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On the front cover: *Cucurbita maxima* L. Francisco Manuel Blanco (1778 – 1845) (O.S.A.) - *Flora de Filipinas. Gran Edición. Atlas II.* 1880 to 1883(?) Image reproduced from the Digital Library of the Royal Botanical Garden of Madrid (CSIC).

The **Cucurbit Genetics Cooperative** (CGC) was organized in 1977 to develop and advance the genetics of economically important cucurbits. Membership to CGC is voluntary and open to individuals who have an interest in cucurbit genetics and breeding. Currently (2018) there are no annual dues. An informal membership list is maintained. If you are interested in becoming a CGC member and receiving email communications concerning CGC, please contact Amnon Levi at amnon.levi@ars.usda.gov.

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Development of Melon Cultivars for Organic Farming

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Introduction

Melon (*Cucumis melo* L.) has been cultivated in Spain since at least Roman times (10), both non-sweet melons (snake-shape, *flexuosus* type), locally known as 'alficoç', and sweet melons. In terms of production, Spain is the first producer of the European Union followed by Italy and France (5). Snake melons were already cultivated in the first century, as stated by Roman author Lucio Junius Moderatus *Collumela* who mentioned the snake-shaped 'cohombro', a *C. melo* belonging to the botanical variety *flexuosus* (L.) Naud. (8), a long snake-shaped non-sweet melon. With the Islamic conquest of the Iberian Peninsula during the Middle Age, sweet casaba type melons were introduced from Central Asia to Europe (12). During centuries, the preference of Spanish farmers and consumers has favoured the selection of sweet melons adapted to diverse agro-climatic conditions. The local farmers cultivated, conserved and exchanged their seeds, carrying the best fruits to the most popular markets (4). A recent classification of melon groups (13), recognizes the sweet melons from Spain and classifies them into a group denominated as *Ibericus*, with sub-group melons like 'Piel de Sapo', 'Rochet', 'Amarillo', 'Blanco' or 'Tendral'. These sub-groups are still cultivated nowadays, although mainly for self-consumption or for local markets, except for 'Piel de Sapo', being one of the most important market class currently.

Organic agriculture refers to the farming system where local resources are maximized, while forgoing the use of agrochemicals and the use of Genetically Modified Organisms (GMOs) (6). Therefore, alternative methods to control pests and diseases must be used. One of these methods is the use of resistant cultivars, as different cultivars have adapted to the pathogens present in their specific agroecosystem (14). Organic foods are widely perceived to be tastier and healthier than conventionally produced products and the production process is less damaging for the environment (7). For this reason, the Valencian government (Conselleria de Educaciò, Investigaciò, Cultura i, Esport, Generalitat Valenciana) has funded a Project (PROMETEO2017/078) in order to select traditional Spanish melon cultivars with suitable features for organic farming conditions.

Materials and Methods

The experimental assays were carried out in 2 different assay fields, both located in the surrounding area of Valencia, where organic farming is being promoted. The first field was in the area of Moncada (Latitude: 39°33'26.8"N, Longitude: 0°25'06.5"W). This field had no previous history of agricultural use for 20 years. The second field was in the area of La Punta (Latitude: 39°26'41.3"N, Longitude: 0°21'14.9"W). This field had a long history of melon cultivation. For this study, fifty landraces, representing the six classes of sweet melons and the non-sweet 'alficoç' were selected among those maintained at the COMAV GeneBank of the Universitat Politècnica de València. In the assay field of La Punta melons were grafted on different rootstocks, a commercial F1 hybrid of *Cucurbita* 'Cobalt' and an experimental rootstock F1 hybrid of melon (cross between *C. melo* ssp. *agrestis* and ssp. *melo*). Melon plants were grown under organic farming conditions. The plants were transplanted to the fields in mid-April, with nine total plants per cultivar distributed in three different blocks. Plants were planted on ridges, with black plastic mulch, to control soil humidity, temperature and weeds. In "Moncada", water was supplied by drip irrigation, whereas in "La Punta" field, water was supplied by flood irrigation.

During the growing cycle, the fields were inspected at least once per week. Soil samples were collected to determine soil conductivity. Pests were identified and plants showing symptoms of disease were sampled to determine the causal agent. Root samples were first cleaned using sodium hypochlorite solution at 20% concentration and any excess of sodium hypochlorite was removed using distilled water. Root tissue showing damage was then planted on Petri Dishes with Potato Dextrose Agar (PDA) + Streptomycin (1ppm concentration) medium and grown for 3 days at 30ºC. Fungal colonies were then characterized to determine the growing fungus. The leaf samples were used to determine the virus which caused the symptoms observed, using the method described by (9). Detected viruses were then cloned and sequenced to determine the virus isolate present.

One fruit per plant was characterized for fruit weight in grams (digital scale) and soluble solids content (SSC), measured as ºBrix using drops of juice (with a hand-held "Pocket" refractometer (PAL-α), Atago CO., LTD, Tokyo, Japan). A t-test was used to compare the results for each cultivar for fruit weight and SSC between both assay fields.

Results

The most common pest found in both fields were aphids, which are vectors to important viruses. The most common viruses in both fields were the Cucumovirus Cucumber Mosaic Virus (CMV) and the Potyvirus Watermelon Mosaic Virus (WMV). 'Blanco' and 'Amarillo' sweet melons were the most sensitive cultivars to powdery mildew, caused by *Podosphaera xanthii* (Castagne) U. Braun & Shishkoff, whereas non-sweet 'alficoç' was quite tolerant to this fungal pathogen. The principal soil pathogenic fungi found were *Fusarium oxysporum* f. sp. *melonis* Snyder & Hansen, *Fusarium solani* (Mart.) Sacc., *Monosporascus cannonballus* Pollack & Uecker and *Macrophomina phaseolina* (Tassi) Goid. Plants grafted onto F1 melon rootstock displayed more resistance against soil pathogens than those grafted onto F1 *Cucurbita* rootstocks. 'Blanco' and 'Amarillo' sweet melon cultivars were especially susceptible to soil pathogens, whereas non-sweet ''alficoç'' presented higher tolerance to these soilborne pathogens. The soil conductivity of La Punta field (0.674±0.081mS/cm) was significantly higher ($P<0.05$) than that of Moncada (0.357±0.015 mS/cm). Figures 1 and 2 show the average fruit weight and flesh SSC of 10 different ungrafted cultivars representative of the different groups for each field. In general, fruits were larger in Moncada (fruit weight ranging from 970g to 1730g) compared with La Punta (from 840g to 1480g), whereas no differences were found in average SSC (ranging from 9.7 to 14.1, and from 9.8 to 13 ºBrix in Moncada and La Punta respectively). The 'alficoç' cultivar yielded smaller non-sweet fruits (240g and 320g, and 3.2 and 3.8 ºBrix). The higher pathogen incidence and soil conductivity may be the cause of fruit size reduction in La Punta field although fungal attack and /or the significant differences in soil conductivity did not significantly affect the SSC. The effect on fruit weight was different for the different landraces. Figure 1 shows the results for ungrafted plants of two 'Piel de Sapo' (03PS and 12Ps), two 'Amarillo' (22AM and 23AM), two 'Blanco' (01BL and 32BL), two 'Rochet' (02RC and 04 RC) and one snake melon (05AL) cultivar. Significant fruit weight losses ($P<0.05$) were observed in 'Amarillo' and 'Blanco' landraces, (between 20-30% fruit weight loss), likely associated to their higher susceptibility to fungi, whereas 'Piel de Sapo' and 'alficoç' cultivars were less affected, and 'Rochet' displayed an intermediate behaviour. Only one 'Blanco' cultivar (01BL) significantly reduced the Brix degree.

Discussion

Viral diseases are the main factors affecting cucurbits cultivation, being the most widespread and damaging the *Potyviridae* family viruses (11). The detected viruses belong to the family *Potyviridae* in the case of WMV and to the *Bromoviridae* family in the case of CMV. Both these viruses are transmitted by aphids (3). Therefore, in our conditions, the control of viral diseases must be focused on aphid control. One way would be the use of resistant cultivars possessing the gene *Vat* which confers resistance to both the aphids and the viruses it carries. A vast survey of aphids on vat and non-vat plants showed that aphid populations were globally affected by resistant melons, but that a few adapted (virulent) clones could develop on vat-plants, questioning the durability of the *Vat* gene (17). A study on *Vat* resistance in melon on viral epidemics (16) found that *Vat* had a limited impact on WMV epidemics and the reduction on CMV epidemics was irregular. In organic farming, one of the methods employed for the purpose of controlling aphids is the use of parasitoids and predators (14), as natural enemies are mass-reared for release in large numbers to obtain immediate control of pests in crops with a short production cycle (18).The other main biotic limiting factor in our assays were soil pathogenic fungi that cause fruit weight losses, leading to unmarketable fruits in the most sensitive cultivars. Plants grafted onto F1 *Cucurbita* rootstocks, which are usually used to control *Fusarium oxyporum* (2), showed lower resistance to soil pathogenic fungi than F1 melon rootstocks. These results can be due to the presence of other *Fusarium* species or other soil pathogens, which specially affect *Cucurbita* rootstocks (1). *Fusarium oxysporum* f. sp. *melonis* (Fom) is specific to melon and it causes a vascular wilt which is considered as one of the most severe disease of melon worldwide, with four races of the pathogen based on the resistance genes (15). The resistance to races 0, 1 and 2 is scattered along all melon botanical types, whereas the high levels of resistance to race 1,2 was found only among accessions belonging to *Cucumis melo* ssp. *agrestis* (15). The results showed that the 'Amarillo' and 'Blanco' cultivars are more sensitive to fungi than the 'Piel de Sapo' and 'alficoç'. Therefore, both the use of resistant rootstocks and the knowledge of soil pathogens in the field are of great importance when dealing with soilborne pathogens. The fact that different cultivars display differential response to biotic and abiotic stresses under organic farming, will allow for an optimized breeding process in each case.

Conclusion

The main biotic factors (pests, viruses and fungi), which limit the organic production of melon in Eastern Spain have been identified. The use of resistant rootstocks to soilborne pathogens, specially melon rootstocks, allowed the cultivation of susceptible melons on non-treated infested soils, where ungrafted plants of the most sensitive landraces ('Blanco' and 'Amarillo' types) were severely affected. Different traditional cultivars of melon, including some 'Piel de Sapo', 'Rochet' and non-sweet 'alficoç', which stand out due to their adaptation have been identified. The knowledge of the different limiting factors, as well as the identification of the cultivars with the greatest potential, will allow the development of melon cultivars adapted to organic farming.

Acknowledgments

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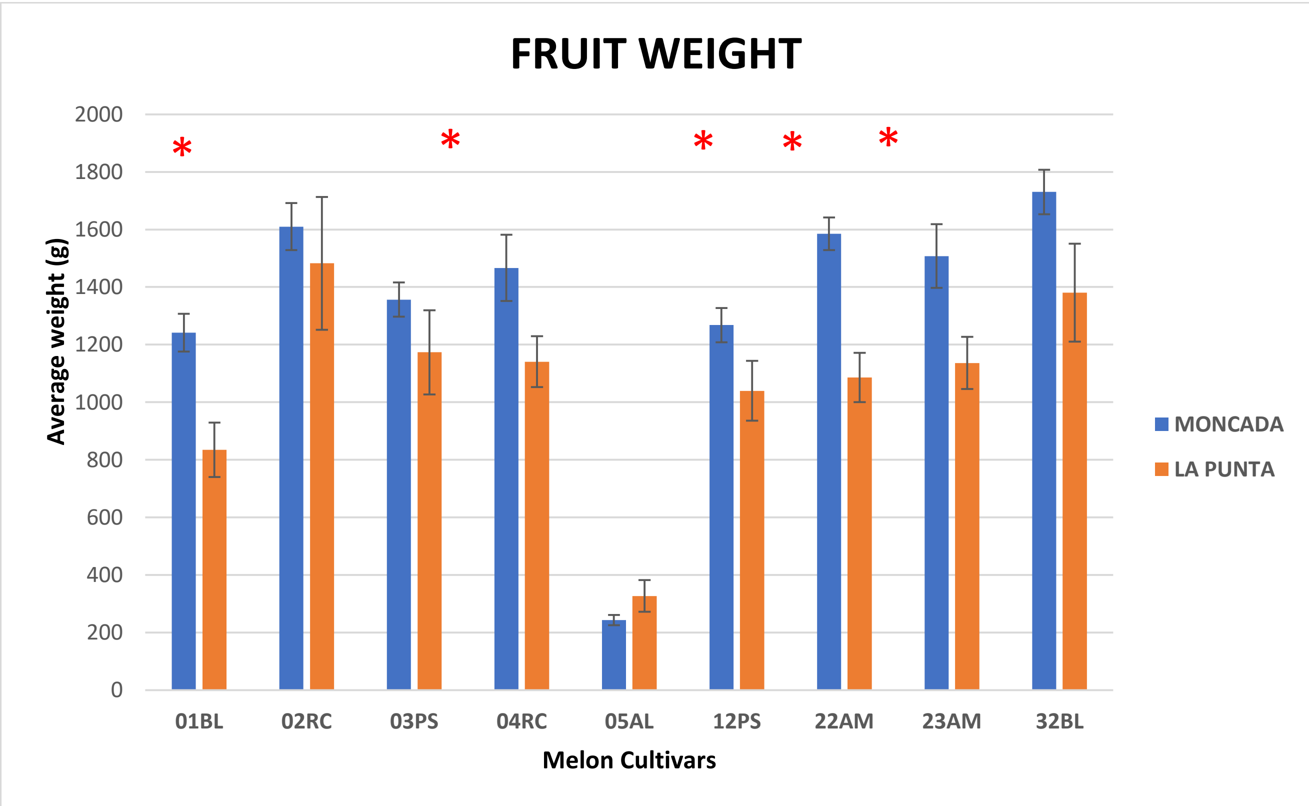

Figure 1. Graphs showing the average fruit weight for 10 different cultivars including sweet and non-sweet melons. The names of the cultivars indicate if it is sweet 'Blanco' (BL), 'Amarillo' (AM), 'Piel de Sapo' (PS), 'Rochet' (RC) or non-sweet 'Alficoç' (AL). (*) Above the bars represent significant difference (P < 0.05) between the experimental fields.

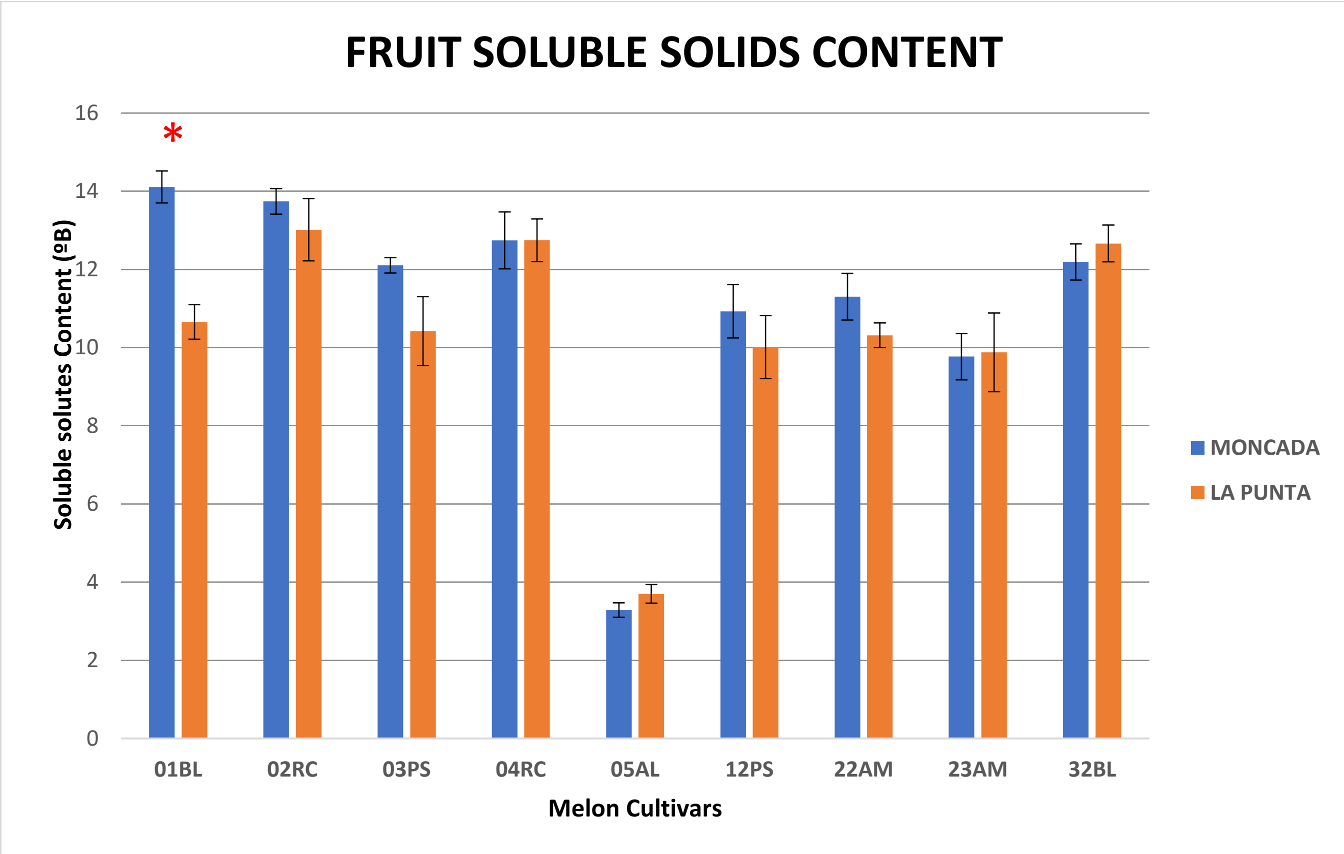

Figure 2. Graphs showing the average SSC for 10 different cultivars including sweet and non-sweet melons. The names of the cultivars indicate if it is a sweet 'Blanco' (BL), 'Amarillo' (AM), 'Piel de Sapo' (PS),' Rochet' (RC) or non-sweet 'Alficoç' (AL). (*) Above the bars represent significant difference ($P < 0.05$) between the experimental fields.