



Genetic and agronomic characterization of almond (*Prunus dulcis*) cultivars from the island of Mallorca

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Introduction

Conserving crop biodiversity is essential for ensuring future agricultural resilience, particularly in the face of emerging challenges such as climate change and phytosanitary threats. Germplasm banks act as critical repositories of genetic diversity and serve as indispensable tools for breeding and adaptation strategies [1]. Almond (*Prunus dulcis* L. [Mill.] D.A. Webb) is a crop of great importance in Mediterranean regions, and traditional cultivars, represent a key source of genetic and phenotypic diversity.

Material and Methods

The characterization was carried out in the germplasm bank, located in Son Real, in the northeast area of Mallorca (39° 44' 15" N, 3° 10' 40" E), including thirty-eight local cultivars and five commercial cultivars. The evaluation of almond cultivars included field prospecting, molecular identification, flowering phenology assessment, incidence of *Xylella fastidiosa*, and detailed morphological characterization. A principal component analysis (PCA) was carried out to identify the primary variations in morphological characteristics within the cultivars [2]. Data analysis was conducted using IBM SPSS software package 23.0.

Results

Following extensive multi-year prospecting efforts targeting local almond genotypes, a germplasm bank has been established in 2014. A high level of genetic diversity (Fig. 1) was observed among the almond cultivars, confirming the richness of the germplasm collection [3]. The genotypes were grouped into six clusters of varying sizes, with further subdivisions based on the proximity of accessions within each cluster. The 'D'en Jordi' cultivar exhibited the lowest genetic similarity (<19%) compared to the other accessions. Two cases of putative genetic synonymy were identified, including 'Bord de Selva' and 'Vivot'; and 'Pou d'Establiments' and 'Pou de Felanitx'.

In general, local genotypes flowered earlier than commercial cultivars (Fig. 2). 'Caragola' was the earliest blooming cultivar, reaching F50 on 38 DOY, making it the most precocious genotype. 'D'en Jordi' exhibited notably extended flowering periods than 'Masbovera' ($p < 0.05$). Flowering duration tended to be longer in local varieties (~18 days) than in commercial ones (~11 days). Statistically homogeneous groups (letters a-f) were determined using Tukey's HSD test at a significance level of $p < 0.05$.

Regarding affectation by *Xylella fastidiosa*, commercial cultivars were significantly less affected than local varieties ($p < 0.001$), showing 49% lower incidence. Among local cultivars, 'Capirons' and 'Mare de Déu' exhibited the lowest levels of infection.

Results of PCA are presented in Figure 3. The first two components accounted for over 60% of the total variance among varieties (PC1: 38.62% and PC2: 22.34%). Additionally, PC3 explained a further 13.55% of the variation. The main morphological variables contributing to PC1, PC2, and PC3 are represented in green, blue, and red, respectively. A high level of phenotypic dispersion was observed, supported by the genetic profiles obtained. 'D'en Jordi' also showed a phenotypic profile clearly distinct from the rest, consistent with its low genetic similarity to the other cultivars.

The PCA revealed phenotypic proximity between 'Bord de Selva' and 'Vivot', and between 'Pou d'Establiments' and 'Pou de Felanitx', consistent with their genetic synonymy observed in the molecular dendrogram. The commercial cultivars 'Masbovera', 'Marinada', 'Vairo', and 'Constantí', all released by IRTA breeding programs, clustered closely in the PCA space, reflecting their morphological uniformity and shared selection criteria. In contrast, 'Marta', developed by CEBAS-CSIC, appeared clearly differentiated, suggesting a distinct phenotypic profile.

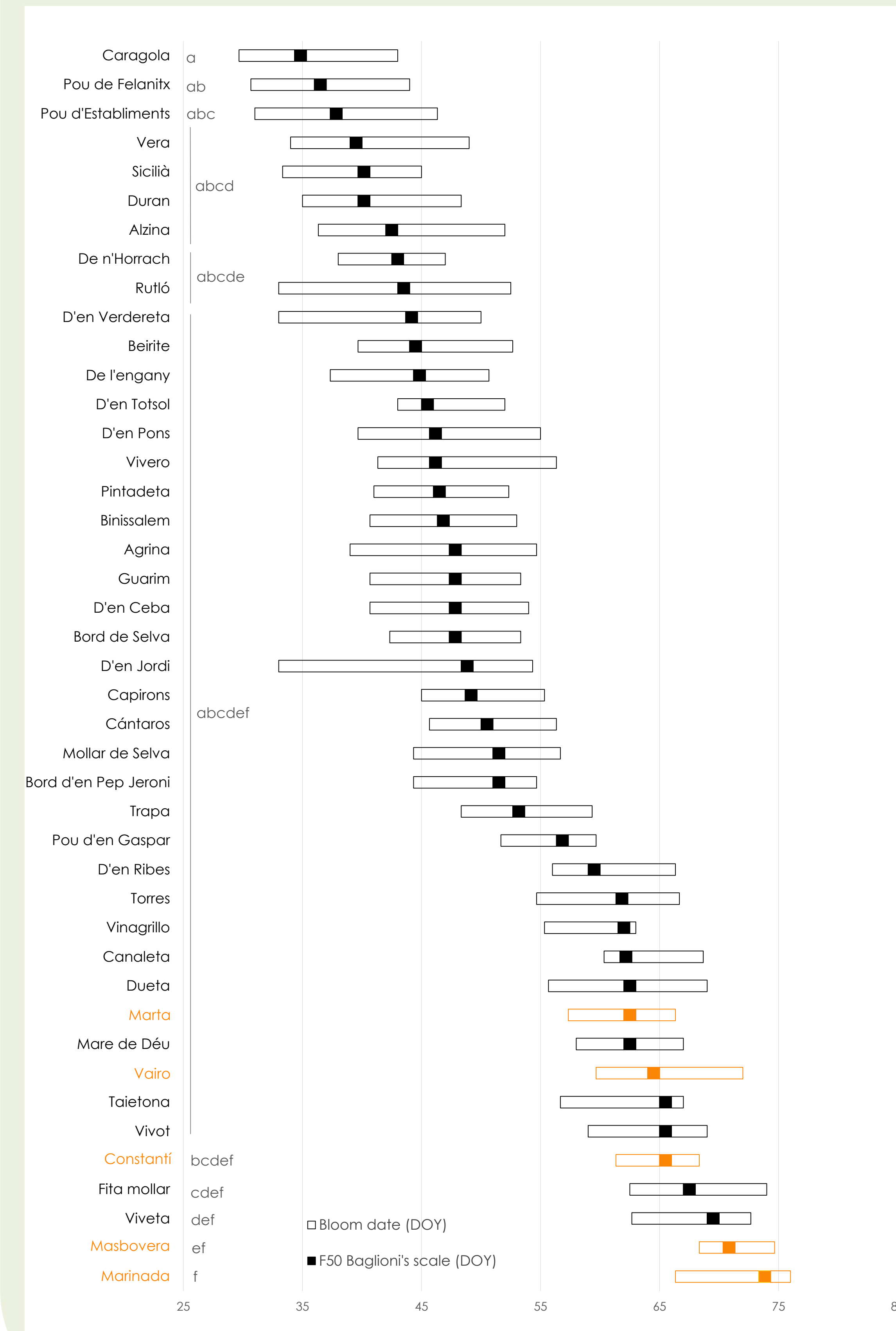


Figure 2. Flowering period and full bloom date (F50) of 43 almond cultivars.

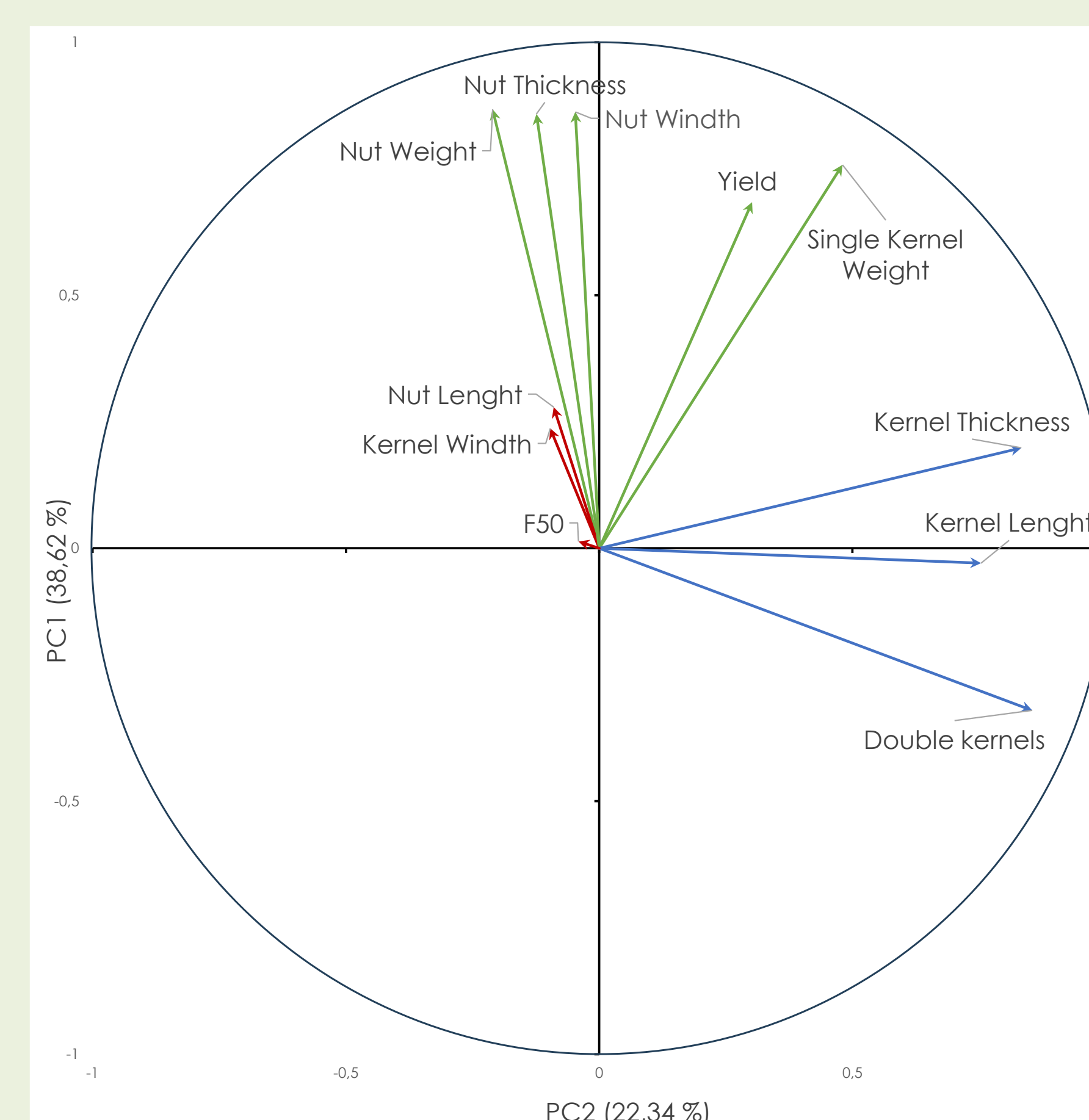


Figure 3. Principal component analysis (PCA) of 43 almond cultivars based on morphological and flowering traits.

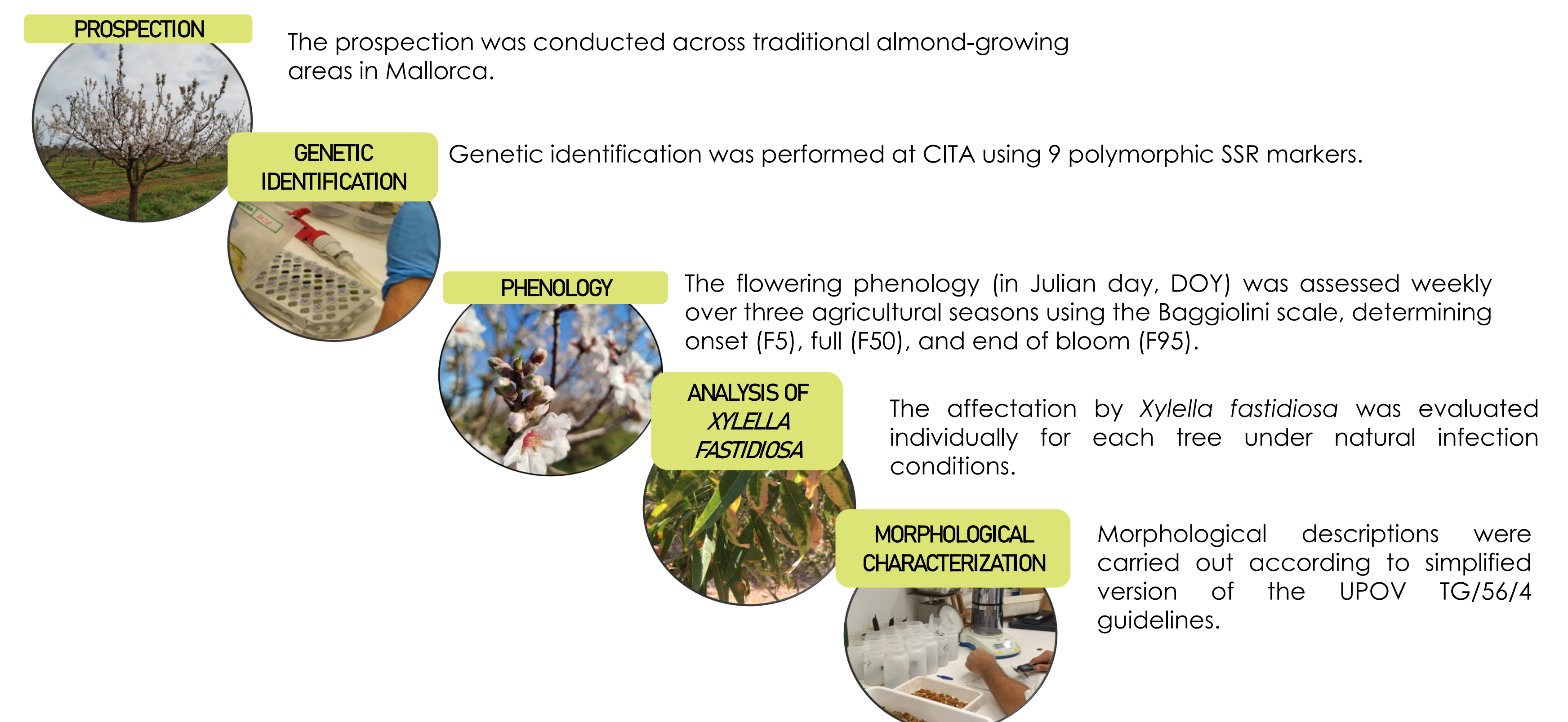
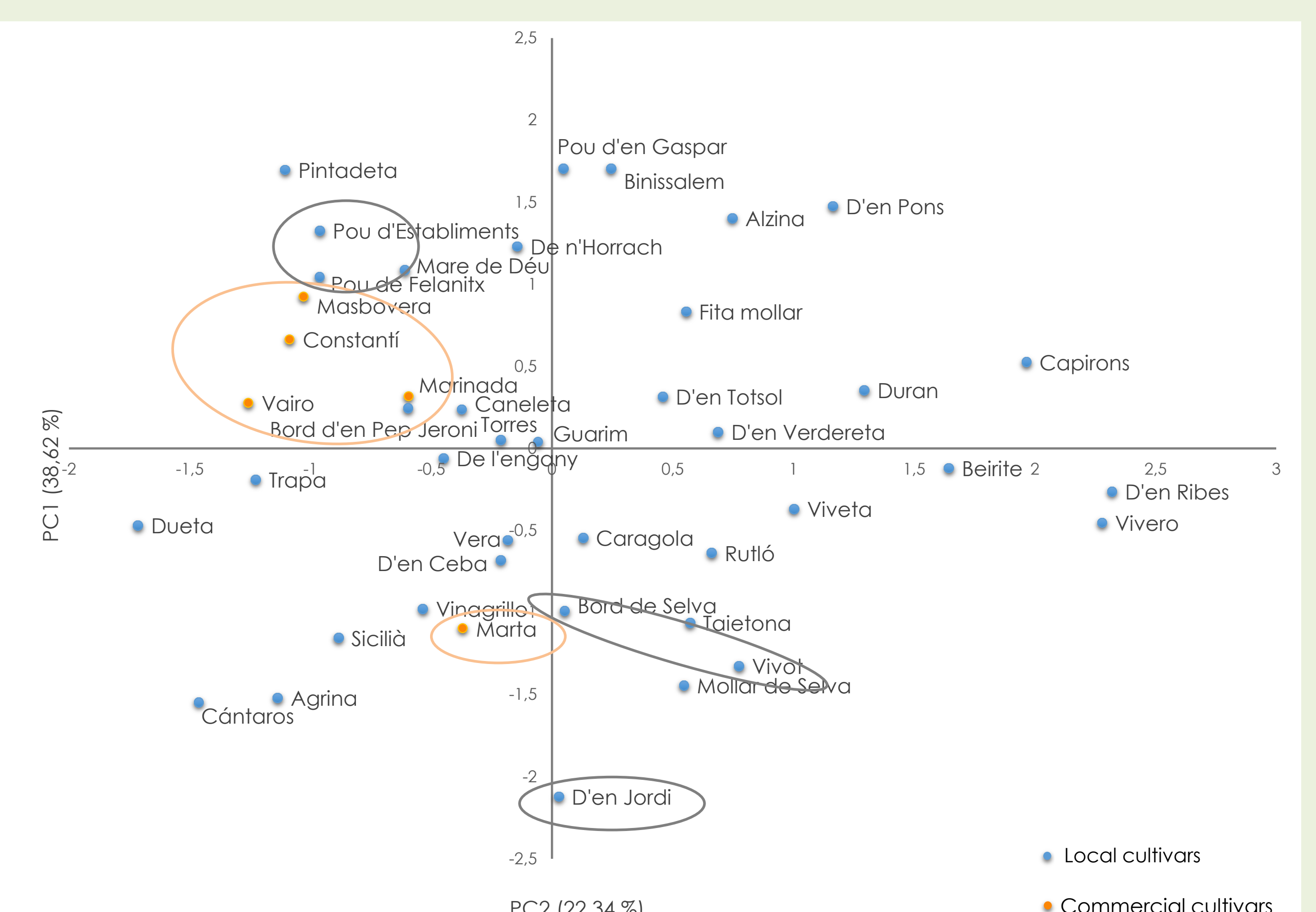


Figure 1. Dendrogram of the 38 local almond cultivars using polymorphic SSR markers.



Conclusions

- High genetic and phenotypic diversity was found among local almond cultivars.
- 'D'en Jordi' exhibited a clearly distinct genetic and molecular profile and an extended flowering period, distinguishing it from all other cultivars.
- Commercial cultivars were significantly less affected by *Xylella fastidiosa*.
- This comprehensive evaluation underscores the underexplored phenological diversity and resilience traits present in local almond germplasm, highlighting its potential for future breeding and conservation efforts.

References

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