

Evaluation of the tolerance to the rosy apple aphid, *Dysaphis plantaginea* (Pass.), in descendants of the crossing 'Raxao' x 'Florina'

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Abstract: In a cider apple breeding programme the susceptible local cv 'Raxao' and the cv 'Florina', resistant to the rosy apple aphid, *Dysaphis plantaginea* (Pass.) (Homoptera: Aphididae), have been crossed. Thirty-four hybrids have been previously selected for their resistance to apple scab and low susceptibility to powdery mildew. The results of the tolerance to *D. plantaginea* of those 34 descendants are reported.

The progeny was tested in controlled conditions after infestation with aptera and in the field after natural colonisation. In the greenhouse test, 44.1 % of the assessed cultivars did not show the typical *D. plantaginea* deformations and were considered as tolerant cultivars. Among the other 55.9 %, the deformation level was of different importance. The male parent and resistant control cv 'Florina' did not show symptoms and the susceptible control cv 'Golden Delicious' was the most damaged cultivar. The female parent cv 'Raxao' was also susceptible to *D. plantaginea*. In the field trials, only 38.2 % of the hybrids showed *D. plantaginea* deformations. The cultivars which showed deformations in the field were also susceptible in the greenhouse conditions, and the cultivars considered as tolerant in the greenhouse did not show deformations in the field trials. The results show clearly that cv 'Florina' is a good parent for the transmission of the tolerance to *D. plantaginea*.

The present study takes another step in offering the grower new cultivars with interesting technological and agronomical implications, such as resistance to pests and diseases, which is considered to be a powerful tool in pest management programs.

Keywords: apple, aphids, cultivars, resistance, breeding

Introduction

Among the regions of the Cantabrian Coast, Asturias has the highest diversity of genetic resources of apples, and can be considered as a secondary centre of genetic variation. Currently, among the cultivars of the National Apple Germplasm Bank located at Villaviciosa (Asturias) there are 550 local cultivars, which are being characterized and evaluated (Dapena, 1996). Paralelly, since 1989, an apple breeding programme has been developed through the crossing of Asturian cider apple cultivars, with interesting agronomical and technological implications, with some cultivars or hybrids possessing important characteristics such as the Vf scab resistance character, high fire blight resistance, relatively late ripening and/or one fruit per inflorescence (kindly provided by the INRA, Angers, France). The local cv 'Raxao' and the cv 'Florina', resistant to apple scab and rosy apple aphid *Dysaphis plantaginea* Pass. (Homoptera: Aphididae) and lightly susceptible to fire blight and European red mite (Lesspinasse *et al.*, 1985) were crossed in 1989. Rat-Morris (1994) concluded that there was independence between the resistance of cv 'Florina' to apple scab and rosy apple aphid. Thirty-four descendants have been preselected for their resistance to apple scab and their low susceptibility to powdery mildew in nursery (Dapena, 1996). This work aims to complete the

evaluation of those 34 hybrids testing their response to *D. plantaginea*, which is a key pest in Asturian orchards.

Material and methods

The susceptibility of the 34 descendants was assessed after infestation with aptera in greenhouse conditions and after natural colonization in the field.

Greenhouse conditions

Plant material

The test was carried out in 1999 using cv 'Golden Delicious' and 'Florina' as susceptible and resistant control, respectively. The female parent cv 'Raxao' was also tested. Fifteen seedlings of each of the tested cultivars were grafted on MM 106 rootstocks and kept outside. Eight seedlings of each cultivar with active growing shoots and a comparable size were introduced into the greenhouse in a completely randomised distribution. An insecticide and a fungicide treatments were applied before the aphid infestation in order to kill all arthropods on the plants and prevent fungal diseases. The aphid movement from one plant to another was prevented putting the pots on dishes with water.

Aphids

Aphids used for infestation were derived from field populations and reared on susceptible plants. As aphid populations present a wide range of both genotypes and response to plants (Dixon, 1985), fundatrix were collected in the field from different strains in order to have enough variability in the attack response to the plants. Four adult apterous females or fourth-instar larvae were carefully placed on the first expanded leaf of each seedling. None of the aphids on each plant belonged to the same strain. When necessary, reinfestation was performed the day after to complete four aphids per plant. As some seedlings did not present aphids one and two weeks after the first infestation, two reinfestation were performed collecting the aphids directly in the field.

Damage control

Observations were made once a week from the day after the infestation to the end of the experiment 21 days later. Based on Rat-Morris (1993; 1994), shoot deformation was quoted from 0 to 5 as follows: 0= no damage; 1= leaf slightly curled at the edge; 2= leaf curled longitudinally; 3= typical *D. plantaginea* rolled leaves; 4= 2 to 5 typically rolled leaves; and 5= more than 5 typically rolled leaves. Following Rat-Morris (1994) one given cultivar was considered as tolerant when presenting only deformation 0 or 1.

Orchard studies

In orchard A, the 34 individuals obtained directly from the seed were planted in 1992. In orchard B, 11 of those 34 hybrids, selected for their production, low susceptibility to powdery mildew in the field and/or technological characteristics, were planted in 1999 in MM 106 and Pajam 1 rootstocks. Each cultivar was repeated randomly into three blocks. All the trees in both orchards were observed for *D. plantaginea* damage in the spring of 2000. Shoot damage was recorded as in the greenhouse test.

Table 1. Number of plants of each 34 hybrids ‘Raxao’ x ‘Florina’ presenting different levels of *D. plantaginea* damage, and susceptibility to this aphid species in field and greenhouse conditions. Cv ‘Florina’ and ‘Golden Delicious’ are, respectively, the resistant and the susceptible control. Cv ‘Raxao’ is the female parent.

cultivar	damage level*						susceptibility**		
	greenhouse						greenhouse	field	
	0	1	2	3	4	5		orchard A	orchard B
1	3	1	2	1	1	0	s	s	n.p.
2	7	1	0	0	0	0	t		n.p.
3	3	0	2	1	1	1	s	s	n.p.
4	0	3	4	1	0	0	s	s	s
5	7	0	1	0	0	0	s		n.p.
6	8	0	0	0	0	0	t		n.p.
7	8	0	0	0	0	0	t		n.p.
8	8	0	0	0	0	0	t		t
9	6	1	1	0	0	0	s		n.p.
10	8	0	0	0	0	0	t		n.p.
11	6	2	0	0	0	0	t		n.p.
12	1	1	1	4	1	0	s	s	s
13	3	2	3	0	0	0	s		n.p.
14	2	2	1	0	2	1	s		s
15	3	0	2	3	0	0	s	s	n.p.
16	8	0	0	0	0	0	t		t
17	4	1	2	1	0	0	s	s	s
18	2	3	2	0	1	0	s		n.p.
19	3	2	2	0	1	0	s	s	s
20	7	1	0	0	0	0	t		n.p.
21	8	0	0	0	0	0	t		t
22	6	0	1	0	1	0	s	s	n.p.
23	3	4	1	0	0	0	s	s	n.p.
24	5	0	1	0	1	1	s	s	n.p.
25	7	1	0	0	0	0	t		n.p.
26	8	0	0	0	0	0	t		t
27	1	0	1	2	3	1	s		n.p.
28	2	1	3	1	1	0	s	s	s
29	1	0	0	1	3	3	s	s	n.p.
30	8	0	0	0	0	0	t		t
31	8	0	0	0	0	0	t		n.p.
32	6	2	0	0	0	0	t		n.p.
33	4	2	2	0	0	0	s	s	n.p.
34	8	0	0	0	0	0	t		n.p.
Golden	0	0	0	0	1	7	s	n.p.	n.p.
Florina	8	0	0	0	0	0	t	n.p.	t
Raxao	0	1	2	2	2	1	s	n.p.	s

* 0: no symptoms; 1: leaf slightly curled at the edge; 2: leaf curled longitudinally; 3: typical symptom; 4: 2 to 5 typically damaged leaves; 5: more than 5 typically damaged leaves.

** s: susceptible; t: tolerant; n.p.: no present in this orchard.

Results and discussion

Greenhouse conditions

In the greenhouse test, 44.1 % of the assessed hybrids did not show the typical *D. plantaginea* deformations (Table 1) and were then considered as tolerant cultivars. Among the other 55.9 %, the deformation level was of different importance (Table 1). The male parent and resistant control cv 'Florina' did not show symptoms and the susceptible control cv 'Golden Delicious' was the most damaged cultivar (Table 1). The female parent 'Raxao' was also susceptible to *D. plantaginea* (Table 1). There were some susceptible hybrids that did not show symptoms in all of the 8 repeated seedlings (Table 1). This may be explained by some factors which could interfere with the development of the experiment. For instance, anthocorids were observed in some seedlings preying on aphids. Caterpillars (Lepidoptera) fed on some of the growing shoots. And some plants stopped growing during the experiment. However, these facts did not change the conclusion about the susceptibility of the plants, which coincided with the results obtained in the field trials.

Orchard studies

The results of the susceptibility observed in the field in orchard A are presented in Table 1. Typical deformations were reported in 38.2 % of the progeny. This percentage, lower than the observed in the greenhouse assay may be explained by the inherent deviations in conditions between greenhouse and field situations, such as a lower infestation rate or the beneficials impact in the field. Therefore we only can say which of them are susceptible cultivars but we can not say anything about those which did not show symptoms. In orchard B, where the 11 hybrids are repeated, we are able to distinguish between tolerant and susceptible cultivars because of the cited factors are minimized in this orchard due to its aleatory design. The tolerant and the susceptible hybrids were exactly the same that in the greenhouse trial (Table 1). Thus, the cultivars which showed deformations in the field were also susceptible in the greenhouse conditions, and the cultivars considered as tolerant in the greenhouse did not show deformations in the field trials.

Rat-Morris (1993, 1994) has characterized the resistance of the cv 'Florina' to *D. plantaginea*, identifying both antibiosis and tolerance. Results showed a nutritional effect on aphids resulting in lower length, weight and fecundity of adult aptera, lower survival rate and longer instar duration. Production of alate morphs was increased and aphid location on the plant affected. On the other hand, cv 'Florina' did not show the typical symptoms, only a very light necrosis (Rat-Morris, 1994). In the present work, only tolerance was tested. Studying the inheritance of the resistance to *D. plantaginea*, Rat-Morris (1994) concluded that it was complex and might imply a maternal effect. Thus, when cv 'Florina' was used as male parent the percentage of tolerant individuals was only 2 % (Rat-Morris, 1994). However in our study the percentage of tolerant descendants was 44.1 %, which shows clearly that cv 'Florina' may be a good parent for the transmission of the tolerance to *D. plantaginea*, being indeed the male parent.

The case of polygenic *versus* monogenic resistance has the disadvantage that it is not as easy to handle (Knight and Alston, 1972). But the fact that some genes are implied in the heredity of this resistance reduces the risk for the appearance of resistance-breaking biotypes (Rat-Morris, 1994). However, three different sources of resistance-breaking have been found recently (Rat-Morris et al., 1999), although none of them spread to another tree nor appeared on the same tree the next year. Probably, due to the obligatory aphid migration to the

secondary host *Plantago* spp and the also obligatory sexual reproduction, the resistance-breaking biotypes are not likely to colonize a broad area.

Thus this attribute of resistance to *D. plantaginea* seems a very good long-term alternative to control this harmful aphid, which joined to the resistance to apple scab and powdery mildew would limit the pesticide inputs to those required against the codling moth. Thereby this work takes another step in offering the grower cultivars which will prove both economically and ecologically beneficial.

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