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Budding success and growth aptitude under rainfed conditions during the first year of plantation: Comparison between *Pistacia terebinthus* L. and UCB-I

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Abstract. In Spain, pistachio area was negligible in the 1990's, nowadays, it is estimated to 6,000 hectares. However, one of the most important issues that created doubt among farmers for its introduction has been the choice of rootstock. The most used rootstocks in the world are *Pistacia atlantica, Pistacia integerrima, Pistacia terebinthus* and *UCB-I. Pistacia terebinthus* is a native Spanish forests rootstock known for its adaptation to the lands of the Iberian Peninsula. However, it is also known for its small vigor and its low tolerance to some diseases like *Verticilium dahliae*. In contrast, UCB-I, a hybrid between *Pistacia integerrima* and *Pistacia atlantica* is a rootstock known for its high vigor, its tolerance to *Verticillium dahliae* and its high yields, however, its behavior is unknown under rain-fed conditions. For this purpose, as a first step, a Split-plot trial comparing these two rootstocks with different cultivars under rain-fed conditions was implemented in Castilla-La-Mancha (Spain). The primary objective was to assess the aptitude of budding success and the difference in the vegetative growth of these two rootstocks under rain-fed conditions. Rootstock diameter, scion diameter, the percentage of budding success and the length of resulted scions were measured. The results showed that UCB-I had a higher percentage of budding success (70% vs. 54%), a significantly higher rootstock and scion diameters (25 mm vs 15 mm for rootstock and 22 mm vs 15 mm for scion). However there was no difference between lengths of sprouted buds. Also, there was no influence of the variety in relation to these parameters.

Keywords. *Pistacia* – Rootstock – Adaptation – Budding – Vegetative growth – Scion.

Succès du bourgeonnement et aptitude à la croissance en conditions pluviales durant la première année de plantation : Comparaison entre* Pistacia terebinthus *L. et UCB-I

Résumé. *En Espagne, la surface plantée en pistachiers était négligeable dans les années 1990, mais elle est estimée aujourd'hui à 6 000 hectares. Cependant, l'une des plus importantes problématiques qui rendait les agriculteurs réticents à l'introduire était le choix du porte-greffe. Les porte-greffes les plus utilisés à l'échelle mondiale sont* Pistacia atlantica, Pistacia integerrima, Pistacia terebinthus *et* UCB-I. *Pistacia terebinthus est un porte-greffe originaire des forêts espagnoles connu pour son adaptation aux terres de la Péninsule Ibérique. Toutefois, il est aussi connu pour son peu de vigueur et sa faible tolérance à certaines maladies comme* Verticilium dahliae. *Par contre, UCB-I, un hybride entre* Pistacia integerrima *et* Pistacia atlantica, *est un porte-greffe connu pour sa forte vigueur, sa tolérance à* Verticillium dahliae *et ses bons rendements, mais son comportement est inconnu en conditions pluviales. Dans ce but, comme premier pas, un essai split-plot comparant ces deux porte-greffes portant différents cultivars en conditions pluviales a été mis en place en Castilla-La-Mancha (Espagne). L'objectif premier était d'évaluer l'aptitude à un bon bourgeonnement et la différence de croissance végétative de ces deux porte-greffes en conditions pluviales. Le diamètre des porte-greffes, le diamètre des scions, le pourcentage de réussite du bourgeonnement et la longueur des scions résultants ont été mesurés. Les résultats ont montré que UCB-I a un plus grand pourcentage de réussite du bourgeonnement (70% vs 54%), des diamètres significativement plus grands pour le porte-greffe et le scion (25 mm vs 15 mm pour le porte-greffe et 22 mm vs 15 mm pour le scion). Cependant il n'y avait pas de différence entre les longueurs des bourgeons qui avaient poussé. Il n'y avait pas non plus d'influence de la variété pour ces paramètres.*

Mots-clés. Pistacia – *Porte-greffe – Adaptation – Bourgeonnement croissance végétative – Scion.*

I – Introduction

In Spain, pistachio area was negligible in the 1990's, nowadays, it is estimated to about 6,000 hectares (Couceiro *et al*., 2013). However, one of the most important issues that created doubt among farmers for its introduction has been the choice of rootstock since drought is the most limiting abiotic factor in the Mediterranean area and the majority of orchards are grown under rain-fed conditions or with limited water inputs. Increasing crop resistance to this stress would be the most economical approach to improve productivity (Wang *et al*., 2012) and grafting is a widespread technique used in arboriculture to achieve this objective. Omitting *Pistacia vera*, the most used rootstocks in the world are *Pistacia atlantica*, *Pistacia integerrima*, *Pistacia terebinthus* and UCB-I. *Pistacia terebinthus* is a native Spanish forests rootstock known for its adaptation to the lands of the Iberian Peninsula. However, it is also known for its small vigor and its low tolerance to some diseases like *Verticilium dahliae*. In contrast, UCB-I, a hybrid between *Pistacia integerrima* and *Pistacia atlantica* is a rootstock known for its high vigor, its tolerance to *Verticillium dahliae* and its high yields, however, its behavior is unknown under rain-fed conditions.

The objective of this work was to start early the monitoring of the behavior of these two rootstocks in order to detect any difference that could prevent their use in this area.

II – Material and methods

The study was conducted during the month of June one year after the budding of an orchard located in "La Entresierra" research station, Ciudad Real (Centre of Spain) (L 3º56´W; L 39º0´N; altitude 640 m). One budding event was done in the subsequent summer after plantation. The plantation was established in the month of February and due to reasons of plants availability, UCB-I has been planted with 6 month old and *P. terebinthus* (PT) with 2 year old and was previously maintained in pots under greenhouse conditions. Weeds were controlled with a tillage management and irrigation was applied only at the moment of plantation. The climate in this area is Mediterranean with an average annual rainfall of 397 mm, mostly distributed outside a four-month summer drought period. The soil at the experimental site is an alkaline (pH 8.1) shallow soil with a discontinuous petrocalcic horizon located at 0.50 m (Petrocalcic Palexeralfs), with a clay loam texture, low electrical conductivity (0.2 dS m^{-1}), 1.05% of organic matter, 0.12% of nitrogen, 17 × 10^{-4} mol kg^{-1} potassium levels and high cationic exchange capacity (0.186 mol kg^{-1}). The volumetric water content of the soil for the first 0.3 m of depth was 22.8% at field capacity (soil matric potential -0.03 MPa) and 12.1% at permanent wilting point (soil matric potential -1.5 MPa); from 0.3 m to 0.5 m it is 43.0% and 21.1%, respectively.

The experimental design was a split plot design with 3 blocks. Each experimental block was composed by two rootstocks and three cultivars for each rootstock. The main factor was rootstock: *Pistacia terebinthus* and UCB-I. The secondary factor was cultivars: Kerman, Sirora and Larnaka. Tree spacing was set at 8 x 6 m (208 trees ha^{-1}) and male cultivars were distributed at a rate of 11% equally divided between subplots.

Rootstock diameter was measured at soil level and scion diameter at 5 cm above budding point. The percentage of budding success was counted and the length of resulted scions was also determined.

III – Results and discussion

The diameter of the rootstock was highly correlated with the diameter of the scion (Fig. 1) being at both levels significantly higher in UCB-I than PT (Table 1). The rootstock diameter was 25.48 mm for UCB-I and 14.98 mm for PT. The diameter of the scion was 22 mm for UCB-I and 15 mm for PT. These

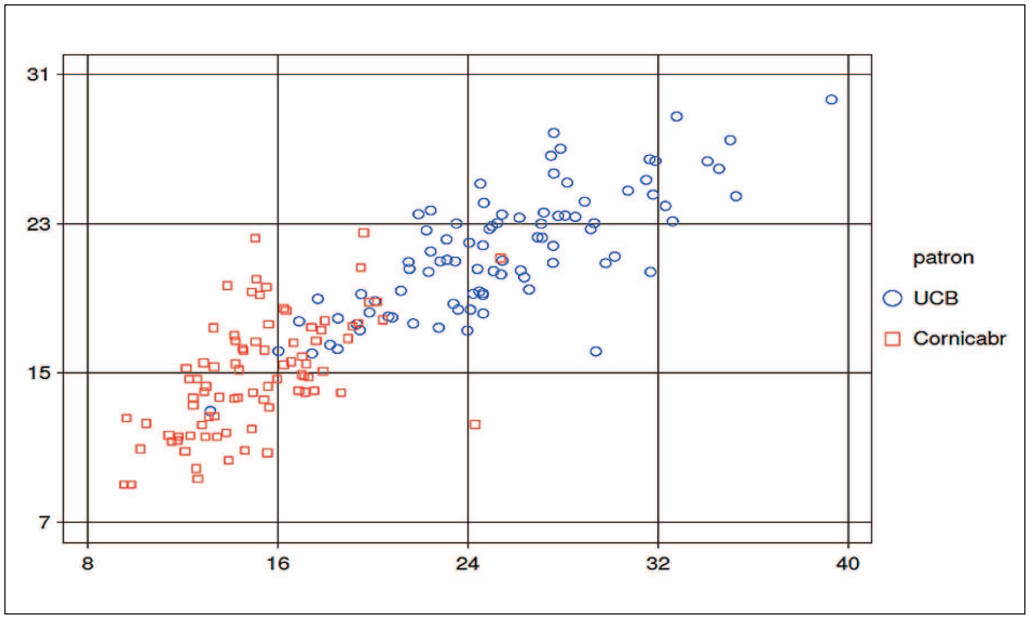

Fig. 1. Scatter graph plotting rootstock diameter in cm (X axis) vs scion diameter in cm (Y axis) of UCB-I (circles) and *Pistacia terebinthus* (squares).

Table 1. Comparison of budding success, rootstock diameter, scion diameter and shoot length between UCB-I and *Pistacia terebinthus*

Rootstock	Budding success (%)	Rootstock diameter (mm)	Scion diameter (mm)	Shoot length (cm)
UCB-I	70.41a	25.48a	22a	58.38a
P. terebinthus	54.33b	14.98b	15b	51.18a

results would have been expected under watered and deep soil conditions since UCB-I is considered the best commercial rootstock under irrigation and is widely characterized to be much more vigorous than PT (Ferguson *et al.*, 2005). However, under rainfed conditions and shallow soils, it was expected that UCB-I will endure worst these conditions and would slow substantially its growth compared to PT. Nevertheless, UCB-I showed a higher growth than PT in the first year of plantation.

This behavior could be related to the age of each rootstock at the moment of plantation since the conservation of PT in pots for a longer time could generate a punctual stopping of growth at the moment of transplantation.

The length of scions was 58.38 cm for UCB-I and 51.18 cm for PT with no significant difference between both. Also, the same amplitude of shoots length variation between trees of the different rootstocks was observed meaning that there was no difference in the homogeneity of plots between the two rootstocks.

The fact that no difference was observed in the length of the resulted shoots weaken the importance of these differences in diameter growth, if the same rate of growth is followed in the next years, since the objective to reach faster a formed tree would be lost.

Regarding the budding success, UCB-I showed a significantly higher percentage than PT being respectively 70.41 and 54.33%. Guerrero *et al*. (2007) mentioned that rootstock diameter is the most important factor for budding success which could explain the obtained results.

Regarding cultivars, no influence was observed of the effect of the variety in relation to these parameters.

IV – Conclusion

UCB-I showed a very promising behavior under the conditions of Castilla-La-Mancha contrasting with the assumptions advancing its poor adaptation. However, no decisive validation could be obtained in a first year of study. These results are preliminaries and should be confirmed in the following years to have conclusive findings.

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