting Agriculture to Climate Change: Collecting, Protecting and Preparing Crop Wild Relatives" which is supported by the Government of Norway. For further information, please visit the project website: www.cwrdiversity.org/. Funding was also received from the European Union's Horizon 2020 Research and Innovation Programme under grant agreements 677379 (Linking genetic resources, genomes and phenotypes of Solanaceous crops; G2P-SOL) and 774271 (Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources; Farmer's Pride), and from Ministerio de Ciencia, Innovación y Universidades, Agencia Estatal de Investigación and Fondo Europeo de Desarrollo Regional (grant RTI-2018-094592-B-I00 from MCIU/AEI/FEDER, UE). Mariola Plazas is grateful to Generalitat Valenciana and Fondo Social Europeo for a post-doctoral contract (APOSTD/2018/014). Pietro Gramazio is grateful to Japan Society for the Promotion of Science for a post-doctoral contract (FY2019 JSPS Postdoctoral Fellowship for Research in Japan [Standard]).

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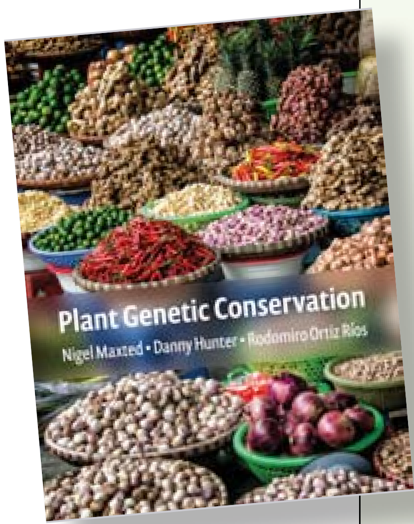
Book review

Maxted, N., Hunter, D. and Ortiz Rios, R.O., (2020). ***Plant genetic conservation****. 560 pp. Cambridge University Press, Cambridge. ISBN 9781139024297.*



Plant diversity sustains all animal life, and the genetic diversity within plants underpins global food security for humankind. This text provides a practical and theoretical introduction to the strategies and actions to adopt for conserving plant genetic variation, as well as explaining how humans can exploit this diversity for sustainable development. It initially offers current knowledge on the characterization and evaluation of plant genetic resources. The authors then discuss strategies from *in situ* and *ex situ* conservation to crop breeding, exploring how crop wild relatives can be used to improve food security in the face of increasing agrobiodiversity loss, human population growth and climate change. Each chapter draws on examples from the literature or the authors' research and includes further reading references. Packed with other useful features such as a glossary, it is invaluable for undergraduate, graduate students and professionals in plant sciences, ecology, conservation biology, genetics, and natural resource management. Drawing on the authors' wealth of experience, this up-to-date and long-awaited text provides a theoretical and practical introduction to the conservation and utilisation of plant genetic diversity, with a focus on sustaining global food security.