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Study of the rooting capacity of ten pomegranate clones (*Punica granatum* L.)

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SUMMARY – Hardwood cuttings are the most commonly used method of propagation of rootstocks and, in many cases, of varieties. The experiment was carried out in the open air at normal temperatures, taking hardwood cuttings from trees cultivated in homogeneous conditions. These were planted on 18/2/97, immediately after they had been taken and were evaluated on 14/7/97. Two factors which effect root formation were studied: (i) treatment with indole butyric acid (IBA) at four concentrations (2000, 4000, 8000 and 12,000 ppm); and (ii) wounding at the cuttings' base. The results clearly demonstrate that IBA generally increases the percentage of rooting (although not at all concentrations), with 12,000 ppm producing the best results in the clones studied. In addition, wounding carried out at the base of the cutting further increased the percentage of rooting in most of the clones studied.

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

RESUME – *"Etude de la capacité d'enracinement de dix clones de grenadier (*Punica granatum *L.)". Des boutures de vieux bois sont la méthode la plus utilisée de propagation des porte-greffes et, dans beaucoup de cas, des variétés. L'expérience a été menée à l'air libre à des températures normales, en prélevant des boutures de vieux bois sur des arbres cultivés dans des conditions homogènes. Elles furent plantées le 18/2/97, immédiatement après avoir été prélevées et furent évaluées le 14/7/97. Deux facteurs affectant la formation de racines furent étudiés : (i) le traitement avec de l'acide indol butyrique (IBA) à quatre concentrations (2000, 4000, 8000 et 12 000 ppm) ; et (ii) les blessures à la base des boutures. Les résultats ont montré clairement que l'IBA augmente généralement le pourcentage d'enracinement (quoique pas pour toutes les concentrations), les meilleurs résultats étant produits chez les clones étudiés avec 12 000 ppm. En outre, les blessures faites à la base des boutures ont encore augmenté le pourcentage d'enracinement chez la plupart des clones étudiés.*

Mots-clés : *IBA, enracinement, bouture de vieux bois, blessure, grenadier.*

Introduction

Rhizogenesis is the most frequently used organogenetic phenomenon in pomegranate (*Punica granatum* L.) vegetative multiplication. Specific bibliography on rooting of pomegranate hardwood cuttings, in Spain and worldwide, is scarce, although during the last decade some investigations have been carried out on the subject, which never go further than the scope of the country or region where the species is cultivated. Hartmann and Kester (1987) affirm that for the majority of 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) state that there has to be supporting heat for the cuttings to improve multiplication, and that there should be a heat difference between the air and the soil. This was ratified by Amorós *et al.* (1997) who worked with pomegranate cuttings in hot beds, showing that cuttings at 22°C presented a higher rooting percentage than those at 18°C and at normal temperatures; as also indicated by Hartmann and Kester (1987), who fixed the ideal temperature between 21 and 27°C – higher than the environment – with the heat applied to the base of the cuttings, which helped to stimulate rooting.

In addition, the use of hardwood cuttings, as opposed to semi-hardwood and herbaceous cuttings, gives a higher rooting percentage; and higher concentrations of IBA application also increases rooting percentage and the number of roots formed (Ghosh *et al*., 1988; Sandhu *et al*., 1991; Singh, 1994).

The aim of this work is to study the rooting capacity of different pomegranate clones, taking into account certain factors which influence root formation in hardwood cuttings of this species. In

particular, tests are carried out with IBA application and wounding at the cuttings' base, as factors which are capable of increasing rooting in different clones. This study will show propagation possibilities and output for some interesting varieties of clones, and others that could be interesting as rootstocks.

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 and BA1. 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 the above trees when they were ripe (one-year-old wood). They were cut on 6/2/97, disinfected, and planted on 18/2/97. The middle and base parts of the branch were chosen for the cuttings, as the ends are normally too thin, with lower reserves content, and they are less suitable for rooting, as we have seen previously in different rooting tests with this species.

The cuttings were submitted to a hormone treatment by rapid immersion in IBA at different concentrations, and to wounding at their base. The IBA treatment was carried out by submerging the base part of the cutting (approximately the last two centimetres) for 5 seconds in a IBA solution dissolved in 95% ethyl alcohol. A control solution was also prepared without hormones. This method has the advantage that the amount of hormone applied per surface unit is constant, and the same solution can be used several times, always making sure that the treatment is carried out in a short time period to reduce the risk of alcohol evaporation, and so avoiding changes in the solution concentration. Four different IBA solutions were prepared: 2000, 4000, 8000 and 12,000 ppm. Other cuttings were also wounded at their base (4 incisions in the last 2 centimetres). The treatments carried out were: T0 – control; T1 – 2000 ppm IBA; T2 – 4000 ppm IBA; T3 – 8000 ppm IBA; T4 – 12,000 ppm IBA; T5 – wounding at the base.

The cuttings were planted directly in the soil, with at least two exposed buds in each case, in double rows with 15 cm between cuttings. They were watered by drip irrigation using the same pipe and separated approximately 20 cm within each line; each double row of cuttings was separated by 1 m, to facilitate weeding and cutting control. The average temperatures during the months in which the tests were carried out were as shown in Table 1.

Table 1. Average temperatures (°C) in 1997

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
11.7	13.9	14.2	16.8	20.3	24.4	24.5	25.7	23.5	21.2	15.5	12.7

Rooting control of the cuttings was carried out on 14/7/97, and uprooting with bare roots was done on 23/12/97 by a tractor with a mould-board.

Results and discussion

The results of the described rooting test are summarised in Table 2, in which the different treatments and results are shown.

The studied clones can be grouped according to their use and productivity. ME1, ME11, ME12, ME14, MC1 and SFB1 are not as tough as CRO2, PTO8, PDO1 and BA1. Clones PDO1 and BA1 are not suitable for fresh fruit consumption because of their seed hardness and because BA1 is a sour clone.

Table 2. Treatments and results of the test†

Clone	T	NCP	NCR	R (%)	Clone	T	NCP	NCR	R (%)
ME1	T0	13	1	7.69	SFB1	T0	39	28	71.79
	T1	13	2	15.38		T1	39	35	89.74
	T2	12	4	33.33		T2	40	33	82.50
	T3	12	2	16.67		T3	39	33	84.62
	T4	12	3	25.00		T4	38	37	97.37
	T5	12	1	8.33		T5	39	34	87.18
ME11	T0	21	11	52.38	CRO2	T0	36	22	61.11
	T1	21	10	47.62		T1	36	31	86.11
	T2	21	15	71.43		T2	34	32	94.12
	T3	21	12	57.14		T3	36	29	80.56
	T4	21	14	66.67		T4	36	34	94.44
	T5	21	12	54.55		T5	36	35	97.22
ME12	T0	24	14	58.33	PTO8	T0	39	32	82.05
	T1	24	10	41.67		T1	39	30	76.92
	T2	24	11	45.83		T2	37	25	67.57
	T3	24	8	33.33		T3	39	22	56.41
	T4	24	18	75.00		T4	39	26	66.67
	T5	26	12	46.15		T5	49	33	67.35
ME14	T0	12	3	25.00	PDO1	T0	28	28	100.00
	T1	12	2	16.67		T1	32	32	100.00
	T2	12	5	41.67		T2	46	38	82.61
	T3	12	4	33.33		T3	31	31	100.00
	T4	12	6	50.00		T4	35	35	100.00
	T5	13	4	30.77		T5	38	38	100.00
MC1	T0	34	19	55.88	BA1	T0	37	35	94.59
	T1	31	19	61.29		T1	37	30	81.08
	T2	30	24	80.00		T2	37	31	83.78
	T3	33	21	63.64		T3	37	33	89.19
	T4	30	25	83.33		T4	37	34	91.89
	T5	33	26	78.79		T5	37	37	100.00

†T: treatment; NCP: no. of cuttings planted; NCR: no. of cuttings rooted; R: % rooting.

Clone ME1 is the least tough, which makes it less suitable for obtaining cuttings for rooting.

The costs of reproducing pomegranates by hardwood cuttings are set out and evaluated in Table 3. Although in the present study only ten clones are analysed (with a total of 1732 cuttings planted), the analysis of the economic costs has been carried out for a higher number of clones and a total of 15,811 cuttings planted, which makes the unitary costs of pomegranate hardwood cuttings more representative. In Table 3 the costs are shown in Spanish pesetas (ptas) and in USA dollars ($ USA).

For clone ME1, the control test (T0) gave a rooting percentage similar to the wounding treatment (T5), with the highest rooting percentage for treatment T2, with 33.33% (4000 ppm IBA), followed by T4 (12,000 ppm) with 25.00%. For clone ME11, the rooting percentage is similar for T0 and T5, with the highest rooting percentage for T2 with 71.43%. For clones ME12, ME14, MC1, SFB1 and CRO2, the highest rooting percentage was obtained with treatment T4 (75.00, 50.00, 83.88, 97.37 and 94.44% respectively), with lower rooting percentages for the rest of the treatments. For clone CRO2, the highest rooting percentage was obtained with treatment T5 (97.22%), followed by T4 and T2 (94.44 and 94.12%) respectively. For clone PTO8 no influence is observed with the treatments, with the highest rooting percentage being obtained with T0 (82.05%). For clone PDO1, there is no influence with the treatments, with a rooting percentage of 100% for T0, T1, T3, T4 and T5. For clone BA1 there is no influence with the IBA treatments, with rooting percentages of 94.5% for T0 and 100% for T5, and lower results with the IBA treatments, with the highest of these being T4 (91.89%).

Table 3. Costs of preparation, cultivation and uprooting of cuttings

Operation	Operation costs for the planting of 15,811 cuttings (ptas)	Operation costs for the planting of 15,811 cuttings ($ USA) †
Ground and irrigation preparation	44,400	296.00
Taking of cuttings	88,500	590.00
Hormonal solution	58,500	390.00
Preparation, disinfection and planting	160,000	1,066.66
Weeding	200,000	1,333.33
Pruning and cleaning before uprooting	66,000	440.00
Power, water, fertilisers and insecticides	85,600	570.66
Uprooting and transport to conservation chambers	66,000	440.00
Paying-off of irrigation installation	9,000	60.00
Direction and administration	42,000	280.00
Total circulating capital	820,000	5,466.66
Interest on circulating capital (10%/820,000)	82,000	546.66
Total	902,000	6,013.33

†1 $ USA = 150 ptas.

The results obtained have been submitted to a rooting variance analysis, which showed significant differences with a 95% confidence level for the different clones tested, with the clone itself having a big influence on the rooting percentage. The LSD multiple range test showed that there are significant differences with a 95% confidence level for the rooting percentage depending on the treatment the cuttings received, and that there are differences between treatments T0-T4, T1-T4 and T3-T4. Finally, from the analysis, it can be deduced that treatment T4 gives the highest rooting percentage.

Average cost of planted cuttings (15,811 units): 57.05 ptas/unit.
Cuttings planted in the test: 1732 units.
Rooted cuttings in the test: 1271 units.
Average rooting coefficient: 1271/1732 = 0.7338.
Average cost of rooted cuttings: 57.05/0.7338 = 77.75 ptas/unit (0.518 $ USA/unit).
Average rooting percentage: 73.38%.

Conclusions

From the study carried out, we deduce that:

(i) The least tough clones give a lower natural rooting percentage, and this can be increased by IBA applications in high concentrations, with 12,000 ppm IBA (T4) giving the best results (ME11, ME12, ME14, MC1, SFB1).

(ii) Wounding at the cuttings' base (T5) produces similar or higher rooting percentages in most of the clones than low concentration IBA applications (ME1, ME11, ME14, MC1, SFB1, CRO2).

(iii) The very tough varieties have a very high natural rooting capacity, which is not increased by IBA application nor by wounding (PDO1 and BA1). The latter show an exceptional ability for natural propagation with hardwood cuttings, and is the clone which had the highest rooting percentage.

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