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Study of the rooting capacity of eleven pomegranate (*Punica granatum* L.) clones, using plastic to cover the soil

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SUMMARY – In a continuation of our studies of the rooting capacity of different pomegranate clones propagated by taking hardwood cuttings, we studied the results obtained the previous year and those obtained by improving cultivation techniques using a polyethylene film, which saves a lot of water and cuts labour cost during the rooting period. Rooting capacity increased with the technique and labour costs of producing rooted cuttings were cut by 37%.

Key words: IBA, hardwood cutting, rooting, wound, plastic cover, pomegranate.

RESUME – *"Etude de la capacité d'enracinement de onze clones de grenadier (*Punica granatum *L.), en utilisant des plastiques pour couvrir le sol". Dans une suite de nos études sur la capacité d'enracinement de différents clones de grenadier propagés en prélevant des boutures de vieux bois, nous avons étudié les résultats obtenus l'année précédente et ceux obtenus en améliorant les techniques culturales par l'utilisation d'un film plastique de polyéthylène, qui économise beaucoup d'eau et réduit les coûts de travail pendant la période d'enracinement. La capacité d'enracinement a augmenté avec cette technique et il y a eu réduction de 37% des coûts de travail pour produire des boutures racinées.*

Mots-clés : *IBA, boutures de vieux bois, enracinement, blessure, couverture plastique, grenade.*

Introduction

For the vegetative reproduction of pomegranates, the use of hardwood cuttings as opposed to semi-hardwood and herbaceous cuttings, and the application of IBA, increases rooting percentage (Ghosh *et al*., 1988; Sandhu *et al.*, 1991; Singh, 1994). This phenomenon happens in certain conditions and for certain clones from this species, especially the application of rooting hormones, whose effects can be at least partially substituted by other factors such as wounding or the base temperature of the substratum in which the rooting takes place. Hartmann and Kester (1987) state that for most species, daytime temperatures of between 21°C and 27°C, and night-time temperatures of 15°C, are satisfactory. On the other hand, Van den Heede and Lecourt (1981) indicate that there has to be a supporting heat for the cuttings in order to improve multiplication, with a heat difference between the atmosphere and the soil; Amorós *et al.* (1997) point out that hardwood cuttings of some pomegranate clones which have been subjected to base heat application during rooting improve their rooting percentage, with the positive effect being greater at 22°C than at 18°C or at normal air temperature (15.75%), and they conclude that the optimum temperature in this experiment was 22°C.

The effects on the rhizogenesis of hardwood cuttings varies for different pomegranate clones: for some, in normal cultivation conditions, the appliction of high IBA applications has a positive effect, whereas in others the rooting percentage does not change with the quantity of hormone used; similarly, wounding at the cuttings' base usually has a positive effect on rhizogenesis.

Subsequently to the studies carried out in 1997 on the rooting capacity of different pomegranate clones, propagated using hardwood cuttings, a new test has been carried out bearing in mind the results obtained in that year, and improving the cultivation technique using a plastic polyethylene film, in order to save water and cut labour costs during the rooting period. This test also aims to discover the influence of plastic covers on the rooting of different pomegranate clones.

Materials and methods

The vegetable matter in this study is made up of pomegranate hardwood cuttings from clones ME1, ME11, ME12, ME14, MC1, SFB1, CRO2, PTO8, PDO1, BA1 and VA2. The cuttings were taken from apparently healthy 6-year-old trees in the Escuela Politécnica Superior de Orihuela (Universidad Miguel Hernández) collection; the trees were cultivated in homogeneous conditions, reproduced by vegetative propagation (Melgarejo, 1993), and planted in a 4×3 m layout. The estate is in the municipal district of Orihuela (Alicante), and is watered by drip irrigation. The trees are goblet-trained.

The hardwood cuttings, of 30 cm average length, were taken from these trees when they were ripe (one-year-old wood). They were cut on 4/3/97, disinfected, and kept in cold storage at 5°C until being planted out on 29/3/98. The middle and base parts of the branch were chosen for the cuttings, as the ends are normally too thin, with lower reserves content, which make them less suitable for rooting.

Before planting, the soil was prepared, a drip irrigation system was installed, and a tractor was used to spread a black polyethylene strip sheet – 0.95 m wide and 25 m long – with the characteristics shown in Table 1.

Table 1. Characteristics of the black polyethylene strip sheet. Make: Sotrafa, S.A.; Model: Sotrafilm NG†

Properties (units)	Value	Norm
Average thickness: gauge (μ).	60 (15)	UNE 53328
F.I. (g/10 min)	1.05	UNE 53098
Tear resistance (g)	M.D.:210	UNE 53220
	T.D.:500	UNE 53220
Traction at tearing point (Mpa)	M.D.:33	UNE 53165
	T.D.:31	UNE 53165
Final elongation (%)	M.D.:510	UNE 53165
	T.D.:720	UNE 53165
Impact resistance F 50 (g)	200	UNE 53119
Spectral properties (%)		
Transmittance	1	–
Absorbance	95	–
Reflectance	4	–

†M.D.: machine direction; T.D.: transversal direction; F.I.: fluidity index.

The use of this plastic sheet has the following advantages:

(i) It improves soil temperature, which in turn has a positive influence on root formation and improves plant development, avoiding important contrasts between daytime and night-time temperatures.

(ii) It noticeably reduces evaporation of water in the soil, and creates dampness uniformity in this area where the radicular system develops.

(iii) The combination of increase in temperature and in soil dampness favours nitrification, and therefore nitrogen nutrition for the plants.

(iv) It helps lateral development of the radicular system at surface level, where there is a greater oxygen concentration and higher nutrient availability.

The ground was then watered for 4 hours so that the cuttings would enter more easily, penetrating the plastic sheet.

Bearing in mind the results of the test carried out in 1997, in which, in general, the best results were obtained with IBA concentrations of 12,000 ppm and with wounding at the cuttings' base, it was decided that these two treatments would be applied to the cuttings of all the clones in the test. The cuttings were first wounded at the base (4 incisions in the last 2 centimetres), and then given a hormone treatment, with quick immersion of the base of the cutting (approximately the last two centimetres) for 5 seconds in an IBA solution dissolved in 95% ethyl alcohol and water, at 12,000 ppm concentration. The VA2 clone was given the same treatment as the rest of the clones, and also a control group, which was wounded but did not receive IBA treatment, was kept in order to study the influence of the hormone on this clone.

The cuttings were planted as stated, leaving at least two exposed buds in each case, in double rows with 20 cm between cuttings. They were watered by drip irrigation using the same pipe and separated approximately 30 cm within the line; each double row of cuttings was separated by 1 m, to facilitate cutting control. The average temperatures during the months in which the tests were carried out were as shown in Table 2.

Table 2. Average air temperatures (°C) in 1998

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug
12.2	13.0	15.3	17.1	19.1	23.6	26.6	26.6

Rooting control of the cuttings was carried out on 1/7/98.

During the test, it was found that the temperature of the air, the plastic-protected soil and the unprotected soil were different. The temperature of the covered soil was approximately 4-5°C higher than the uncovered soil, and the uncovered soil was approximately 2°C higher than air temperature. The best soil temperature is obtained without energy costs, because of this increase in air temperature during the months when rooting takes place, which leads to an increase in rooting.

Results

The results of the described test are summarised in Table 3, showing the different treatments applied and results obtained in the test.

Table 3. Treatments and results of the test[†]

Clone	T	NCP	NCR	R	Clone	T	NCP	NCR	R
ME1	T1	61	53	86.89	SFB1	T1	77	75	97.40
ME11	T1	75	69	92.00	CRO2	T1	74	74	100.00
ME12	T1	73	73	100.00	PTO8	T1	75	75	100.00
ME14	T1	75	54	72.00	PDO1	T1	77	75	97.40
MC1	T1	78	70	89.74	BA1	T1	75	74	98.67
VA2	T1	304	262	86.18	VA2	T0	66	63	94.45

[†]T: treatment; NCP: no. of cuttings planted; NCR: no. of cuttings rooted; R: rooting percentage; T1: 12,000 ppm IBA+wounds+plastic cover; T0: wounds+plastic cover.

In Table 4, the cultivation costs for the multiplication of the above pomegranate clones, using hardwood cuttings, is described and evaluated. Although in the current study, only eleven clones with a total of 1110 planted cuttings are analysed, the economic costs analysis has been carried out for a plantation with a greater number of clones and a total of 4687 planted cuttings, which makes the costs more representative of the technique of using the plastic cover. In Table 4 the costs are shown in Spanish pesetas (ptas) and USA dollars ($ USA).

Table 4. Costs of preparation, cultivation and uprooting of cuttings

Operation	Operation costs for the planting of 4687 cuttings (ptas)	Operation costs for the planting of 4687 cuttings ($ USA)
Ground and irrigation preparation	14,800	98.66
Plastic sheet and covering	7,800	52.00
Taking of cuttings	30,000	200.00
Hormonal solution	13,000	86.66
Preparation, disinfection and planting	36,000	240.00
Weeding	6,000	40.00
Pruning and cleaning before uprooting	22,000	146.66
Power, water, fertilisers and insecticides	19,000	126.66
Uprooting and transport to conservation chambers	22,000	146.66
Paying-off of irrigation instalation	3,000	20.00
Direction and administration	14,000	93.33
Total circulating capital (C.C.)	187,600	1,250.66
Interest on circulating capital (10%/C.C.)	18,760	125.06
Total	206,360	1,175.73

1 $ USA = 150 ptas.

Average cost of planted cuttings (4687 units): 44.03 ptas/unit (0.29 $ USA).
Cuttings planted in the test: 1110 units.
Rooted cuttings in the test: 1017 units.
Rooting coefficient: 1017/1110 = 0.9162.
Average cost of rooted cuttings: 44.03/0.9162 = 48.06 ptas/unit (0.32 $ USA).
Average rooting percentage: 91.62%.

From the study carried out, it can be deduced that:

(i) Rooting was very high for all cuttings, especially clones ME12, CRO2 and PTO8, which reached 100%. The clones with lowest rooting percentages are the weakest ones such as ME1 and ME14, which is attributed to the fact that these cuttings have fewer reserves; many of these cuttings had a diameter of less than 5 mm.

(ii) Covering the soil with the 60-gauge black plastic sheet led to an increase in soil temperature which helped in the rooting of the cuttings, and led to excellent vegetative development.

(iii) The use of the cover, and the favourable temperature and humidity conditions created by it in the rooting area, can substitute the effect of IBA, as observed in clone VA2, where the 12,000 ppm IBA solution did not improve the rooting percentage.

(iv) Using Student's test to compare media for the rooting of the clones in this test, and setting a confidence interval with the test carried out in 1997 (without the plastic cover), it was found that, with a 99% confidence level, rooting is much higher in 1998. The increase is attributed to the plastic cover technique used this year.

(v) The plastic cover, as well as increasing the rooting percentage, saves large quantities of water and cuts labour costs. These savings, along with the saving produced as a consequence of the increased rooting, can be valued at 28.69 ptas/cutting (77.46 ptas/unit – 48.06 ptas/unit), which means a reduction of 37% in costs compared to the technique without the plastic cover.

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