

Susceptibility to peach leaf curl (*Taphrina deformans* Berk.) Tul. in a peach germplasm collection

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SUMMARY

The susceptibility of 1103 peach genotypes (738 dessert peach, 168 clingstone, 197 nectarines) and 152 unselected seedlings to leaf curl (*Taphrina deformans*) was assessed. No cultivars rated zero, which is equivalent to immunity, only six rated 1, while 62% had the highest susceptibility rating 5. Presence or absence of leaf glands and fruit type were not correlated to resistance or susceptibility. The distribution of the different fruit type and the unselected seedlings over the various susceptibility categories indicates a loss of resistance to leaf curl during selection for improved agronomic characters.

PEACH leaf curl, *Taphrina deformans* (Berk.) Tul. causes considerable damage, especially in areas where springs are cold and damp; frequent applications of fungicide are necessary for its control. Resistant cultivars would be very useful and highly desirable but until now all cultivars have proved to be more or less susceptible with the exception of a single seedling noted by Fideghelli *et al.* (1983), and a few resistant selections recently described by Bellini *et al.* (1993).

Resistance appears to be controlled by two or three genes (Hesse, 1975; Monet, 1984). In breeding programmes, it is important to assess resistance and where possible, to correlate it with other phenotypic characters (morphological, anatomical, biochemical) that could prove useful in early progeny screening.

Correlations have been found between the absence of leaf glands and resistance to leaf curl, and between susceptibility and the possession of reniform glands. Rivers (1906) and Hesse (1975) found an association between the possession of globose glands and moderate susceptibility, but Simeone (1987) found no correlation between susceptibility and number, type and position of glands on leaves. The nectarine trait (an absence of pubescence) has also been correlated with a higher tolerance than the presence of pubescence (Hesse, 1975), but the opposite has also been reported

(Ritchie and Werner, 1981). Another positive correlation between resistance and a reduced susceptibility to flesh-browning was reported by Clayton *et al.* (1976).

The aim of this study was to evaluate leaf curl susceptibility of a large peach collection, to seek sources of resistance, and to determine whether any phenotypic traits could be correlated with that resistance and how these related to the geographical origin of the material.

MATERIALS AND METHODS

The investigation was carried out in 1992 on 1103 cultivars of the peach germplasm collection at the Santa Paolina experimental station in Follonica (Grosseto) on the west coast of Italy. Four 15 year old plants, grafted on peach seedlings and trained as free "palmetta", at a spacing of 5 m × 5 m were considered for each cultivar. The trees had not received any routine fungicide treatments for leaf curl since the winter of 1990 and by the spring of 1992 were showing severe symptoms although these varied in severity among the genotypes.

The cultivars, surveyed from June 1992 onwards, consist of 738 dessert peach, 168 clingstone peach for canning and 197 nectarines.

Infection was evaluated on a 0-5 scale (Ackerman, 1953), in which the percentage of infected leaves and the percentage of leaf area showing symptoms was assessed as:

TABLE I
List of peach cultivars for susceptibility grade to leaf curl

Class 1	Monroe	Percoca Romagna 2
<i>peach</i>	Morettini 146	Prof. Neethling
Lorenzini	Neroday	Pullar's cling
Lucchese Tardina	Orion	Ricciana
Morellone	Precoce Sansavini	San Marti
	Presidente	Toil Anh
<i>nectarine</i>	Prete	Tres Dias
Lippiat's Late Orange	Primavera Morettini	Tufts
	Regina	Vivian
<i>clingstone</i>	Rio Grande	Woltemade
Paloro	Rosa Dardi	Xixos
Walgant	Royal April	
	Safari	
	Salway	Class 4
Class 2	San Pierre	<i>peach</i>
<i>peach</i>	Septembriska	Alexander
Alberge Jaune	Southern Glow	Amsden
Dupnisca	Springbrite	Amsden Precoce
Fitzgerald	Stark Delicious	Amsden Sel. 42
Fogado Precoce	Stark EarliGlo	Army
Precoceissima Morettini	Sunnyside	Auvil July Elberta
	Sunray	Bella Cartesienne
<i>nectarine</i>	Swellengrebel	Belvedere
Lord Napier	Tardiva Di Firenze	Bianca Casali Tardiva
Morton	Tunisia 344/15	Bianca Russotto
	Valsecchia	Blake
<i>clingstone</i>	Waccler	Boland
Ciani 1	Western Pride	Bonita
Cotogna del Berti	White Knight 1	Brackett
Cotogna di Rosano 1	White Knight 2	Camden
Pavia Giallo 1	Zachary Taylor	Capucci 2
		Capucci 3
		Cardinal
Class 3	<i>nectarine</i>	Cascata
<i>peach</i>	Armqueen	Ceriale
Albatros	Armred	Charles Roux
Amber Gold	Gold Mine	Cherryred
Aurora	H 6318	Colorado
Bella Di Roma Precoce	Incognita Zanzi	Cornonese
Blazing Gold	Lamberubis	Coronet
Brighton	Mayred	Dawne
Cardinal 20094/9	Mericrest	Dorata Tardiva
Cardinal G.F.S. 24/32	Nectarine 785	Double Delight
Ciani 2	N.J. 38	Dugelay
Collins	Nectarina Dwarf	Earlible
Desertgold	Pocahontas	Earligold
Earlihale Sel.	Redbud	Early Amber
Early Coronet	Redchief	Early Elberta
Early Hale	Sunlite	Early Gold Dust
Favorita II Morettini	64-15	Early White Giant
Fior Di Maggio		Envoy
Fogado Tardivo	<i>clingstone</i>	Erlyvee
Gialla Nunziati	Black	Excellens
Giallo Della Fogliaccia	Code 35	Fairhaven
Giant Freestone	Cotogna	Favorita I Morettini
Giulia Settembrina	Cotogna Ceccarelli	Favorita III Morettini
Imperani	Cotogna Cicalini	Fayette
Ingwe	Cotogna Del Padule	Fertilia I Morettini
Inkoos	Cotogna Del Poggio 1	Fertilia II Morettini
Italia 61 Precoce	Cotogna Di Rosano	Fidai
Jondet	Cotogna Massima	Fillette
Krümmler October	Escarolita	Flamecrest
Lucchese Prima	Goosen	Flordabelle
Madaleine Pouyet	Jolly 1 A	Flordahome
Martinis 23 Est	Jolly 2	Flordared
Merrill Red Lady	Kakamas	Florida
Merrill Scarlet Lady I	Keimoes	Francia I
Merrill Sundance	Maluti	Gabriella
Merveille Garet	Moroni 2	

TABLE 1—*continued*

Gaillard 2	Mikado	Xavante
Gaillard 4	Miorita	
Garnet	Morettini 1/14	<i>nectarine</i>
Garnet Beauty	Morettini 291	A. Marzocchella
Gemmers Late Elberta	Morettini 1636	Armking
Gialla Bellini	Morettini 4436	Autumn Grand
Gialla Di Ferrara	Morettini 14/II	Bob Grand
Gialla Di Piangipane	Muir	Camariet
Gialla Tardiva di Cogo	Mutazione Fior Di Maggio	Crimson Gold
Giant Elberta	Newday	Early Sungrand
Giant Elberta B	Pacemaker	F 11/97
Ginared	Pesco Di Acireale	F 67/95
Golden Amber	Pesco Di Vigna	F 69/47
Goldgem	Ponte Romano	F 100/62
Goldray	Poppa Di Venerè Settembrina	Fairlane
Groncher	Pourpree Dott. Bernard	Fantasia
Grossa Gialla Di Verona	Prairie Dawn	Favols
Guichard	Precoce Di Saumachez	FLA 3-3
Hale Sel. 570	Redcap	FLA 3-4
Harbelle	Redhaven	FLA 3-6
Harken	Regina D'Autunno	Francia III
Herb Hale	Regina Di Montalcino	Francia V
Herholdt's Banner	Regina Elena	Francia VIII
Herholdt's Summer Pride	Ribet	Fuzalode
Incomparabile Vilmorin	Rochester	Garden State
Isontina	Rochon	Giuglianese
Jaune D'Ales	Royal Crest	Golden Grand
Jerseyqueen	Royal Crimson	H 2111-D
Kayred	Royal Gold	H 6310-C
Kenlate	Roza P.O. - 1384	Jacquotte
Keystone	Rubidoux	June Belle
La Gold	Rubigoot 2	Lafayette
La Red	Rubired	Madame Baltet
Late Crawford	Semenzale Londa A	Madonna Di Agosto
Late Elberta	Sentinel	May Grand
Late Suncrest	Silver Logan	Moneymaker 2
Lemon Free	Slappay	Moon Grand
Liana Baruzzi	Slivenska Kompotna	N.Z. 2
Lizzie	Solo	Nectarose
M.me Kira Evreinoff	Somervee S. 1842	Niagara
Madame Beauty	Springold	Red Grand
Madame Bey	Springtime V.E.	Red June
Madison	Starking Delicious	Ruby Gold
Maglia Rosa	Summergold	S 137-139-205-61
Magnific 47	Suncland	S 137-139-205-63
Magnific 87	Sunhigh	S 137-148-168-61
Magnific 89	Sunshine	Stark RedGold
Magnific 90	Supercardinal	Sunbright II
Mamagan	Surpasse Amsden	Sungrand 2
Marcus	Tardiva Di Renacci	Sunking
Marhigh	Tardiva Fresu	Sunrich
Marsun	Tardiva Goretti	Sweet Gold
Matthews Beauty	Tardiva Zuliani	V.P.I. 67
Merrill Autumn Gem	Tos-China-Ottobre	V.P.I. 171
Merrill Bonjour	Trevisana	8 P 525
Merrill Carnival	Trionfo	
Merrill Delicious	Tulip	<i>clingstone</i>
Merrill Fiesta	Tunisia 318/12	AL 43124
Merrill Franciscan	Tunisia 352/6	Andora
Merrill Gem Free	Vanity	Antonio Di Francia
Merrill Halloween II	Vedoka	Atecestvennii
Merrill Harmony	Vellutata Di Hollywood	Avanguard
Merrill July Lady	Velvet	Babygold 6
Merrill June Lady	Ventura	Bowen
Merrill Pacifica	Vittorio Emanuele III	Code 26
Merrill Pacifica (clone BO)	Welcome Hale	Cotogna Pandolfini
Merrill Pacifica (clone VR)	Wheeler	Dixon 1
Merrill Sparkle	Whynot	Experimental 4
Merrill Tardif Pec. 545	World's Earliest	Farida

TABLE 1—*continued*

Fino Calabacero PEC 301	Bella Di Bussolengo	Colora
Gaume	Bella Di Cesena	Com-Pact Redhaven
Halford	Bella Di Cesena Precoce	Comanche
Halford II	Bella Di Cotignola	Conflent
Herrington	Bella Di Georgia	Cordioli
Jungerman	Bella Di Praizzola	Crawford E. Improved
Klamt	Bella Di Roma Tardiva	Cresthaven
Kremliovskij	Bella Rita	Cropopus Num. 3
Luscanese	Bellezza	Cumberland
Mallorqui	Benoni	Daniela
Masterpiece	Benvenuto Bianca	Danilo Bianca
Merrian	Bertacchina	Dantin
Moneymaker	Bianca Fantino	Daroga Red
Myojo	Bianca Tardiva Del Friuli	De Gasperi
Nuevo	Bianca Tardiva Mattarelli	Delicious
Oom Sarel	Biscoe	Delle Serre
Paragon	Bompieri	Desideria
Paragon II	Bonetti 1	Dessie
Peak	Bonetti 2	Dewson
PEC 112	Bonvicini	Di Montaldo
Percoca Molinella	Botto	Dixigem
Percoca Romagnola 7	Breviglieri 2	Dixiland
Phillips Cling	Buco Incavato	Dixired
Riccia 'e Fuoco Tardiva	Buco Incavato Sel A	Dorata J-3
Roqueta Gelat	Buco Incavato Sel C	Dottor Gökai
Sims	Buco Incavato Sel F	Earlhale
Sovietskij	Buco Incavato Sel I	Earlfired
Starn	Burbank Elberta	Early Babcock
Sweeney	Burrona Di Rosano	Early Crawford
Tatura Aurora	Burrona Di Terzano	Early Fair Beauty
Tokane	Buttapietra	Early Hiley
Ximelis	Buttercup	Early Redhaven
Zaragoza Encarnado	California Tardiva	Early Rivers
	Camillo Mancini	Early Rochester
	Campione	Early Rose
Class 5	Canadian Harmony	Earlycrest
<i>peach</i>	Candoka	Eclipse
Admirable Jaune	Candor	Eden
Admiral Dewey	Capucci 1	Elberta
Afterglow	Capucci 3 Migliorata	Elberta Cling
Agnazly	Capucci 6	Elberta Precoce
Agostina	Capucci 11	Elberta Queen
Alamar	Capucci 13	Electa
Alba D'Oro	Capucci 14	Emery
Albertina	Capucci 15	Erly-Red-Fre
Aletta	Capucci 16	Eureka
Ambergem	Capucci 17	Facchin
Amsden Capucci	Capucci 18	Fair Beauty
Amsden San Giovanni	Capucci 19	Fairtime
Amsden Tardivo Ponton	Capucci 20	Fay Elberta
Armgold	Capucci 23	Ferradia
Arnaud Num. 3	Capucci 24	Fiammesco
Arp	Capucci 25	Ficksburg
Arp Beauty	Carlo Zanzi	Fillette Precoce
Autumn	Carman	Fior Di Monaco
Autumn Gold	Cascina	Fireball
Aves	Celeste Impero	Fireglow
Aviatore	Cereser (S. Lucia)	Flachat
Babcock	Cervetto	Flavorcrest
Badogno	Cesarini	Fleury
Baldassarri	Charles Ingouf	Flordaqueen
Barbara	Chievo	Flordawon
Baronesa	Chili	Fontana 3/53
Bayer	Chilon	Fontana Tardivo
Begnin	Chjeri	Frank
Beicabin	Cimatti	Friuli
Belfiore	Cinamomo	Frumos De Baneasa
Bella Anita	Cinzia	Gage Elberta
Bella Di Borgo D'Ale	Ciocolan	Gaillard 8

TABLE I—*continued*

Gaillard 9	La Gem	Midway
Galdrik	La Premiere	Miglioranzo
Genadix 5	Lambertin Num. 1	Miniera D'Oro
Genadix 6	Late Glo	Mora Di Moriano (Dolfi)
Genadix 7	Late Gold	Mora Di Moriano (Nottoli)
Generale	Late Sunhaven	Morettini 286
Gentile Della Crocetta	Laterose	Morettini 293
Gialla Del Garda	Laura	Morettini 0/14
Gialla Di Briganza	Laureat	Morettini 1
Gialla Di Firenze	Lavarone	Morettini 2
Gialla Di Oppi	Lenin	Morettini 5/14
Gialla Di San Bartolomeo	Littorio	Morettini 5/22
Gialla Di Zevio	Loring	Morettini 9/14
Gialla Morsiani	Luisa Berselli	Morettini 11/14
Gialla Num. 2	Lutea	Moroni 1
Gialla Precoce Cremonini	Madaleine De Courson	Moscattello
Gialla Precoce Morettini	Maddalena Reale	Moscattellone
Gialla Valgimigli	Magnific 43	Mutazione Mamie Ross
Giulietta	Magnific 45	Mutazione Moscatello
Glohaven	Magnific 46	Mutazione Pieri 81
Gloria	Magnific 76	Nectalseatly
Gold Dust	Magnific 79	Nector
Golden Globe	Magnific 92	Ninotto
Golden Honey	Magnolia	Nora Fortusini
Golden Jubilee	Malik	Norman
Golden Logan	Malinovij	Nuova Europa
Goldencast	Mamie Ross	Okubo
Goldenred	Maravilha	Olinda
Goldfinch	Marglow	Oriole
Goldkugel	Marigold	Ozark
Goodcheer	Marilyn	Palazzina
Greensboro	Marina	Parva
Grezzano	Marland	Peach-Arine
Grossa Di Montagna	Marpride	Pekin
Guidi	Marqueen	Peregrine
Guldoniana	Mater Beauty	Pesco Fortusini
Hakuto	Mazenaud	Pesco Poli
Hal-Berta Giant	McGuigan	Pfalzperle
Hale Castagnoli	McKay	Pieri 81
Hale Harrison	Meraviglia Di Verona	Pietro
Hale Precoce	Meredith	Pillar
Halehaven	Merrill 3	Pirovano 510
Harbinger	Merrill Aurora	Pirovano 519
Harbrite	Merrill Beauty	Pisana I-13
Harrison	Merrill Early O'Henry	Platicarpa
Henri Adenot	Merrill Elegant Lady	Plummer
Henri Moulin	Merrill Fortyniner	Polly
Hickman's Elberta	Merrill Gem	Poppy
Hiland	Merrill Gem Cling	Potu
Hinners Hale	Merrill Gem Free 1	Prairie Daybreak
Holu 26/V	Merrill Gem PEC 135	Precoce Bicocchi
Honey Dew Hale	Merrill Goldrush	Precoce Di Thrace
Impero	Merrill Hale	Prodigiosa
Impero II	Merrill Halloween	Pulchra
Impero Precoce	Merrill June	Purpurea
Incomparabile Gouilloux	Merrill Lisbeth	Pushstyjy Rannyj
Indian Blood Cling	Merrill Mardigras I	Ranger
Iris Rosso	Merrill May Lady	Raritan Rose
J.H. Hale	Merrill O'Henry	Reale Di Pescantina
Jefferson	Merrill Rodeo	Red Bird Cling
Jocznyj	Merrill Scarlet Lady I	Red Gold
Julia	Merrill Tardif Pec. 546	Red Robin
Juliana	Merrill Tardif Pec. 547	Redcrest
July Elberta	Merrill Tardif Pec. 548	Redelberta
July Heat	Merrill Tardif Pec. 549	Redentore
June Gold	Merrill Treasure	Redglobe
Kalhaven	Meteor	Redhaven Bianca
Kappa 2	Michelini	Redqueen
Kweckersgood	Michigold	Redrose

TABLE 1—*continued*

Redskin	Triestina	Kay Grand
Redtop vf	Triogem	King David 3
Redwing	Troy	Lamberoyal
Ree	Tyler	Late Le Grand
Regina Di Londa	Uneeda	Le Grand
Reliance	Up-To-Date	Le Grand Sel.
Richhaven	Valeria	Leopoldo Conforti
Rio Oso Gem	Valiant	Lexington
Robin	Vecchi 74	Lily Baltet
Romeo	Vecchi 87	Lola
Rosso Perina	Vedette	Love
Rossone Della Costa	Veneziana	Mabiba
Rosu Dangat	Vesper	Maria Aurelia
Rouge Julienne	Victor	Maria Emilia
Roza	Vigiù Dorsello	Maria Laura
Rubidoux Sel. Mangidvacchi	Vincitore	Meldolesi
San Giorgio	Vincitore Sel. 17	Merrill X
San Gottardo	Vito	Mid Gold
San Michele Giallo	Vivid	Mirian
San Michele Rosso	Waddell	Nectacrest
San Pietro	Washington	Nectaheart
San Vigilio	Wildrose	Nectalate
San Vito	William's Gem	Nectared 2
Sanguigna	Winblo	Nectared 3 Bis
Sant'Anna	Wright's Bountiful	Nectared 4
Sant'Anna Balducci	Zambelli	Nectared 6
Santa Lucia	2174 P	Nectared 7
Santa Maria (R. di B0)		Nectared 8
Segattini	<i>nectarine</i>	Nectared 10
Segreto Di Cogo	Aurelio Grand	Nectarine 26
Selvaggio Di Canove	Autumn Free	Nectarine 27
Selvatico Rosegaferro	Berçon	Nectarine 601
Semenzale Londa B	Blood Fleshed	Nectarine 602
Semenzale Londa C	Brugnon 101	Nectarine 719
Semenzale Londa D	Cavalier	N.J. 40
Serena Baruzzi	Cherokee	N.J. 55-10-29
Shilling Pride	Clargold	N.J. 56
Smock	Croquelardit	N.J. 57
Sogood	Durbin	N.J. 59
Southhaven	Early Sunrise	N.J. 63-21-17002
Southland	Fertilia Mutata	N.J. 624462
Sovietique	Firebrite	New Yorker
Spectabilis	Firegold	Novelred
Spicca Bianca	Flamekist	N.Y. 2603
Springcrest	Flaming Gold	Obil 'niyj
Sputnik	Flavortop	Panamint
Stardust	Fuzzless-Berta	Pesco Noce Cardinale
Sullivan E. Elberta	Fuzzless-Berta vf	Pesco Noce C.T.
Summerqueen	Fra Le Russe	Pesco Noce Numero 1
Summerset	Francesco	Pesco Noce Pescagialla
Summertime	Francia II	Philp
Sunago Wase	Francia VI	Precoce Castelli
Sunbeam	Francia VII	Precoce Di Croncels
Suncrest	Freedom	Quetta
Suncrest vf	Fruda	Red Diamond
Sundar	Galopin	Red Free
Sunhaven	Garden Beauty	Rhone Gold
Sunland	Garden Delicious	Rose
Sunqueen	Garden Delight	Royal Giant
Sunrise	General Camel	Rubired
Superba	Golden Prolific	Russa Gialla
Supergem	Golden State	San Castrese
Suwanee	Granderli	Silver Lode
Tabalet	Hardired	Silver Prolific
Tardiva Di Caiano	Harko	Spring Red
Tejon	Honey Gold	Stanwich
Tilo	Independence	Stark Delicious
Tondona	Independence Screapo	Stark Earliblaze
Topazio	Kay Gold	Stark Grand II

TABLE I—*continued*

Stark SunGlo	Carson	Orange Cling
Summer Grand	Chairs Choise	Pavie William
Sunbrite	Coral	PEC 299
Sunhared	Corona	PEC 536
Sungold	Coronado	Percoca Romagnola
Sungrand	Cortez	Percoca Romagnola 1
Sunred	Cotogna Del Castellare 1	Percoca Romagnola 3
S 137-158-236-61	Cotogna Del Castellare 2	Percoca Romagnola 9
S 137-158-236-63	Cotogna Di Gigi Tardiva	Piedmontgold
S 137-163-61-C	Domiziana	Prairie Jeronimo
Tom Grand	Duro Black	Prairie Jeronimo PEC 156
V.P.I. 54	Ellis	Riccia Precoce
V.P.I. 70	Everts	RR 51-173
Weinberger	Excelsior	San Lorenzo
White Das	Experimental 1	Selma PEC 126
Zee Gold	Experimental 3	Sgaste
58248-2	Fortuna	Shasta
	Giblin	Stanford
<i>clingstone</i>	Golden Queen	Stuart
Adriatica	Goodman's Choice	Sudanell PEC 564
Amarillo De Agosto 1	Groc Anis	Sudanell
Amarillo De Agosto 2	Halford Precoce	Sullivan 2
Amarillo De Agosto 3	Jeronimo A	Sullivan 4
Amarillo Tardio	Jeronimo PEC 338	Suncling
Andross	Johnson	Tamponi GT 1
Babygold 5	Jolly 1	Tatura Sunset
Babygold 7	Jolly 1B	Taylor Queen
Babygold 8	Kudiesnik	Tebana
Babygold 9	Lampedella	Terzarola Gialla
Bienvenido	Loadel	Terzarola Rossa
Boyce	Majac	Trakijaska Ranna
Brasilena	Maiherbe	Tudor
Cadriano S.	Maruja	Tuscan
Campiel	McKune	Vesuvio
Campillo	Mountaingold	Wiser
Carolyn	Nishiki	Yanco Queen

0 – no visible damage; 1 – up to 20% of leaves with symptoms; 2 – 21–40% of leaves with symptoms; 3 – 41–60% of leaves with symptoms; 4 – 61–80% of leaves with symptoms; 5 – 81–100% of leaves with symptoms;

The degree of infection was evaluated by three researchers. Each examined the four plants and scored the genotype. In most cases this method was able to classify the genotypes because the four plants belonged to the same class on the scale. When the plants differed,

TABLE II
Number of cultivars per susceptibility class in relation to fruit and leaf glands type

Fruit	Glands	No.	Susceptibility class					
			0	1	2	3	4	5
Peach	reniform	566	0	3	4	49	139	371
	globose	165	0	0	1	13	51	100
	absent	7	0	0	0	3	2	2
Clingstone	reniform	95	0	1	4	20	23	47
	globose	69	0	0	0	7	20	42
	absent	4	0	1	0	1	2	0
Nectarine	reniform	169	0	0	1	15	45	108
	globose	22	0	0	0	0	6	16
	absent	6	0	1	1	1	1	2
Total		1103	0	6	11	109	289	688
Goodness of fit test statistic for model adequacy								
Likelihood ratio L ²				chi-square		d.f.		P-value
				63.11		40		0.01

TABLE III
Cultivar and seedling distribution into susceptibility classes

Genotype	No.	Susceptibility class						chi square
		0	1	2	3	4	5	
Cultivars	1103	0	6	11	109	289	688	60
Seedlings	152	0	17	48	52	30	5	433
Total	1255	0	23	59	161	319	693	493**

The two populations differ for $P < 0.01$.

the value assigned to the genotype was that of the most infected plant. The three values were rounded to the nearest unit. During 1993 the cultivars that scored 1 and 2 in the first year were reassessed to confirm their tolerance. For each genotype other than fruit type, presence and type of glands and crenate or serrated leaf margins were examined, although this last trait has been omitted from the statistic elaboration because of the correlation with the presence (crenate) or absence (serrated) of leaf glands.

Data were organized in a three-way contingency table and analyzed by the log-linear procedure of the Statgraphics program (Manugistics, Rockville, MD, USA). This analysis provides a log-linear model fitting the

observed frequencies and estimates the relationships among the variables (Bishop *et al.*, 1975). For the model we used the factors: grade of susceptibility, fruit type, gland type and the interaction between these last two. The zero frequencies were replaced by a positive number close to zero. Finally, cultivars distribution in susceptibility classes was compared with that of 152 peach seedlings, growing in the same orchard and evaluated by the same method, using Pearson's dispersion index chi square. The seedlings, widely used in Italy as peach rootstocks, were obtained from seeds of wild plants raised in the Balkans (former Yugoslavian Republic) and had not been subjected to human selection.

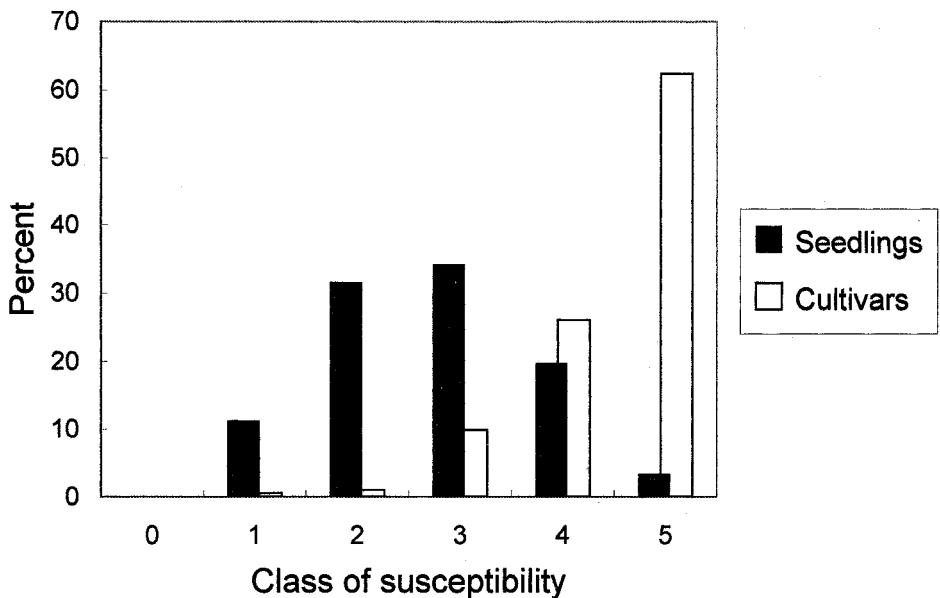


FIG. 1

Relative frequencies of cultivar and seedling genotypes over the various susceptibility classes.

RESULTS AND CONCLUSION

The susceptibility of all the genotypes examined is shown in Table I. Susceptibility ratings to *Taphrina* of the 1103 cultivars surveyed are reported in Table II. None of the genotypes scored 0, corresponding to immunity to leaf curl; only six (0.5% of the total) scored 1 and most of the remainder (688, 62% of the total) scored 5, the highest score for susceptibility. The results are similar to those obtained in previous surveys (Ackerman, 1953; Simeone, 1987; Scorza, 1992).

The group of cultivars scarcely susceptible to *T. deformans* grade 1 is represented by a) the three white-fleshed peach cultivars Lorenzini, Lucchese tardina and Morellone, probably obtained by free pollination of some local cultivars, b) one yellow-fleshed nectarine cv. Lippiat's Late Orange highly susceptible to mildew (glandless leaves with serrated margin) and c) two canning peach cvs, Paloro, with glandless serrated leaves and yellow flesh, highly susceptible to powdery mildew and Walgant with crenate margin, reniform leaf glands and yellow flesh.

The model from the log-linear analysis did not fit since the likelihood-ratio goodness of fit test was significant (Table II) hence mutual

dependence among grade of susceptibility, fruit and gland type or interaction of these last two was rejected. The glandless trait is not an indication of resistance to leaf curl as suggested by Scorza (1992), while it is strictly correlated with a high susceptibility to powdery mildew (Roselli and Bellini, 1976).

The comparison between cultivars and seedlings distribution within the classes is shown in Table III. The chi-square indicates that the frequencies are different from the expected and that the two populations differ significantly. The distribution of the Balkan seedlings frequencies is close to a normal curve (Figure 1). This population has not been subjected to selection for fruit quality, yield and other agronomic traits and the differences from the cultivars (Table III) might suggest that such selection is at the expense of stress and disease resistance. The fruit type of the seedlings was not known but all had reniform glands, this confirms the absence of a correlation between this leaf trait and susceptibility grade. The leaf curl resistance character is present, albeit more within wild peach populations than in the cultivars, and it could be exploited in breeding programmes.

REFERENCES

- ACKERMAN, W. L. (1953). The evaluation of peach leaf curl on foreign and domestic peaches and nectarines grown at the USDA plant introduction garden, Chico, California. *Bureau of Plant Industry, Rept. Soil and Agr. Engineering, USDA*, 1-31.
- BELLINI, E., SURICO, G., MUGNAI, L., NATARELLI, L. and NENCETTI, V. (1993). Osservazioni su una progenie di pesco resistente a *Taphrina deformans* (Berk.) Tul. *Italus Hortus*, **1**, 11-3.
- BISHOP, Y. M. M., FIENBERG, S. E. and HOLLAND, P. W. (1975). *Discrete multivariate analysis: Theory and practice*. The MIT Press, Cambridge, MA, USA.
- CLAYTON, C. N., CORRELL, F. E., BALLINGTON, J. R. and WORTHINGTON, S. M. (1976). Four new peach varieties in North Carolina. *North Carolina Agricultural Experiment Station Bulletin* No. 454.
- FIDEGHELLI, C., DELLA STRADA, G. and QUARTA, R. (1983). A source of immunity for the peach leaf curl (*Taphrina deformans* (Berk.) Tul). *Acta Horticulturae*, **140**, 129-32.
- HESSE, C. O. (1975). *Advances in fruit breeding. Peaches*. Purdue University Press, West Lafayette (Indiana), USA, 325-6.
- MONET, R. (1984). Modalità di trasmissione del carattere di resistenza alla bolla (*Taphrina deformans*) e afide verde (*Myzus persicae*) nel pesco. *Atti del Convegno Internazionale del pesco, Verona-Ravenna-Campania*, 67-70.
- RITCHIE, D. F. and WERNER, D. J. (1981). Susceptibility and inheritance of susceptibility to peach leaf curl in peach and nectarines cultivars. *Plant Disease*, **65**, 731-4.

- RIVERS, H. S. (1906). The cross-breeding of peaches and nectarines. *Proceedings of the 3rd International Conference on Genetics, London*, 463-7.
- ROSELLI, G. and BELLINI, E. (1976). Indagine sulla suscettibilità all'oidio (*Sphaerotheca pannosa* (Vallr.) Lev.) in una collezione di pesco. *Rivista della Ortoflorofruitticoltura Italiana*, **60**, 40-55.
- SCORZA, R. (1992). Evaluation of foreign peach and nectarine introduction in the U.S. for resistance of leaf curl (*Taphrina deformans* (Berk.) Tul.). *Fruit Varieties Journal* **46**, 141-5.
- SIMEONE, A. M. (1987). Osservazioni su alcuni caratteri morfologici e sulla sensibilità del pesco (*Prunus persica vulgaris* Stokes) alla *Sphaerotheca pannosa* (Wallr.: Fr.) Lev. e alla *Taphrina deformans* (Berk.) Tul. *Informatore Fitopatologico*, **7-8**, 71-6.

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