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Nicotra A., Pellegrini M.

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A. NICOTRA
M. PELLEGRINI
IINSTITUTO SPERIMENTALE
PER LA FRUTTICOLTURA
ROMA (ITALY)

RESUME - L'amandier, le pêcher et différentes espèces de prunier, des potentiels porte-greffes pour l'amandier, ont été revisés en vue de leur facilité de propagation par bouture. Ainsi les cultivars et les sélections les plus facilement multipliés ont été identifiés dans le but de les utiliser comme parents potentiels dans des programmes d'amélioration génétique pour porte-greffes d'amandier de facile multiplication végétative.
Mots-clés: Amandier, pêcher, prunier, propagation.

SUMMARY - Almond, peach and several plum species, potential rootstocks for almond, are reviewed regarding their propagation ability by cuttings in order to identify the cultivars and selections more easily propagated. These could be used as parents in breeding programmes of new vegetatively propagated rootstocks for almond.
Key words: Almond, peach, plum, propagation.

Potential almond rootstock, and thus main genetic sources for the breeding of its new rootstocks are almond itself, peach and plum, and these species cross-breeds.

Almond is a source of resistance to limestone and to drought because of its roots, which reach deep layers of soil; it is also more resistant than peach to Na and Bo.

Peach generally gives more vigorous plants, and has various sources of resistance to root knot nematodes (Meloidogyne sspp); it furthermore presents a good graft compatibility with almond cultivars.

The various types of plum are generally far the most resistant to waterlogging. The Marianna plum is resistant to Oak Root fungus (Armillaria mellea), to root knot nematodes, and to Phytophtora sspp. but its graft compatibility is not always good with all cultivars; the Prunus domestica (Brompton, St. Julien, Damas), and some Myrobalan (P. cerasifera) clones have a good graft compatibility with almond.

Taking into account all the aforesaid genetical sources, the ideal aim for a breeder is to concentrate in an individual seedling the most of the positive characters existing in almond, peach, plum or prune.

Easy propagation is an indispensable characteristic required for any rootstock program. Infact, leaving all the other characteristics out of consideration, no new rootstocks or lines of stock can be put into commercial use if propagation performance in the nursery is not fully satisfactory.

Asexual or vegetative propagation is an hereditable characteristic (32-37-41) and this paper is a review of genetical sources available on this character for almond rootstock breeding.

Almond

The bibliographic reference regarding this species, vegetative propagation is very poor. Within Titan, Tuono, Cristomorto, Atocha, Sovietskij and Garrigues cultivars, only the Garrigues hardwood cuttings are able of emitting adventitious roots (86 %), if treated with IBA at 4000 ppm (10). Arrubia cultivar cuttings have given 60 % rooting (50).

The populations originated from cross breeding an Almond B x Texas haven't shown any ability of propagation by hardwood cutting (25) even if Texas hardwood cuttings are able to produce adventitious roots (tab. 1).

Table 1 shows the rooting percentages obtained in a two-year experiment involving 77 almond cultivars, using the bottom heating technique and IBA at 2000 ppm. The table only registers the highest values obtained during the two years. From the results it is possible to deduce that almond is a species of difficult propagation by hardwood cutting. Infact, only 26 varieties have emitted adventitious roots, and only 7 varieties have given values higher than 30% (M 51, M 49, Ferragnes, M 55, Genco, M 50 and Texas). The M selections are seedlings cultivated at the Instituto Sperimentale per la Frutticoltura of Rome.

The Cristomorto, Tuono and Sovietskij cultivars, also tested by Felipe with negative results (10), have confirmed this negative trend. The Marcona and Bartre varieties, which have given 40% rooting ability in experiments carried out in

France, and clearly inferior rooting percentage in experiments carried out in Italy (tab. 1), transmit this propagation characteristic to their cross-breeds with peach (7).

Table 1

ROOTING ABILITY OF ALMOND VARIETIES BY HARDWOOD CUTTINGS (IBA 2000 PPM): IN THE TABLE ARE SHOWN THE HIGHEST ROOTING PERCENTAGES OBTAINED IN A TWO YEAR TRIAL (NICOTRA, MOSER, UNPUBLISHED DATA)

VARIETY	ROOTING %	VARIETY	ROOTING %
M 51	80.0	BARTRE	12.0
M 49	60.0	ARDECHOISE	11.0
FERRAGNES	52.0	FOURCURONNE	11.0
N 55	40.0	PICANTILE	8.0
GENCO	39.0	M 52	7.0
M 50	35.0	MORSKA	6.0
TEXAS	31.0	CRISTOMORTO	5.0
FERRADUEL	29.0	SANTORO	4.0
ESPERANZA	28.0	FILLIPPO CEO	4.0
RACHELE	17.0	TUONO	4.0
MARCONA	13.0	FASCIONELLO	3.0
CRISTAL	13.0	CONVENIO	3.0
M 53	13.0	M 54	3.0

Following varieties did not root:

AI	FRA GIULIO	PIZZUTELLA
A LA DAME	IXL	POINTURE D'AVREILLE
BARI	ITALIA	PRIMORSKI
BREZENAUD	JALTANO	PRINCESSE
BURBANK	JORDANOLO	RANA
CASTELTERMINI	KAPAREIL	RETSIOU
CAVALIERA	LANGUEDOC	RIEDENHOME
CRISTAR	MALAGUEÑA	SOVETSKI
DAWEY	MAZZETTO	TARDIVE DE LA VER-
DHEN	MIAGKUSCULUNEM	DIERE
DESMAYO LARGUETA	MOLLAR DE TARRA-	THOPMSON
DESMAYO ROJO	GONA	TOKIO
DISTOMOU BIOTAS	MONTRONE	TRAITO
DOREE	NEC PLUS ULTRA	VERA
DRAKE	NON PAREIL	VESTA
FLOTS	NORTHLAND	VIAZZANO
FLOUR EN BAS	OCCHIO ROSSO	
FOURNAT DE BREZE-	PEERLESS	
NAUD	PILUSEDDA	

Peach

The bibliography regarding this species is large.

In an experiment carried out on hardwood cuttings of 164 varieties of peach treated with IBA at 2000 ppm dissolved in alcohol or ammonia, 141 varieties have shown an ability of giving out adventitious roots. 19 of these, that is the 11% of the varieties, have given values higher than 30% of rooting (tab. 2).

Table 2

PEACH VARIETIES GIVING PERCENTAGE OF ROOTED CUTTINGS HIGHER THAN 30% (NICOTRA, DAMIANO 1975).

VARIETY	ROOTING %	VARIETY	ROOTING %
FLORDAHOME	80.3	N.J. 211	38.0
PROF. BLACK	80.0	CASCATA	35.1
BARONESA	65.2	PREMIER	35.0
HD 24 II/22	59.1	ARNAUD N. 3	33.3
BELVEDERE	56.0	B 27/30	33.3
WALGUANT 2	53.7	MALUTI	32.6
C 516 - 347	52.4	N.J. 183	32.5
W FLA FLORDABE-	46.4	FV 89 - 14	32.4
LLA		WALGUANT 1	32.1
FLORDARED	45.8	GIALLA DI	
FLORDASUN	45.0	MORSIANI 2	30.4
XAVANT	41.3	FERTILIA II	30.3

The following varieties rooted less than 30 %:

AMARILLO DE AGOSTO 1 (0.0), ANDROSS (0.0), ARMGOLD (8.6), BABCOK (20.0), BABY GOLD 5 (0.0), BABY GOLD 6 (16.7), BABY GOLD 8 (15.4), BABY GOLD 9 (25.0), BELLA DI CESENA PRECOCE (13.3), C 31/243 (7.1), CAMPILLO (4.0), CANDIOLI (3.4.), CANDOR (5.7), COLORADO (11.7), CORONADO (0.0), CRESTHAVEN (0.0) DAWNE (4.6), DI FRANCIA 1 (0.0), DI FRANCIA 2 (21.0), DIXIGEM 1 (20.0), DIXIGEM 2 (0.0), DIXON 1 (2.1), EARLY BABCOCK (10.0), EARLY CORONET (4.8), EMERY (3.1), ENVOY (13.3), F 14-71 (22.5), F 47-70 (13.3), F 51-99 (10.9), F 52-103 (15.2), PEKIN (12.5), FAVORITA III MORETTINI (10.8), FAY ELBERTA (3.6), FILLETTE (13.9), FLAVIA (0.0), FLORDAQUEEN (19.4), GAGE ELBERTA (13.0), GARNET BEAUTY (8.3), GAUME (0.0), GENADIX (17.6), GENADIX 7 (6.9), GIALLA DI MORSIANI 1 (5.5.), GOLDEN BLUSH (1.8), GOODMAN'S CHOISE (9.1), GOOSEN (5.9), HALE HARRISON (28.6), HALE HAVEN (2.7), HD 15 III/22 (10.2),

HD 20 III/22 (3.6), HD 22 II/22 (16.0), HD 26 II/22 (23.8), HD 27 II/22 (24.3), HD 25 III/22 (8.0), HEARLY HILEY (20.0), HF 7 (III) 11 (19.0), HR 16 IV/23 (2.9), JUNGERMAN (0.0), KAKAMAS (17.4), KEIMOES (0.0), KLAMT (3.7), LA GOLD (21.7), LA PREMIERE (4.5), LA RED 1 (2.8), LA RED 2 (0.0), LATE SUN-HAVEN (4.8), LIZZIE (15.0), LOVELL (3.3.), MARGLOW (4.5), MARINA (4.5), MERRIL AURORA (8.7), MERRIL FORTININER (11.8), MERRIL GEM (0.0), MERRIL JUNE (9.4), MONROE (13.9), MORETTINI 20 V 23 (4.0), MORETTINI 10 V 23 (9.5), MOUNTINGOLD (23.1), MR. HIGH (3.6), NORMAN (20.0), N.J. 231 (7.4), N.J. 642020119 (0.0), N.J. 642038007 (1) (18.2), N. J. 642038007 (2) (3.5), N. J. 642040062 (8.8), N. J. 642144009 (20.0), N. J. 642148040 (0.0), N.J. 652042073 (7.4), N.J. 652148030 (7.1), N.J. C 68 (4.5), N.J. C 80 (14.3), N.J. C 81 (12.1), N.J. C 82 (4.0), N.J. N 59 (11.5), N.Y. 2604 (2.8), N.Y. 2622 (2.8), PARAGON (10.5), PI 5 (0.0), PI 54 (22.6), PIEDMONGOLD (19.0), PO 978 (4.8), PO 1384 (21.9), PRINCESA (18.5), RARITAN ROSE (1.8), REDHAVEN (10.0), RED QUEEN (7.7), REDWIN (0.0), ROBIN (0.0), ROUBIDOUX (14.3), S. ANNA BALDUCCI (0.0), SOMERNEE (0.0), SPRIN-GOLD (22.8), SPRINGTIME (4.0), STARNA (5.0), SULLIVAN (22.4), SUDANELL (4.0), SUNRISE (0.0), SUNSHINE (0.0), TERZAROLA GIALLA (0.0), TRIO-GEM (24.0), TROY (18.2), TYLER (11.1), V 46-108 (24.0), VESUVIO (6.0), VIVIAN (2.9), WASHINGTON (7.9), 16-33 FLA (26.7), 318-12 FLA (18.5), 10-48 FLA (6.3), 19 V 23 (7.9), 1372 FLA (26.3), 642019064 (6.7), 44 RR 51-173 (12.5), 17-2 NW FLA (11.5), 6421441014 (6.4), 603014 (27.5), 632075020 (4.0), 652041058 (6.0), 652042077 (23.7), 642022048 (2.3), 632052018 (6.3), 624422 (12.9), 642021040 (2.5).

As with almond, the IBA treatments have been essential for the obtaining of rooting. Although the ability of generating roots induced by the two treatments seems to be related to the variety, in general the treatment with alcohol used as a solvent has turned out best.

Hardwood cuttings of nectarine varieties seem to have a clearly higher rooting ability than those of peach varieties. Infact, in an experiment carried out on 29 varieties, 28 have shown rooting ability; 23 of them, that is the 80% of the whole, have a rooting ability higher than 30% (tab. 3).

This tendency is confirmed by the experiments carried out by Bartolini and others, in which the hardwood cuttings of 40 peach cultivars have given an average rooting percentage of 70%, and the 13 nectarine cultivars one of 80%.

Other genetic sources of the rooting characteristic have been found in seedlings originated from different F_1 of Rancho resistant, S 37, S 60, S3328, Nemaguard, GF 305, GF 677 and Harrow blood. These seedlings which have been selected for their resistance to Root knot nematodes, have also shown excellent rooting ability by hardwood cutting (tab. 4).

Table 3

PROPAGATION ABILITY OF NECTARINE VARIE-TIES BY HARDWOOD CUTTINGS (NICOTRA, MO-SER, 1979)

VARIETIES	TEST	IBA 2000	IBA 4000
ANGELO MARZOCCHELLA	0.0	20.0	8.0
CAVALIER	0.0	33.3	31.1
CRIMSON GOLD	0.0	35.0	30.0
C 516-347 FLA	6.7	83.3	96.7
F 14-17	0.0	12.0	16.0
F 100-37	0.0	62.5	20.0
JOHN RIVERS	0.0	0.0	0.0
LEXINGTON	0.0	48.6	37.1
MAY GRAD	0.0	30.0	40.0
MOON GRAND	0.0	42.8	60.0
MORTON	2.0	70.0	70.0
NECTARED 1	0.0	57.1	20.0
N. J. N 38	0.0	40.0	44.4
N. J. N 40	0.0	75.0	22.5
N. J. N. 54	0.0	48.6	22.8
N. J. N. 57	0.0	52.5	40.0
N. J. N. 59 1	0.0	51.4	45.7
N. J. N. 59 2	0.0	31.7	16.7
N. J. 603014	0.0	85.0	41.7
N. Y. 1017	0.0	25.0	15.0
N. Y. 2603	0.0	18.3	30.0
PANAMINT	0.0	52.0	38.0
POCAHONTAS	0.0	23.3	16.0
RED JUNE	0.0	13.3	6.7
RUBY GOLD	0.0	60.0	54.3
STARK EARLY FLAME	0.0	75.0	37.5
STARK SUNGLO	0.0	30.0	17.5
SUNGOLD	0.0	70.0	82.0
V.P.I. 61	5.4	85.4	74.5
Mean	0.004	46.210	35.645

It is evidet that Nemaguard, GF 305 (tab. 5), and GF 677 (28), whose cuttings are able to root, transmit this characteristic to their offspring. Some of the above mentioned seedlings reach a rooting and taking ability that is next to a success of 100%.

Therefore peach (and nectarines) can generally be defined as a species which root esasily, as can also be observed from table 5.

Table 5

PEACH AND NECTARINE PERCENTAGE OF ROOTING OBTAINED BY DIFFERENT AUTHORS

VARIETIES	ROOTING %	REF.
PROF. BLACK	100	(2)
MORETTINI 286	100	(47)
SUNGOLD*	99.7	(8)
LORING	98.6	(8)
BLAKE	98.5	(8)
SPRINGOLD	98.5	(8)
MONGRAND*	97.1	(2)
REDHAVEN	96.1	(8)
MAYGRAND*	96.0	(2)
MORTON*	96.0	(2)
CORONET	95.6	(8)
MORETTINI 5/14	95.0	(47)
MORETTINI 1	95.0	(47)
P.S. B2	95.0	(28)
GOLDEN MONARCH	93.8	(8)
BICENTENNIAL	93.7	(8)
MAYFLOWER	93.3	(2)
BABCOCK	93.3	(9)
NEMAGUARD	93.0	(8)
REDSKIN	92.5	(8)
ROYALGOD	92.5	(2)
1-8-2 clone	91.3	(19)
MORETTINI 1/14	90.0	(47)
SUNRED*	90.0	(2)
GOLDEN EAST	90.0	(2)
FLAMEKIST*	90.0	(2)
FUZZLESS-BERTA*	88.9	(2)
NECTARED 10*	87.0	(2)
FLAVORTOP*	85.0	(2)
PRECOCISSIMA	85.0	(47)
PESCIA	85.0	(14)
CARDINAL	85.0	(2)
GF 305	85.0	(3)
SUNNYSIDE	83.6	(2)
MISSOUR	83.3	(13)
EARLY GRAND	82.1	(9)
CANDOR	82.0	(2)
MARCUS	82.0	(2)
EARLY ROSE	82.0	(2)
FLORDAWON	80.0	(2)
P.S.A. III	79.0	(4)
TOKANE	78.0	(2)
WOLFEMADE	77.3	(2)
MALHERBE	77.0	(2)
MARGLOW	77.0	(2)
STARK EARLY FLAME*	76.0	(2)
CORAL	75.0	(2)

VARIETIES	ROOTING %	REF.
MARQUEEN	75.0	(2)
EARLY AMBER	73.1	(2)
BOKHARA peach x x BOKHARA peach	72.7	(25)
13-72	72.4	(9)
M. FRANCISCAN	72.1	(2)
FERTILIA I	72.0	(2)
WHITE KNIGHT 2	72.0	(2)
NEETHLING	70.2	(2)
LOVELL	70.0	(8)
CRIMSON GOLD*	69.1	(2)
1455	69.0	(9)
KAKAMAS	69.0	(52)
TEJON	68.9	(2)
RELIANCE	68.0	(44)
OOM SAREL	67.0	(52)
ROCHON	66.7	(2)
ARMGOLD	66.0	(2)
COLORA	66.0	(2)
INDEPENDENCE*	66.0	(2)
PANAMINT*	61.8	(2)
MALUTI	61.7	(2)
P.S.A. VI	61.0	(4)
EARLY CORONET	60.0	(2)
RHODES	60.0	(9)
RARITAN ROSE	56.7	(2)
WHITE KNIGHT	55.5	(2)
FLORDABELLE	55.2	(2)
ANTONIO DI FRANCIA	54.0	(2)
EARLYGOLD	51.1	(2)
MARLAND	51.0	(2)
OKINAWA	43.5	(52)
MADISON	42.0	(44)
ELBERTA CLING	40.0	(2)
CULEMBORG	39.0	(52)
NECTARED 6*	38.7	(2)
CAMPIEL	37.0	(2)
RANGER	34.3	(2)
VANRIEEBECK	30.0	(52)
VARKPERSKE (white flesh)	27.0	(52)
SUMMERQUEEN	27.0	(2)
BOLAND	25.0	(52)
EARLY DAWN	24.0	(52)
FAY ELBERTA	14.0	(25)
ELBERTA	13.0	(52)
PEREGRINE	12.0	(52)

* Nectarines (ref. = references)

Table 4

ROOTING ABILITY BY HARDWOOD CUTTING (IBA 2000 PPM) OF PROGENIES ORIGINATED FROM DIFFERENT MOTHER PLANTS

MOTHER PLANTS	PERCENTAGE OF ROOTING OF THE PROGENIES
F_1 of RANCHO RESISTANT/M	48.0
F_1 of RANCHO RESISTANT/2-3	65.0
F_1 of RANCHO RESISTANT/4	75.0
F_1 of RANCHO RESISTANT/5	69.0
F_1 of S 60	57.0
S 3328	47.0
NEMAGUARD	66.0
GF 305	58.0
GF 677	39.0
HARROW BLOOD	55.0

This table shows rooting percentages in using hardwood or softwood cuttings, based on results obtained from various Authors.

Plums and Prunes

Many genetic sources for easy propagation are found as far as this species is concerned. Before all, of course, stand plum rootstocks of stone fruits, such as Myrobalan, St. Julien, Brompton, etc., which were selected by their breeders mainly because of their ability for easy vegetative propagation. Their ability of propagation by hardwood cutting often reaches 100% success (tab. 6).

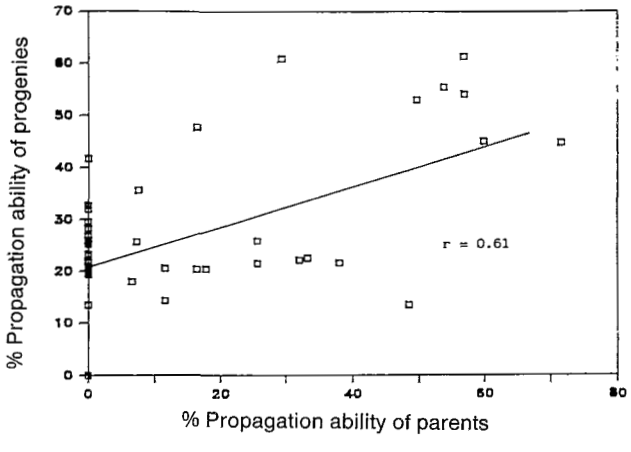
Many plum varieties show potential ability of propagation by hardwood cuttings. In an experiment carried out on hardwood cuttings of 65 varieties treated with IBA at 2000 ppm dissolved in alcohol or ammonia, 38 varieties have been able to develop adventitious roots. 12 of these, that is over the 18% of the varieties, had rooting values higher than 30% (tab. 7).

As far as plum is concerned, on the contrary of peach, the treatement with IBA dissolved in ammonia has given higher average rooting values than IBA dissolved in alcohol, even if the single varieties have given different results to the two different types of treatment.

The Japanese types of plum (n = 8 chromosomes) tested by various authors in a definitely inferior number than European plums, seem however to have an average ability of propagation by hardwood cutting superior to the European types of plum (n = 24 chromosomes) (tab. 6 and 7). This is even more evident if compared with the experiments carried out by Nicotra and Moser who have tested the propagation ability of populations originated from 64 varieties of the European type, 17 of the Japanese type, and populations originated from 11 rootstocks (tab. 8). The propagation ability has infact been of an average of 18.1% for the European type populations, of 31.0% for Japanese ones, and 54.75 for the populations originated from rootstocks.

Obviously rootstocks, which have a high degree of ability for vegetative propagation, in proportion, are able to better transmit this characteristic to their offspring.

The easy propagation characteristic is thus hereditary. The ability of propagation by hardwood cutting of many varieties has infact been compared to that of their offspring, and it has been possible to observe that there exists a strict relationship between the two (graph 1). This characteristic seems however to be regulated by many genes.



Grap. 1 - Correlation between the propagation ability of the parents and that one of their progenies (Nicotra, Moser, 1987)

Table 6

PLUMS AND PRUNES: PERCENTAGE OF ROOTING OBTAINED BY DIFFERENT AUTHORS

VARIETIES	ROOTING %	REF.
MARIANNA 2624*	100	(38)
MIRABOLANO BIANCO*	100	(38)
MIR. LESDAIN*	100	(38)
MIRABOLANO B*	100	(38)
VERITY	100	(43)
MARIANNA GF 8-1	97.5	(38)
STANLEY	93.7	(43)
MIROB. P 31-6*	92.5	(38)
S. ROSA**	92.5	(4)
BEAUTY**	91.0	(4)
SORRISO DI PRIMAVERA**	89.0	(4)
PECHE	85.7	(38)
SAN GIULIANO A*	83.0	(20)
EMLA-BROMTON*	78.4	(27)
PRECOCE DI EBERSUCIER	76.9	(4)
ALUBUKHARA	76.0	(48)
FIORENZA**	75.0	(3)
VALOR	75.0	(43)
KUBAN	74.0	(29)
TULEU TIMPURI	73.1	(43)
OZARK PREMIER**	71.0	(3)
MORETTINI-243**	70.0	(36)
ELEPHANT HEART**	68.0	(3)
KLAIMEN	67.0	(49)
ARBUZNAYA	66.1	(49)
KRASNAYA KRASAVITSA	65.5	(49)
YUZNAYA KRASAVITSA	64.8	(49)
JEFFERSON	62.0	(36)
EARLY GOLDEN**	58.0	(36)
CLAUDIA DI BAVAY	52.2	(4)
PRESIDENT	52.0	(3)

VARIETIES	ROOTING %	REF.
SHIRO**	51.0	(3)
REGINA CLAUDIA VERDE	49.0	(3)
PRECOCE DI GIUGNO	48.0	(4)
ANNA SPATH	46.5	(49)
P 450	46.0	(36)
VERNGERKA DIOMASHNYAYA R.	45.8	(49)
CAMBRIDGE GAGE	44.0	(4)
S. PIERO	43.6	(4)
BPR 32	40.0	(42)
TULEU GRAS	38.5	(43)
ELDORADO**	38.0	(3)
PRUGNA DI DRO'	38.0	(36)
CASALINGA	34.0	(36)
CLAUDIA VERDE	33.2	(4)
POZEGACA	28.0	(36)
FAVORITA DEL SULTANO	26.0	(36)
VINETE ROMANESC CLONE 300	25.0	(43)
MASCINA DI MONTEPULCIANO	23.0	(3)
FORLI'II	22.5	(36)
PRECOCE DI ERSINGER	21.0	(3)
GIANT	18.0	(36)
MORETTINI 355**	12.0	(36)
GRASS ROMANESC	11.5	(43)
PERSHORE	10.0	(3)
MONTPORT	8.0	(3)
SUGAR	7.0	(3)
MONSIEUR HATIF	4.0	(36)
RUTH GERSTETTER	4.0	(36)
PRUGNA D'ITALIA	3.0	(3)
P 711	2.0	(36)

* Clonal rootstocks ** Japanese types (ref. = references)

Table 7

PLUM AND PRUNE VARIETIES GIVING PERCENTAGE OF ROOTED CUTTINGS HIGHER THAN 30% (NICOTRA, DAMIANO, 1975)

VARIETY	ROOTING %	VARIETY	ROOTING %
LATE S. ROSA*	80.0	MORETTINI 243*	52.0
FK 9-7*	72.0	S. ROSA*	48.0
TULEU DULCE	68.0	DE BORDEAUX	48.0
ROYAL DE TOORS	60.0	N.Y. 858	42.0
FORLI'II	56.0	VALOR	38.0
JORI'S PLUM	52.0	QUEENSTON	32.0

The following varieties rooted less than 30%

BERNARDINA (14.0), BORDACE DE COTNARI (0.0), BREMOND (19.2), BURTON P.88 (0.0), CASALINGA (0.0), DAME AUBERT (0.0), DE MONTFORT (0.0), FAVORITA DEL SULTANO (28.0), FORLI' I (0.0), FORLI' III (9.6), FRENCH IMPROVED (0.0), GIANT (1.3), GITHANE (1.3), GRAS-ROMANESCU (0.0), IMPERIAL-EPINEUSE (0.0), ITALIA (0.0), ITALIAN-PRUNE (0.0), JEFFERSON (0.0), LAXTON BOUNTIFUL (24.0), LINCOLN (26.7), LO CZAR (1.0), MASCINA DI MONTEPULCIANO (2.0), MOHAWK (0.0), MONSIEUR HATIF (6.0), MORATELLO (0.0), N. Y. 929 (0.0), ONEIDA (2.0), ONTARIO (14.7), P 450 (6.0), P 632 (6.0), P 711 (0.0), POND'S SEEDLING (2.7), POZEGACA (1.0), PRUGNA DI DRO' (0.0), RED HEART* (0.0), REGINA CLAUDIA MOSTRUOSA (0.0), REGINA CLAUDIA VERDE (0.0), REGINA D'ITALIA (8.0), RICHARD EARLY ITALIAN (0.0), RUTH GERSTETTER (1.0), SHROPSHIRE (0.0), SIMONIS (0.0), S. M. PORTOLANO (18.7), SUGAR (0.0), SUSINO II (8.3), SUSINO DI BRIKINI (1.3), TIMPURI DE AIUD (0.0), TRAGEDIE (1.0), TULEU TIMPURI (12.0), UTILITY (1.3), ZUCCHELLA (18.7).

* Japanese types.

Table 8

PROPAGATION ABILITY BY HARDWOOD CUTTING (IBA 2000 PPM) OF PROGENIES ORIGINATED FROM DIFFERENT PLUM AND PRUNE VARIETIES (NICOTRA, MOSER 1987)

VARIETIES	MEAN PERCENTAGE OF THE PROGENIES PROPAGATED BY HARDWOOD CUTTING
EUROPEAN TYPES	
ANNA SPATH	19.2
BARDACE DE COTNARI	20.4
BERNARDINA	12.4
BLUEFRE	20.0
BORSUMER	5.9
CASALINGA	13.6
DE AIUD*	15.3
DE BORDEAUX	14.7
DE MONTFORT	44.4
EARLY LAXTON P 848	42.8
FAVORITA DEL SULTANO	14.2
FORLI' I*	22.4
FORLI' II	5.4
FRENCH IMPROVED*	11.4
GITLANE	9.6
GRAS ROMANESC	12.7
IMPERIAL CALIFORNIA	12.9
IMPERIAL EPINEUSE	15.6
ITALIA	15.7
ITALIAN PRUNE	11.1
JORI'S PLUM*	23.5
LAXTON'S BOUNTIFUL	44.1
LINCOLN	12.2
MONSIEUR HATIF	6.1
MORATELLO	13.8
N. Y. 858*	42.8
ONEIDA*	36.5
ONTARIO	18.3
P. 450	10.8
P. 632	3.3
P. 711	15.7
POND'S SEEDLING	20.5
POPESTI*	15.9
POZEGACA*	24.9
PRUGNA D'ENTE	6.8
P. D'ENTE 707	11.3
PRUGNA DI DRO'	45.5
QUEENSTON*	30.9
QUETSCHE D'ALSACE	13.6

Table 8 (Cont.)

PROPAGATION ABILITY BY HARDWOOD CUTTING (IBA 2000 PPM) OF PROGENIES ORIGINATED FROM DIFFERENT PLUM AND PRUNE VARIETIES (NICOTRA, MOSER 1987)

VARIETIES	MEAN PERCENTAGE OF THE PROGENIES PROPAGATED BY HARDWOOD CUTTING
EUROPEAN TYPES (Cont.)	
REGINA CLAUDIA VERDE	18.2
REGINA CLAUDIA VIOLETTA	28.1
REGINA D'ITALIA	55.0
REGINA VITTORIA	21.4
ROPLUMA	5.9
ROSIOR VARATEC*	27.6
SENECA	10.7
SHROPSHIRE*	29.2
SIMONS	5.4
STANLEY*	11.7
SUSINA DEL MACCHINISTA*	27.3
SUSINA DI BRIKINI	12.8
SUSINO II*	34.0
TIMPURI DE ALBACH	6.4
TULEU DULCE	23.2
TULEU GRAS	14.7
TULEU TIMPURI*	12.1
UTILITY	0.0
VALOR	13.6
VENGERKA BORDOVAJA*	41.9
VENGERKA KIBRASKAJA*	33.5
VERITY	9.1
VINETE ROMANESTI	4.6
VISION	9.1
ZUCCHELLA	13.5
mean	**18.1**

Table 8 (Cont.)

PROPAGATION ABILITY BY HARDWOOD CUTTING (IBA 2000 PPM) OF PROGENIES ORIGINATED FROM DIFFERENT PLUM AND PRUNE VARIETIES (NICOTRA, MOSER 1987).

VARIETIES	MEAN PERCENTAGE OF THE PROGENIES PROPAGATED BY HARDWOOD CUTTING
JAPANESE TYPE	
BURBANK	25.4
DUARTE	53.8
EARLY GOLDEN*	63.8
FIALETOVAJA DESERTNAJA	29.9
FK 5-7	21.9
LARODA*	29.0
MORETTINI 243*	5.9
PLODORODNAJ*	33.8
REDHEART	18.7
REDROY	1.3
SAN MICHELE PORTOLANO*	19.2
SATSUMA	16.5
SHIRO*	26.8
SIEMLIANICA*	62.2
SIMKA*	47.2
STARKING DELICIOUS*	53.8
WICKSON*	17.2
mean	**31.0**

Table 8 (Cont.)

PROPAGATION ABILITY BY HARDWOOD CUTTING (IBA 2000 PPM) OF PROGENIES ORIGINATED FROM DIFFERENT PLUM AND PRUNE VARIETIES (NICOTRA, MOSER 1987)

VARIETIES	MEAN PERCENTAGE OF THE PROGENIES PROPAGATED BY HARDWOOD CUTTING
ROOTSTOCKS	
DAMASCHINO*	40.3
DAMAS GF 1869*	42.5
MARIANNA GF 8-1*	48.5
MYROBALAN B*	77.0
MYROBALAN 29-C*	92.1
MYROBALAN GF 31*	54.7
MYROBALAN LESDAIN*	67.8
MYROBALAN P. 31-6*	65.6
PRUNIER GF 43*	30.2
S. JULIEN A	50.0
S. JULIEN GF 655-2*	31.9
mean	**54.7**

(Varieties with* originated some seedlings whose propagation ability was higher than 75%).

Bibliography

1. BARBEAU, G., et EL BOUAMI, A. (1980): «Les hybrides 'amandier x pêcher' naturels du Sud marocain». *Fruits,* 35 (3) 171-176.

2. BARTOLINI, G.; BELLINI, E., et MESSERI, C. (1979): «Influenza dell'epoca del prelievo sulla radicazione delle talee di cultivar di pesco a diverso fabbisogno in freddo». *Riv. Ortofruttic. It.,* 63 (5) 343-355.

3. BARTOLINI, G., et ROSELLI, G. (1979): «Ricerche sulla propagazione del susino per talea di ramo: 3 - radicazione ed attecchimento in talee legnose di susini con o senza radici preformate». *Riv. Ortofruttic. It* vol. 63 n.º 1.

4. BARTOLINI, G., et ROSELLI, G. (1975): «Ricerche sulla propagazione del susino per talea di ramo. 2. Moltiplicazione di alcune cultivar di P. domestica L. fornite di radici avventizie preformate». *Riv. Ortofruttic. It.,* 59 (5) 340-347.

5. BERNHARD, R., et CLAVERIE, J. (1986): «Le bouturage d'extrémités semi-ligneuses application à diverses espèces fruitiéres à noyaux«. *Cinquième colloque sur les recherches fruitiéres.* Pont-de-la-Maye, France, CTIFL-SDIT, 229-236.

6. BERNHARD, R. et GRASSELLY, Ch. (1981): «Les pêchers x amandiers». *Arboricolture Frutière,* n. 238.

7. BERNHARD, R.; GRASSELLY, Ch., et SARGER, J. (1976): «Possibilites d'emploi des hybrides F1 intra-et interspecifiques pour l'amélioration et la sélection des porte-greffes d'arbres fruitiers à Noyaux». *Proccedings Eucarpia meeting on tree fruit breeding.* Wageningen (Pays Bas), 7-10 sept. 1976 52-62.

8. COUVILLON, G.A., and EREZ, A. (1980): «Rooting, survival and development of several peach cultivars propagated from semi-hardwood cutting». *Hort Science,* 15 (1) 41-43.

9. EREZ, A., et YABLOWITZ, Z. (1981): «Rooting of peach hardwood cuttings for the meadow orchard». *Scientia Horticulturae,* 15 (2), 137-144.

10. FELIPE, A. (1984): «Enracinement de l'Amandier par bouturage ligneux». *5th G.R.E.M.P.A., Options méditerranéennes,* IAMZ, 2, 97-100.

11. FELIPE, A.R., et SOCIAS COMPANY, R. (1975): «Un amandier sauvage, probablement A. WEBBII, non encore mentionne en Espagne». *2nd Colloque du G.R.E.M.P.A.,* CIHEAM, Montpellier, France.

12. FIORINO, P. (1968): «Prove di moltiplicazione dell'albicocco da talee mediante la tecnica della nebulizzazione». *Riv. Ortofruttic. Ital.,* 52, 481-3.

13. FIORINO, P., et VITAGLIANO, C. (1968): «Nuove tecniche per ottenere barbatelle di pesco. III. Ulteriori ricerche sulla nebulizzazione». *Riv. Ortoflorofruttic. Ital.,* 52, 779-95.

14. FIORINO, P., et ZUCCONI, F. (1968): «Nuove ricerche per ottenere barbatelle di pesco. I Ricerche sulla 'Nebulizzazione'».

FIORINO, P.; Idem. II. Ricerche sulla «Propaggine per trincea». *Riv. Ortoflorofruttic. Ital.* 52, 205-12.

15. GRASSELLY, Ch. (1969): «Les porte-greffes du pêcher. Travaux de selection-possibilités d'application». *Journ. fruit.,* 111-23. Avignon.

16. GRASSELLY, Ch. (1969): «Etude de la compatibilité de l'amandier (Prunus Amygdalus L. Batsch) greffé sur divers pruniers». *Ann. Amelior. Plant.,* 19 (3), 365-276.

17. GRASSELLY, Ch., et DAMAVANDY-KOZAKONANE, H. (1974): «Etude des possibilités de production d'hybrides F1 intra-et interspécifiques chez le sous-genre amygdalus». *Ann. Amelior. Plant.,* 24 (4), 405-414.

18. GRASSELLY, Ch.; GALL, H., et OLIVIER, G. (1977): «Etat d'avancement des travaux sur les porte-greffes de l'Amandier». *3rd Colloque du G.R.E.M.P.A.,* Bari, Italy.

19. HANSEN, C.J., et HARTMANN, H.T. (1968): «The use of indolebutyric acid and captan in the propagation of clonal peach and peach-almond hybrid rootstocks by hardwood cuttings». *Proc. Amer. Soc. Hortic. Scie.,* 92, 135-140.

20. HOWARD, B.H., et NAHLAWI, N. (1968): «A progress report on the propagation of some new plum rootstocks from hardwood cuttings». *A.R.E., Malling Research Station,* A52, 71-3.

21. HOWARD, B.H., et NAHLAWI, N. (1969): «Factors affecting the rooting of plum hardwood cuttings». *J. Hortic. Sci.,* 44, 303-310.

22. JONES, R. W. (1969): «Selection of intercompatible almond and root-knot nematode resistant peach rootstock as parents for production of hybrid rootstock seed». *J. Amer. Soc. Hortic. Sci.,* 94: 89-91.

23. KESTER, D.E. (1975): «Almond rootstock research in California». *2nd Colloque du G.R.E.M.P.A.,* Montpellier, France.

24. KESTER, D.E., et HANSEN, C.J. (1966): «Rootstock potentialities of F1 hybrids between peach (P. persica L.) and almond (P. amygdalus Batsch)». *Amer. Soc. Hortic. Sci.,* 89.

25. KESTER, D. E., et SARTORI, E. (1966): «Rooting of cuttings in populations of peach (P. persica L.), almond (P. amygdalus Batsch) and their F1 hybrids». *Proc. Amer. Soc. Hort. Sci.,* 88, 219-23.

26. KOCHBA, J., et SPIEGEL-ROY, P. (1972): «Resistance to root-knot nematode in bitter almond progenies of almond x Okinawa peach hybrids». *Hort Science.* Vol. 7 (5).

27. KOSINA, J. (1983): «Moŝnosti mnoŝeni Klonuº slivoňovych podnoŝire relenych ŝizkuº». *Progresîuni Směry Ovocnářské Uỳrobé Holorousy,* Czechoslovakia; Vỳzkumnỳ a Slechtitelskỳ Ustav Oovoknářskỳ, 135-140.

28. LORETI, F.; MORINI, S., and GRILLI, A. (1985): «Rooting response of PS B2 and GF677 rootstock cuttings». *Acta Hort.* 173, 261-269.

29. MASKOVA, S.A. (1984): «Nauchno-Tekhnickeskiĭ Byulleten Vsesoyuznogo Ordena Lenina i Ordena Druzhby Narodov Naucno-issledovatel's Kogo Instituta Rastenievodstva Imeni N.I., Vavilova» 137, 50-54.

30. MERCADO-FLORES, I. and KESTER, D.E. (1966): «Factors affecting the propagation of some interspecific hybrids of almond by cuttings». *Proc. Amer. Soc. Hortic. Sci.,* 88, 224-31.

31. NAHLAWI, N., and HOWARD, B.H. (1971): «Effect of position of IBA application on the rooting of plum hardwood cutings». *J. Hortic. Sci.,* 46 (4), 535-543.

32. NICOTRA, A. (1970): «Prove di radicazione di talee legnose di albicocco mediante la tecnica del riscaldamento basale». *Ann. I.S.F.,* 1 (1), 137-146.

33. NICOTRA, A. (1971): «Prove di radicazione di talee di 'S. Giuliano A' mediante la tecnica del riscaldamento basale». *Ann. I.S.F.,* 2 (1).

34. NICOTRA, A. (1973): Prove di radicazione di talee legnose di numerose varietà di albicocco. *Ann. I.S.F.,* 4, 213-217.

35. NICOTRA, A.; CAPPELLINI, P. (1972): «Prova di radicazione di talee legnose di varietà di albicocco trattate con IBA». *Ann. I.S.F.,* 3, 397-410.

36. NICOTRA, A.; CAPPELLINI, P. (1974): «Indagine sulla capacità di radicazione di talee legnose di numerose cultivar di susino». *Ann. Ist. Sperl. Frutic.,* 5 (1).

37. NICOTRA, A.; DAMIANO, C. (1975): «Rooting trial of several peach and plum varieties by hardwood cuttings». *Acta Hort.* 54.

38. NICOTRA, A.; MOSER, L. (1978): «Propagazione di diversi portinnesti utilizzando talee legnose conservate in frigorifero». *Ann. I.S.F.,* IX, 57-70.

39. NICOTRA, A.; MOSER, L. (1979): «Propagazione per talea legnosa di varietà di nettarine». *Atti Incontro Frutticolo SOI-IF* su «Problemi e prospettive della coltura delle nettarine». Roma, 13 luglio 1979.

40. NICOTRA, A.; MOSER, L. (1984): «Prunus Tenella as an hypothetic rooststock for sweet cherry». *Ann. I.S.F.,* XV.

41. NICOTRA, A., and MOSER, L. (1987): «Breeding program for peach rootstocks resistant to waterlogging». *Eucarpia Fruit Breeding Section Meeting.* Hradec Kràlovà, Czechoslowakia. sept. 7-11.

42. OLDEN, E. J. (1978): BPr 32-en longrundstam för plumon framställd vid Balsgard. Tidskrift för Frukt-och Barolding, 20 (1) 14-18.

43. POPESCU, S., et STANCIU, N. (1986): «Capacitatea de autoinràdacinare a mor soiuri de pomifructiferi». *Productia Vegetalà, Horticultura.* 35 (9) 9-14.

44. ROBITAILLE, H.A., and YU, K.S. (1979): «Cuttage propagation of peaches». *Compact Fruit Tree,* 12, 95-97.

45. ROSELLI, G.; PISANI, P.L., et CERULLI, M. (1985): «Osservazioni sul comportamento di alcuni ibridi di Prunus davidiana x P. persica come portinnesti del pesco». *Inf. Agra.* 41 (12) 75-81.

46. RUGINI, E., et VERMA DEVI, C. (1982): «Micropropagation of difficult-to-propagate almond (Prunus amygdalus, Batsch) cultivar». *Plant Science Letters,* 28 (1982-1983), 273-281.

47. SCARAMUZZI, F. (1965): «Nuova tecnica per stimolare la radicazione nelle talee legnose di ramo». *Riv. Ortoflorofruttic. ital.* 49, 101-4.

48. SOHAN SINGH: (1978): «Propagation of plum by cuttings». *Punjab Hort. J.,* 18 (1/2) 62-64.

49. UMAROV, A. (1985): Nauchnye Trudy. Tashkentskiĭ Sel's-kokhozyaĭstvennyé Institut, 114, 58-60. Da Referatiunyé Zhurnal.

50. VAIRA, G. (1969): «La propagazione per talea legnosa del mandorlo». *Riv. Ortoflorofrutt. Ital.* Vol. 53, 55-60.

51. VLASIC, A. (1977): «L'Amygdalus webbii Spach ed i suoi ibridi col pesco come portainnesti del mandorlo». *2nd Colloque du G.R.E.M.P.A.,* C.I.D.A.M., Montpellier, France.

52. ZYL, H.J. VAN, and JOLLY, P.R. (1971): «Results of rooting experiments with peahc and apricot hard-wood cuttings». *Deciduous Fruit Grower,* 21 (5) 104-108.