

Field Evaluation of Old Italian Apple Cultivars for Scab Susceptibility

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Abstract

Scab resistance is one of the main targets in apple breeding. Plants with low susceptibility to this disease are checked to introduce in biological or integrated fruit growing systems or as a source of durable resistance in breeding programs.

The local or ancient apple germplasm offers good examples of tolerance and adaptation to biotic and abiotic stresses. For this reason, fifty old Italian apple cultivars from central Italy evaluated individually and those cultivars collected at the experimental farm of Tuscia University were observed for three years. Cultivars Golden Delicious, Ozark Gold and the scab resistant Florina were considered as control. The plants, grafted on M26 rootstock, were not sprinkled with fungicides during the experiment. The symptoms on samples of 100 leaves per plant and on all the fruits were periodically checked during the growing season and classified on the basis of their intensity and diffusion; the incidence of the disease was then calculated.

The difference among cultivars was relevant. While the test cultivars, with the exception of Florina, showed susceptibility to scab, with high incidence both at fruit and leaf level, some of the old cultivars (Agostina, Fragola, Musella, Rosa Romana, Agre, Paradisa) did not show any symptom on the leaves or only slight attack were detected during the three years. Only two cultivars, Fragola and Musella, fruits were not affected by the disease. Many cultivars showed few symptoms and low incidence of disease (Rosa Romana, Rosa, Rosetta, S. Agostino).

INTRODUCTION

The interest of the consumer for healthy food has focused in the last ten years the attention of fruit growers on the biological or integrated fruit growing systems.

Scab, caused by *Venturia inaequalis*, is the most relevant fungal disease of apple, needs more than twenty treatments per year. Therefore, apple cultivars with low susceptibility to that disease are proposed for new orchards in order to reduce the use of fungicides and/or they are utilized in breeding programs. The resistance to apple scab is in fact one of the main targets in apple breeding since the beginning of the 20th century (Crosby et al., 1992; Kellerhals et al., 1993; Kellerhals and Furrer, 1994; Lespinasse et al., 1999).

The old local apple germplasm has good potential as a source of tolerance and adaptation to biotic and abiotic stresses. Studies on the varietal behaviour in response to scab have been carried out in some areas and tolerant genotypes have been selected (Corbaz and Rosset, 1991; Buscaroli et al., 1996; Quadretti et al., 1996).

The aim of this research was to evaluate the field resistance to scab of old Italian apple cultivars collected in central Italy and grown ex situ at the experimental farm of Tuscia University, Viterbo (Bignami, 1989; Bignami, 1990), in order to select cultivars for low input growing systems and/or to provide a source of resistance for breeders.

MATERIALS AND METHODS

The observations were carried out from 1997 to 1999. Fifty-four cultivars were examined in the trial (table 1). Two modern cultivars were used as a control: Golden Delicious and Ozark Gold; the cultivar Florina was also considered as a scab resistant

control. Four plants for each cultivar were grafted on M26 rootstock, planted in 1987-93 and trained at free palmette at a distance of 4 m x 2 m apart. The plants were not sprinkled with fungicides starting from the end of 1996 until to the end of the experiment. During the three growing seasons, the symptoms were checked each month from the beginning of June to September, on samples of 100 leaves per plant, and on all the fruits at harvest time, recording the number of attacked leaves or fruits and the intensity of the symptoms. The intensity of leaf symptoms were ranked into eight classes on the basis of the percentage of leaf surface covered by chlorotic, necrotic and sporulating lesions: 0 = no visible symptoms; 3 %; 5 %; 10 %; 15 %; 20 %; 30 %; 45 % of leaf surface with lesions. The fruits symptoms were ranked into five classes, on the basis of the percentage of skin covered by scab lesions: 0=absence of symptoms; 5 %; 20 %; 40 %; 50 % of fruit with scab lesions. The disease index was then calculated with the McKinney's formula (McKinney, 1923), which gives a numeric index:

$$\text{Disease index} = (\sum vn) / (NV) \times 100$$

where v represents the numeric value corresponding to the class; n is the number of leaves or fruits assigned to the class, N is the total number of the leaves or fruits in the replication and V is the numeric value of the highest class.

The data were submitted to the analysis of variance within each year, considering cultivar, day and the interaction as a source of variation. Least significant difference (LSD $p=0.05$) was calculated.

The varieties were classified on the basis of the disease index values in 3 classes of tolerance to scab:

- 1- resistant: disease index ≥ 0 and ≤ 2
- 2- moderately resistant: disease index > 2 and ≤ 6
- 3- sensitive: disease index > 6

RESULTS

The incidence of scab was significantly affected by the year (Fig. 1). The attack was low in 1997 and increased in 1998 and 1999 as a consequence of different factors. In 1997, the climatic conditions were characterised by a lower relative humidity and number of rainy days with respect to the following years (Fig. 2). Furthermore, the increase of the natural inoculum and the decrease of the residual protection exerted by the fungicides applied before the starting of the experiment played certainly a key role. For this reason the final classification of the cultivars in classes of resistance was based on the 1999 results only.

A significant interaction between cultivar and date was observed within each year. The susceptible cultivars showed an evident increase of the incidence of disease during the growing season, whereas the moderately resistant or resistant cultivars had only a slight increase or maintained low and stable values of disease index (Fig. 3).

The values of incidence of disease at the end of 1999 showed high differences among cultivars (Table 1). While the modern cultivars, with the exception of Florina, revealed high susceptibility to scab, with strong incidence both at fruit and leaf level, some of the old cultivars (Fragola, S. Agostino, Musella, Melo rosso, Agostina, Rosa Romana, Agre, Paradisa) did not show any symptom or only slight attack were detected on the leaves during the three years. Only two varieties, Fragola and Musella, were not affected by the disease at fruit level. Many cultivars showed few symptoms and low incidence either on fruits or the leaves (Agre, Rosa Romana, Rosa, Rosa/8, Rosa/12, S. Agostino).

Fruits and leaves showed a different sensitivity to scab. Fruits were more susceptible than leaves. For this reason, leaves can be a better sign than the fruits to evaluate the resistance of cultivars (Fig. 4).

CONCLUSIONS

The local germplasm of apple in central Italy represents a good source of useful traits of tolerance to scab. Several cultivars showed low symptom incidence on leaves and

fruits. This seems to demonstrate the existence of polygenic tolerance, which is a trait presently searched by the breeders, as alternative to the monogenic form of resistance. Few cultivars did not show any symptom, similarly to the scab resistant Florina, but further investigations are needed to confirm the total resistance to the disease.

These characteristics seem worthy of exploitation in breeding activity. They represent an additional value for those cultivars which revealed good taste and quality during chemical and sensory evaluation (Bignami et al, 2001). Resistant or tolerant cultivars can fit well with low input systems of fruit growing (integrated or organic production processes), to obtain a healthy product suitable for consumers sensitive to the intrinsic quality more than to the external commercial appeal.

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Tables

Table 1. Incidence of scab on leaves at the end of the growing season and on fruits at harvest of old Italian apple cultivars (1999).

Cultivar	Geographical origin	Leaves	-September	Fruits - Harvest
Agre		0.08		1.07
Agre (LT)		1.63		3.56
Appia	Lazio	0.12		11.00
Brusciano		0.36		3.89
Capo d'asino		0.28		1.98
Capo d'asino 1		16.30		15.89
Cedra		1.02		9.26
Cocoina		9.64		2.81
Dolce		0.73		12.04
Francesca		9.30		14.14
Francese		9.18		7.14
Gaetana		0.86		8.82
Maiolina		5.45		8.17
Mela Fragola (VT)		0		0
Mela Fragola (LT)		0		0
Mela nana		1.53		3.09
Muso di Bove		1.34		4.32
Paoluccia		2.20		3.94
Paradisa		0.31		7.24
Pontella		1.64		6.50
Prata		1.95		4.13
Rosa		0.18		0.34
Rosa 8		1.51		0.45
Rosa 12		1.66		1.08
Rosa Mantovana		1.01		3.53
Rosa Sezze		9.38		12.08
Rosetta (RI)		6.13		0.91
Rosetta		4.07		5.00
Rosone		8.36		2.77
Sanguinella		1.70		5.57
S.Agostino		0		0.77
Sconosciuta		0		4.95
Tonnorella		4.28		5.04
Zuccherina		13.48		19.36
Agostina	Molise	0.28		7.20
Appia (IS)		0.28		12.63
Dolce		0.77		7.41
Eppia bianca		0.53		8.35
Eppia		3.72		2.73
Iaccia		7.95		8.44
Mela rosa		1.15		4.77
Ranettone		9.40		6.95
Rotella		0.90		3.97
Tosta		0.99		4.19
Zitella		11.37		17.01
Ruzza	Umbria	1.09		1.45
Sona		2.84		14.21
Musella	Emilia Romagna	0		0
Rosa romana		0.13		0.79
Melo rosso	Calabria	0		5.45
Cocciolo		3.01		-
Florina	Control	0		0
Golden Delicious	Control	17.51		6.86
Ozark Gold	Control	17.40		11.06
L.S.D. (P=0.05)		0.75 **		1.29 **

Figures

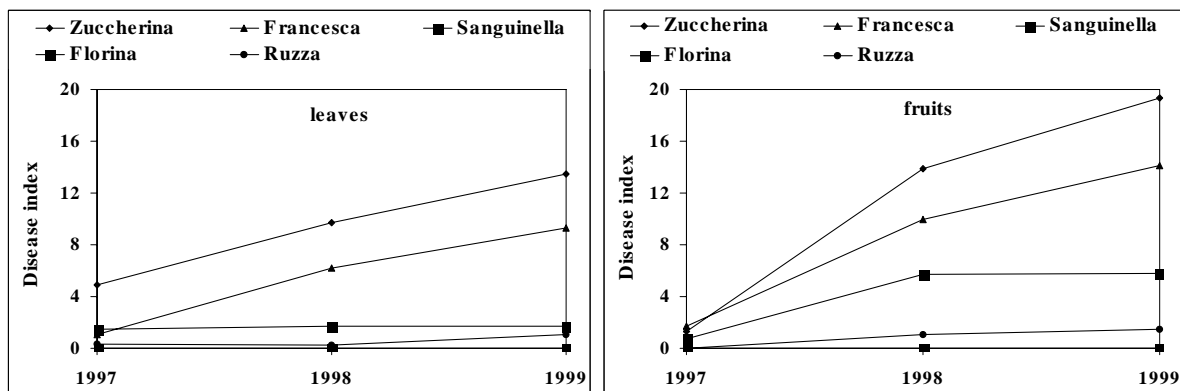


Fig. 1. Variation of the disease index of apple scab on leaves and fruits of old Italian apple cultivars during the three years of the experiment.

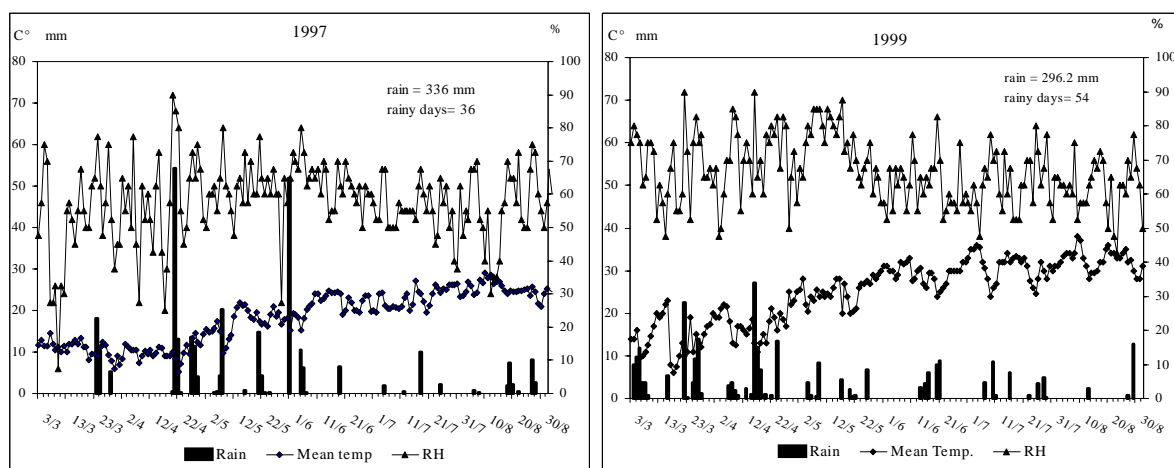


Fig. 2. Meteorological parameters during the growing seasons of 1997 and 1999.

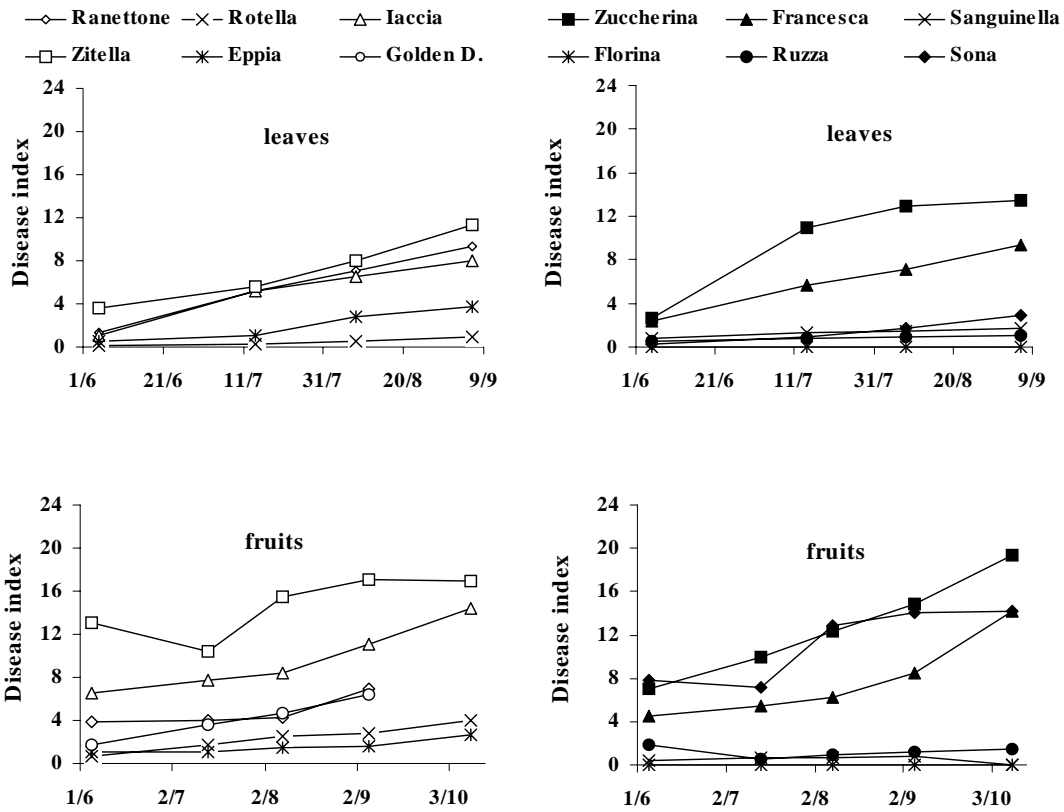


Fig. 3. Disease index of apple scab in leaves and fruits of some old Italian apple cultivars during the growing season 1999. L.S.D. ($P=0.05$) of the interaction cultivar \times day = 0.75 (leaves); 1.29 (fruit).

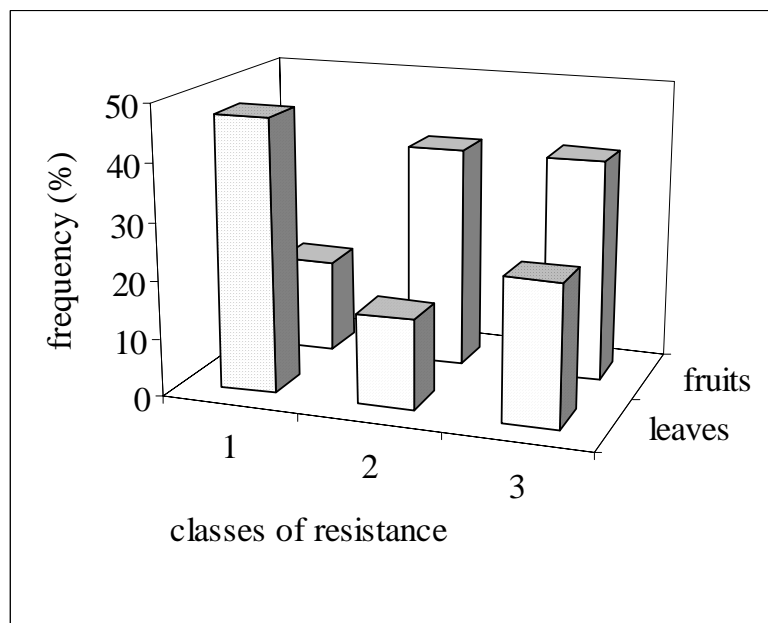


Fig. 4. Frequency of the old Italian cultivars within each class of resistance. 1 = resistant 2 = moderately resistant; 3 = susceptible.