May 2017. Horticultural Plant Journal, 3 (3): 125–132.

Horticultural Plant Journal

Available online at www.sciencedirect.com
The journal's homepage: http://www.journals.elsevier.com/horticultural-plant-journal

Origin of the Domesticated Horticultural Species and Molecular Bases of Fruit Shape and Size Changes during the Domestication, Taking Tomato as an Example

SUN Liang [a,b,*], *CHEN Jie* [a,b], *XIAO Kai* [a,b], *and YANG Wencai* [a,b]

[a] *Beijing Key Laboratory of Growth and Developmental Regulation for Protected Vegetable Crops, Beijing 100193, China*
[b] *Department of Vegetable Science, China Agricultural University, Beijing 100193, China*

Received 26 December 2016; Received in revised form 20 February 2017; Accepted 24 April 2017

Available online 4 July 2017

A B S T R A C T

Domestication of crop plants is the foundation of modern agriculture, which brings forth desirable changes in cultivated species that distinguish them from their wild relatives. This resulted in the origin of crop species at known geographical locations coinciding with the transition of human societies from hunter-gather to agrarian civilizations. Fruit size and shape are very important traits for horticulture industry, as well as for studying the domestication of the horticultural species. In this review, we have summarized the origin of some widely-grown horticultural crops and also the molecular bases of the fruit size and shape changes of the horticultural crops during the domestication, taking tomato as an example.

Keywords: horticultural crops; domestication; fruit size; fruit shape; tomato

1. Introduction

Domestication is a subfield of evolution, in which the selection procedure is brought by human instead of nature. The domestication processes of most of the crop plants are not restricted in a small area where they originated, such as apple, and the main production area of a certain crop in modern agriculture industry is often not its origin (Cornille et al., 2014). Thus, it is necessary to trace the origin of the domesticated crops not only for scientific research but also for breeding, because the diversity of every species is often larger in the origin location than other places and it is highly possible to find valuable wild species for breeding in the origin site. There are several ways to trace the crop origin site, including analyzing and combining the evidence in the archeological, ecological, linguistic and genetic aspects. With the development of the high-throughput sequencing technology, it is much easier and more accurate to analyze the genomic diversities of a huge number of samples, which gives the researchers a new way to investigate and trace the origin sites of the crops.

In horticulture industry, fruit is a very important organ for selling, and its size and shape are important traits for the determination of its usages, for example, flat and large tomatoes are often used in the fast food chains such as in hamburger, while small and pear-shaped tomatoes are popular in making salad (Fig. 1, A,D). Based on the data we can get, there are five and three main QTLs controlling the tomato fruit shape and size, respectively, and most of them have been cloned (Van der Knaap et al., 2014). Although, according to the recently published paper, only the fruit size is thought to be selected during the tomato domestication, it is hard to exclude the fruit shape to be selected in the future, because the breeder of processing tomato prefers to select the varieties bearing rectangle-shaped fruits, which are convenient for transport. Therefore, in this review, we summarized the progress in the investigation of the origin sites of some key domesticated horticultural crops. At the same time, we also summarized the molecular bases of the genes controlling fruit size and shape of horticultural plants by taking tomato as an example.

2. Old World originated horticultural species

Tracing the location of domestication and path for subsequent dispersal to other parts of the world is a key step in the

* Corresponding author. Tel.: +86 10 62731014
E-mail address: liang_sun@cau.edu.cn

Peer review under responsibility of Chinese Society for Horticultural Science (CSHS) and Institute of Vegetables and Flowers (IVF), Chinese Academy of Agricultural Sciences (CAAS)

http://dx.doi.org/10.1016/j.hpj.2017.07.007

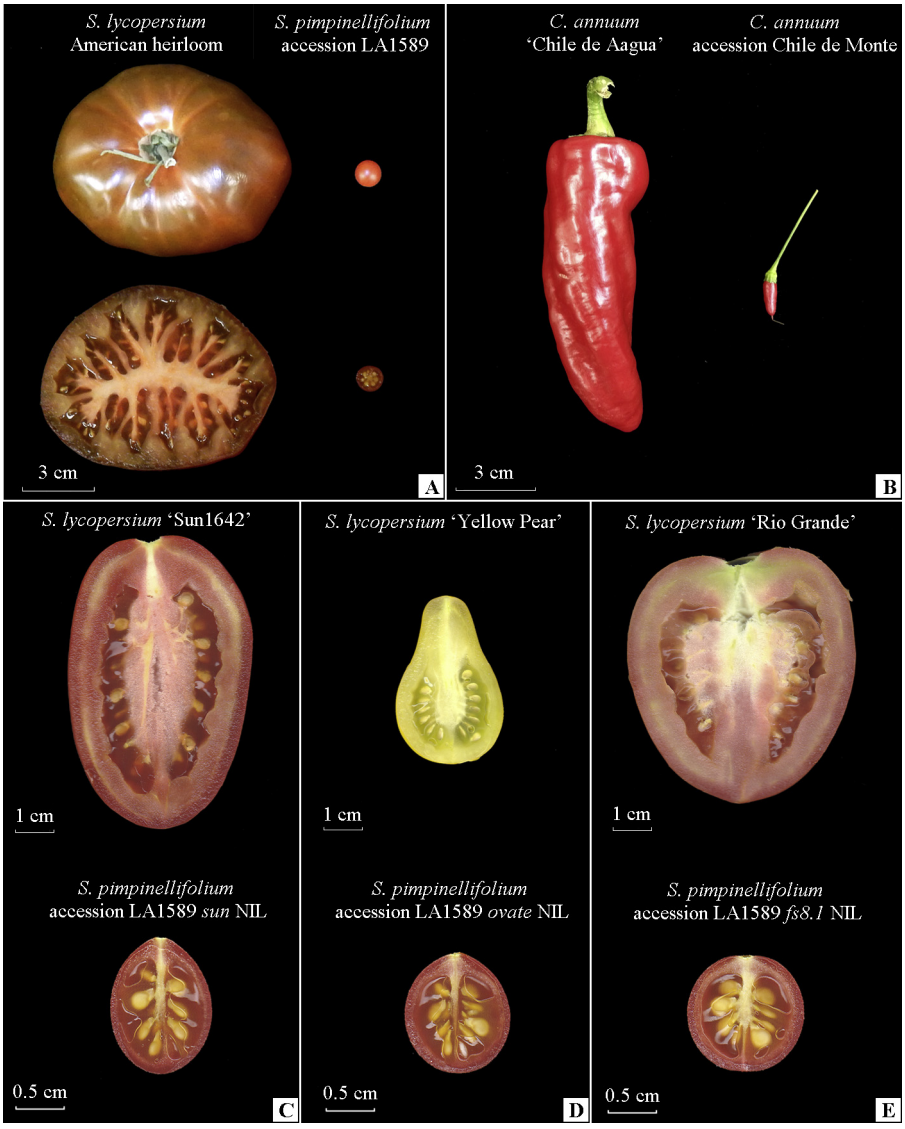

Fig. 1 Fruit size changes in the domestication of tomato and chili

(A) Cultivated tomato (*Solanum lycopersicum*, American heirloom, left) and wild tomato (*S. pimpinellifolium* accession LA1589, right) fruits; (B) Cultivated pepper (*Capsicum annuum* 'Chile de Aagua', left) and wild pepper (*C. annuum* accession Chile de Monte, right); (C) Fruits harboring the *sun* locus in 'Sun1642' (upper) and LA1589 background (lower); (D) Fruits harboring the *ovate* locus in 'Yellow Pear' (upper) and LA1589 background (lower); (E) Fruits harboring the *fs8.1* locus in 'Rio Grande' (upper) and LA1589 background (lower).

evolutionary study of domesticated crops. Besides giving evolutionary history of domesticated crops, such studies also provide an account of prevailing genetic diversity of the concerned crop. Integrated approach including archeological evidence, geographical distribution of wild ancestors, evolutionary genetic studies using molecular markers played vital role in elucidating the domestication history of crop species (Gepts et al., 2012; Kraft et al., 2014). Recent advancement in high-throughput sequencing has led to the adaption of genomic approaches to study the evolutionary history of horticultural crops (Blanca et al., 2012). Here we will briefly describe the domestication history of some key horticultural plants. Based on the geographical distribution of domestication centers, the crops introduced in this section can be divided into two categories: Old World crops, which were domesticated in Eurasia and Africa, such as grape, apple, melon and *Brassica*, and New World crops, which were originally domesticated in America, such as tomato and pepper (Zohary et al., 2012).

Among the Old World crops, *Brassica* is a kind of very important vegetable, which is widely grown all over the world and originated and domesticated in the Eurasia, especially in the areas around the Mediterranean basin, southwestern Asia and northern Africa (Prakash and Hinata, 1980; Prakash et al., 2011; Al-Shehbaz, 2012). Based on the karyotype, the *Brassica* crop complex comprises six species, including *B. rapa* (n = 10, AA), *B. nigra* (n = 8, BB), *B. oleracea* (n = 9, CC), *B. carinata* (n = 17, BBCC), *B. juncea* (n = 18, AABB) and *B. napus* (n = 19, AACC). Among them, *B. carinata*, *B. juncea* and *B. napus* are considered to be the high-