

Evaluation of Susceptibility of Different Pear Hybrid Populations to Fire Blight (*Erwinia amylovora*)

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Abstract

Fire blight disease caused by pathogenic bacterium *Erwinia amylovora*, is the serious disease of pear, and there is not a certain chemical management against this disease except antibiotic-type compounds such as streptomycin. It is very important to improve new fire blight resistant cultivars in case of integrated disease management. With this purpose, different crosses have been made between *Pyrus communis* varieties that have good fruit characteristics and resistant cultigens. Besides, self and open pollination treatments have been carried out in maternal plants. The disease resistance level of the hybrids obtained from these combinations was determined by artificial inoculations by *Erwinia amylovora* in greenhouse conditions. A total of 3284 hybrids were inoculated, and 2631 of them survived and were distributed to different susceptibility classes. 19.88% of the inoculated hybrids was killed by *Erwinia amylovora*. Total distribution of the hybrids to susceptibility classes was as 6.18% in class "A- slightly susceptible", 3.11% in class "B- less susceptible", 8.89% in class "C- mid-susceptible", 20.28% in class "D- susceptible", and 61.54% in class "E- very susceptible". Majority of class "A- slightly susceptible" hybrids were obtained from 'Magness' x 'Ankara' combination. 'Kieffer' x 'Santa Maria', 'Kieffer' open pollination, 'Magness' x 'Akça', 'Magness' x 'Kieffer', 'Magness' x 'Santa Maria', 'Mustafa Bey' x 'Moonglow' treatments displayed good results with respect to "A- slightly susceptible" character. It is very important to evaluate these hybrid pear populations through different fruit and tree characteristics in the future.

Keywords: artificial inoculation, breeding, *Erwinia amylovora*, pear, resistance, susceptibility

Introduction

Fire blight disease, caused by *Erwinia amylovora*, is one of the most destructive diseases of pear (*Pyrus communis*) in the world and affects some other species in the *Rosaceae* family (van der Zwet and Beer, 1995). It is stated that growers and scientists would agree that fire blight is like no other plant disease. For growers, fire blight is a capricious bacterial disease which can decimate apple and pear orchards in a single season, thus limiting areas where most susceptible apple and pear varieties can be grown. Today, fire blight is spread almost all over the world where pear trees are grown. So far, mountains and oceans have not been able to keep fire blight at bay (Vanneste, 2000).

It was indicated that, once fire blight became established in the Egypt-Cyprus-Israel triangle, it was only a matter of time before the disease appeared in neighbouring countries. In 1985, fire blight was reported from the coastal areas of Turkey and the following year from the island of Crete in Greece (Momol *et al.*, 1992; Vanneste, 2000). In Turkey, the disease spread rapidly across the country from west to east and was particularly severe on quince (*Cydonia oblonga*) and medlar (*Mespilus* spp.) (Momol *et al.*, 1992).

Pear species were ranked in descending order, based on their degree of fire blight resistance, *Pyrus ussuriensis*, *Pyrus calleryana*, *Pyrus betulaefolia*, *Pyrus pyrifolia* and *Pyrus communis* (Shay *et al.*, 1962; Vanneste, 2000).

Although there is no certain solution for the disease, mechanical and chemical management can be performed. Biological methods have started to be used recently against the disease (Aysan *et al.*, 1999; Sobiczewski *et al.*, 1997). Today only heavy metals and antibiotic-type compounds are registered for control of fire blight; the best antibiotic, streptomycin, is not registered in every country where fire blight occurs and, as pointed out earlier, development of streptomycin-resistant strains compromises its effectiveness (Vanneste, 2000). Improving resistant cultivars is one of the main objectives of the integrated management of bacterial diseases. Using resistant cultivars, rootstocks and interstocks come into primary prominence in controlling fire blight disease (Bergamaschi *et al.*, 2006; Layne and Quamme, 1975).

Up to date, lots of breeding programs have been performed by crossing cultivars with different resistance levels to attain resistant varieties. Several simple and complex hybridization programmes have been used on fire blight resistance breeding of pear (Bergamaschi *et al.*, 2006; Du-

rel et al., 2004; Fischer and Mildenerger, 2000; Hevesi et al., 2004; Hunter and Layne, 2004; Layne and Quamme, 1975; Ryugo, 1982; Sobiczewski et al., 1997; Thibault and Lezec, 1990). On this matter, it was stated that, it is possible to be successful by choosing resistant parents in disease resistance breeding (Layne and Quamme, 1975).

With respect to the above mentioned explanations, this project has started with the aim of obtaining resistant and high quality cultivars by crossing susceptible but qualified commercial cultivars grown in our country and worldwide with resistant commercial cultivars and local cultigens. In this scope, controlled hybridizations have been performed between susceptible and resistant pear genotypes and susceptibility levels of hybrids were detected by artificial inoculations that were conducted using *Erwinia amylovora*.

Materials and methods

The current study was conducted between 2007 and 2010. Hybridization studies were performed at Ege University, Ödemiş Vocational Training School and Atatürk Central Horticultural Research Institute in 2007 and 2008.

The cultivars listed in Tab. 1 were used in hybridization treatments. With this purpose, different crosses have been planned between susceptible ('Akça', 'Mustafa Bey', 'Santa Maria', 'Williams') or resistant ('Güz', 'Magness', 'Kieffer') *P. communis* varieties (♀), and resistant or moderately resistant cultigens (♂) (Aysan et al., 1999; Bell et al., 2005; Çıtır and Mirik, 1999; Honty et al., 2006; McGraw, 2006; Momol et al., 1992; Öden, 1999; Sobiczewski et al., 1997; Ünal et al., 1998; van Der Zwet and Beer, 1991).

Hybridizations were performed between cultivars that bloom in the same period as susceptible x susceptible, susceptible x resistant, resistant x susceptible and resistant x resistant combinations (Rosati et al., 2002).

Pollen, which was used for hybridization studies was provided from the balloon stage buds of the parents, chosen as pollinators (Layne and Quamme, 1975). In terms of

Tab. 1. Cultivars and cultigens used in hybridization treatments

Maternal Parents		Pollinators
'Akça'	Cultivars	'Ankara'
'Güz'		'Cleveland Select'
'Kieffer'		'Conference'
'Magness'		'Dancer'
'Mustafa Bey'		'Kaiser Alexandre'
'Santa Maria'		'Kieffer'
'Williams'		'Limon'
	Local Cultigens	'Moonglow'
		'Bursa'
		'Güz'
		'Taş'
		'Ekşi'
		'Pamuk Akçası'

hybridization studies, 3 flowers per cluster were emasculated by removing petals and anthers. One day after emasculation, pistils were pollinated (Layne and Quamme, 1975). As for self-pollination, pink bud stage buds were isolated. For open pollination, buds on the shoots were counted and labelled. In every combination, almost 500 buds were emasculated. These treatments were carried out for three consecutive years (Evrenosoğlu et al., 2010).

Ripened fruits were harvested; then, seeds were stratified at 2-4°C for 90 days. After stratification, seeds were transplanted to vials containing peat, and after germination (Fig. 1a), they were transmitted to a media consisting of sand, manure and soil (Layne and Quamme, 1975). Hybrids were grown for one or two years in polyethylene bags (Fig. 1b).

Susceptibility levels of the obtained hybrids were detected by artificial inoculations with *E. amylovora*. With this target, 15 strains, previously isolated and identified as *E. amylovora* by Aysan et al. (2004), inoculated three shoots of pear for each strain. After disease symptoms on pear shoots, bacteria were re-isolated and identified by tra-



a



b

Fig. 1. (a) Germination and (b) growing of hybrids



Fig. 2. (a) Growth of *Erwinia amylovora* on the media and (b) preparation for inoculum



Fig. 3. (a) Inoculation and (b) measuring of shoots

ditional methods (colony morphology on King's medium B, HR test on tobacco leaves and bacterial exudate on immature pear fruits) and serology by ELISA. The highly virulent strains (AP-1 and AP-2) were selected for further inoculation studies. Using ELISA and MIS methods were provided from Çukurova University, Faculty of Agriculture, Department of Plant Protection. Each of the pathogenic bacteria strains AP-1 and AP-2 were streaked on King's medium B plates and incubated at 25°C for 48 h. Bacterial suspensions were prepared from the strains and the density was adjusted to approximately 10^8 cell/ml by spectrophotometer at 600 nm (Fig. 2a and b) (Thibault and Lezec, 1990).

Inoculations were performed by injecting an equal mix of the each inoculum suspensions using a sterile 26 numbered syringe into the apex of the shoots (Fig. 3a).

Inoculation was carried out in two periods, the first was at the second week of May 2010, and the second was at the first week of August 2010, when the shoots of hybrids reached a length of 15-20 cm. In each hybrid, length of 1 or 2 shoots according to the plant's growing condition was measured and recorded (Fig. 3b). This application was done at 25-30°C heat and 80-90% relative humidity con-

ditions (Quamme *et al.*, 1976). These conditions are necessary for the development of fire blight disease and were met in a greenhouse.

Disease development continued for 8 weeks and at the end of this period, infected parts of inoculated shoots were measured (Fig. 4a), recorded, cut and removed (Fig. 4b). Susceptibility level of the shoots to fire blight, was found out by the formula below (Thomson *et al.*, 1962):

$$\text{Susceptibility of shoot} = \frac{\text{Length of infected part (cm)}}{\text{Total shoot length (cm)}} \times 100$$

Thus, the susceptibility level for each hybrid was determined as average value of two different inoculation periods. Then, the data were classified according to Tab. 2, and susceptibility classes and characters of hybrids were detected (Fig. 5A-E) (Thibault *et al.*, 1987).

After determining susceptibility classes, hybrids were counted for their susceptibility level in each hybrid combination, and grouped for 2007 and 2008 treatments. Then, hybrids in combinations for two years were assembled, counted, and distribution of hybrids to susceptibility classes was calculated as percentage (Işık and Çelik, 2009).

Results and discussion

Hybrid numbers in susceptibility classes belong to different cross combinations and treatments in 2007 can be seen in Tab. 3.

As it was seen in Tab. 3, a total of 105 hybrids were in class “A”, 38 hybrids were in class “B”, 68 hybrids were in class “C”, 161 hybrids were in class “D”, and 300 hybrids were in class “E”. 44 of inoculated 672 hybrids were killed by *Erwinia amylovora*. For combinations of ‘Akça’ maternal parent, 7 hybrids took place in class “A”, and 69 were in class “E”. Number of hybrids increased from class “A” to “E”. There was only one hybrid in ‘Akça’ x ‘Conference’ combination and it included in class “E”. Only two hybrids were obtained from ‘Güz’ open pollination, and 1 hybrid was in class “D”, and the other was in class “E”. In comparison of maternal parents, fire blight resistant ‘Magness’ cultivar had relatively maximum hybrids (70) for “slightly susceptible- A”, and minimum hybrids (60) for “very susceptible- E”. Additionally, ‘Magness’ x ‘Ankara’ combination possessed the highest hybrid number (45) in class “A” among all combinations. Besides, total hybrid loss (6) was low in ‘Magness’ cultivar. In ‘Mustafa Bey’ cultivar, distribution of hybrids was as 15 class “A”, 6 class “B”, 10 class “C”, 16 class “D”, and 26 class “E”. On the other hand, maximum hybrid number in class “A” was found in ‘Mustafa Bey’ x ‘Moonglow’ combination, whereas, maximum hybrid number in class “E” was found in ‘Mustafa Bey’ x ‘Williams’ combination. On the first year of the hybridizations, few hybrids were obtained in ‘Santa Maria’ combi-



Fig. 4. (a) Measuring and (b) removing infected shoots



Fig. 5. Susceptibility classes (A-E)

Tab. 2. Evaluation of the susceptibility by artificial inoculation (Thibault *et al.*, 1987)

Susceptibility of hybrid (%)	0-10	11-20	21-40	41-60	61-100
Susceptibility class	A	B	C	D	E
Susceptibility character	Slightly susceptible	Less susceptible	Mid-susceptible	Susceptible	Very susceptible

Tab. 3. Hybrid numbers in susceptibility classes belong to different cross combinations and treatments in 2007

Combination	Hybrid numbers of resistance groups					Total of inoculated hybrids	Hybrid loss	Total of surviving hybrids
	A	B	C	D	E			
‘Akça’ combinations								
‘Conference’	-	-	-	-	1	1	-	1
Open pollination	7	10	12	36	68	133	12	121
Total	7	10	12	36	69	134	12	122
‘Güz’ combinations								
Open pollination	-	-	-	1	1	2	-	2
Total	-	-	-	1	1	2	-	2
‘Magness’ combinations								
‘Akça’	9	3	5	6	8	31	2	29
‘Ankara’	45	10	11	33	32	131	1	130
‘Güz’	1	2	4	5	7	19	1	18
‘Kieffer’	-	-	-	1	-	1	-	1
‘Limon’	4	1	4	12	6	27	2	25
‘Taş’	4	2	3	3	3	15	-	15
Open pollination	7	1	4	7	4	23	-	23
Total	70	19	31	67	60	247	6	241
‘Mustafa Bey’ combinations								
‘Güz’	2	-	-	2	4	8	1	7
‘Moonglow’	11	4	8	11	7	41	-	41
‘Williams’	2	2	2	3	15	24	-	24
Total	15	6	10	16	26	73	1	72
‘Santa Maria’ combinations								
‘Akça’	-	-	1	-	3	4	1	3
‘Cleveland Select’	1	1	-	1	3	6	1	5
‘Kieffer’	-	-	-	-	2	2	-	2
‘Limon’	-	-	1	1	2	4	-	4
‘Taş’	-	-	-	1	1	2	-	2
Open pollination	2	-	-	-	-	2	-	2
Total	3	1	2	3	11	20	2	18
‘Williams’ combinations								
‘Akça’	1	1	1	2	6	11	-	11
‘Ankara’	2	-	4	13	37	56	6	50
‘Bursa’	-	-	-	3	20	23	3	20
‘Conference’	-	-	-	2	10	12	2	10
‘Dancer’	-	-	2	2	5	9	2	7
‘Ekşi’	-	-	-	1	1	2	1	1
‘Güz’	1	-	-	3	10	14	3	11
‘Kaiser Alexandre’	2	1	1	2	11	17	2	15
‘Kieffer’	-	-	1	-	3	4	-	4
‘Limon’	1	-	-	-	1	2	-	2
‘Moonglow’	1	-	1	1	1	4	-	4
‘Pamuk Akçası’	-	-	-	-	1	1	-	1
‘Santa Maria’	2	-	2	4	6	14	-	14
‘Taş’	-	-	-	3	13	16	2	14
Open pollination	-	-	1	2	8	11	2	9
Total	10	2	13	38	133	196	23	173
Final total	105	38	68	161	300	672	44	628

Tab. 4. Hybrid numbers in susceptibility classes belong to different cross combinations and treatments in 2008

Hybrid numbers of resistance groups								
Combination	A	B	C	D	E	Total of inoculated hybrids	Hybrid loss	Total of surviving hybrids
‘Akça’ combinations								
‘Conference’	1	-	2	7	40	50	22	28
‘Güz’	-	-	-	-	3	3	1	2
‘Kaiser Alexandre’	1	1	-	2	16	20	8	12
‘Kieffer’	4	-	1	2	8	15	2	13
‘Moonglow’	-	-	1	-	-	1	-	1
‘Santa Maria’	-	-	1	3	10	14	-	14
‘Taş’	-	-	-	-	4	4	-	4
‘Williams’	-	1	1	-	15	17	4	13
Open pollination	-	-	2	9	25	36	9	27
Total	6	2	8	23	121	160	46	114
‘Kieffer’ combinations								
‘Santa Maria’	12	6	50	105	201	374	24	350
Open pollination	16	10	44	46	114	230	14	216
Total	28	16	94	151	315	604	38	566
‘Magness’ combinations								
‘Akça’	13	6	9	21	35	84	7	77
‘Kieffer’	11	10	28	13	11	73	2	71
‘Santa Maria’	12	16	17	26	35	106	6	100
‘Taş’	4	1	-	3	10	18	-	18
‘Williams’	1	-	-	-	2	3	2	1
Open pollination	4	1	5	9	14	33	3	30
Total	45	34	59	72	107	317	20	297
‘Santa Maria’ combinations								
‘Akça’	-	-	-	1	6	7	1	6
‘Bursa’	-	-	-	-	1	1	-	1
‘Güz’	-	1	1	6	23	31	8	23
‘Kieffer’	-	-	1	5	18	24	7	17
‘Taş’	1	-	-	3	12	16	1	15
‘Williams’	-	-	3	22	109	134	26	108
Open pollination	7	2	12	29	131	181	43	138
Total	8	3	17	66	300	394	86	308
‘Williams’ combinations								
‘Akça’	3	2	11	54	95	165	14	151
‘Ankara’	2	4	9	60	403	478	227	251
‘Bursa’	-	-	1	-	2	3	1	2
‘Güz’	-	-	1	8	19	28	4	24
‘Kieffer’	2	2	12	30	104	150	37	113
‘Taş’	1	-	1	4	115	121	67	54
Open pollination	3	1	11	37	140	192	69	123
Total	11	9	46	193	878	1137	419	718
Final total	98	64	224	505	1721	2612	609	2003

nations (20), and much of these hybrids (11) were placed in class “E”. When it comes to ‘Williams’ combinations, totally 133 of 196 hybrids took part in class “E”, and only 10 of them were in class “A” (Tab. 3).

In a general evaluation according to Tab. 4, “A”, “B”, “C”, “D” and “E” classes owned 98, 64, 224, 505, and 1721 hybrids, respectively in 2008. 609 of inoculated 2612 hy-

brids were killed by disease. Inoculated hybrid number of ‘Akça’ cultivar was 160, and only 6 of them were in class “A”. The significant amount of the inoculated ‘Akça’ hybrids existed in class “E” (121), and 46 of them were lost because of this disease. In ‘Kieffer’ combinations, there were 604 hybrids and a total of 28 of them were placed in class “A”. Most of the hybrids were in class “D” (151), and “E”

(315), in addition 94 hybrids were determined as “mid-susceptible- C”. When ‘Kieffer’ x ‘Santa Maria’ combination (12) and ‘Kieffer’ open pollination treatment (16) compared, there were much more “slightly susceptible- A” hybrids in open pollination application. As for ‘Magness’ combinations, there were relatively more class “A” hybrids (45) than the other maternal parents, and this situation is due to ‘Magness’ is a resistant cultivar (Honty *et al.*, 2006; Mcgraw, 2006). The amount of “slightly susceptible- A” hybrids ranged between 1 (‘Magness’ x ‘Williams’) and 13 (‘Magness’ x ‘Akça’) according to the cross combinations. For ‘Santa Maria’ parent, only 8 of the 394 hybrids were observed in class “A”. One of these hybrids was obtained from ‘Taş’ pollinator, and the others were from open pollination. Most of the hybrids were present in “very suscep-

tible- E” character (300). In ‘Williams’ cultivar, similar to ‘Santa Maria’ cultivar, class “A” had few hybrids (11). 878 hybrids of inoculated 1137 hybrids included in “very susceptible-E” character, and 419 of hybrids were killed owing to *Erwinia amylovora*. Most of the killed hybrids belong to the ‘Williams’ x ‘Ankara’ combination (Tab. 4).

In both years, it was noticed that the amount of “slightly susceptible- A” hybrids were detected much more in combinations of resistant maternal parents like ‘Magness’ and ‘Kieffer’, when compared to combinations of susceptible maternal parents (‘Akça’, ‘Santa Maria’, ‘Williams’). Controversely, when these resistant cultivars are used as pollinators, it could not be possible to get the same promising conclusion. Besides, even if we use susceptible cultivars as pollinators for these resistant maternal parents,

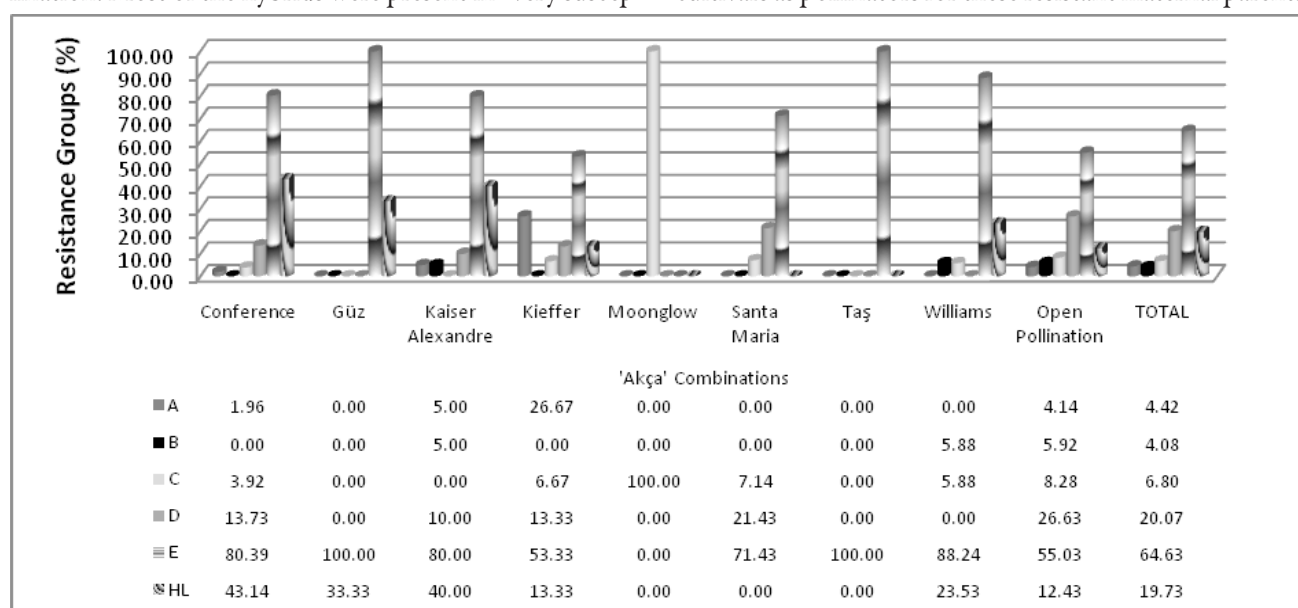


Fig. 6. Distribution of ‘Akça’ hybrids to susceptibility classes (%)

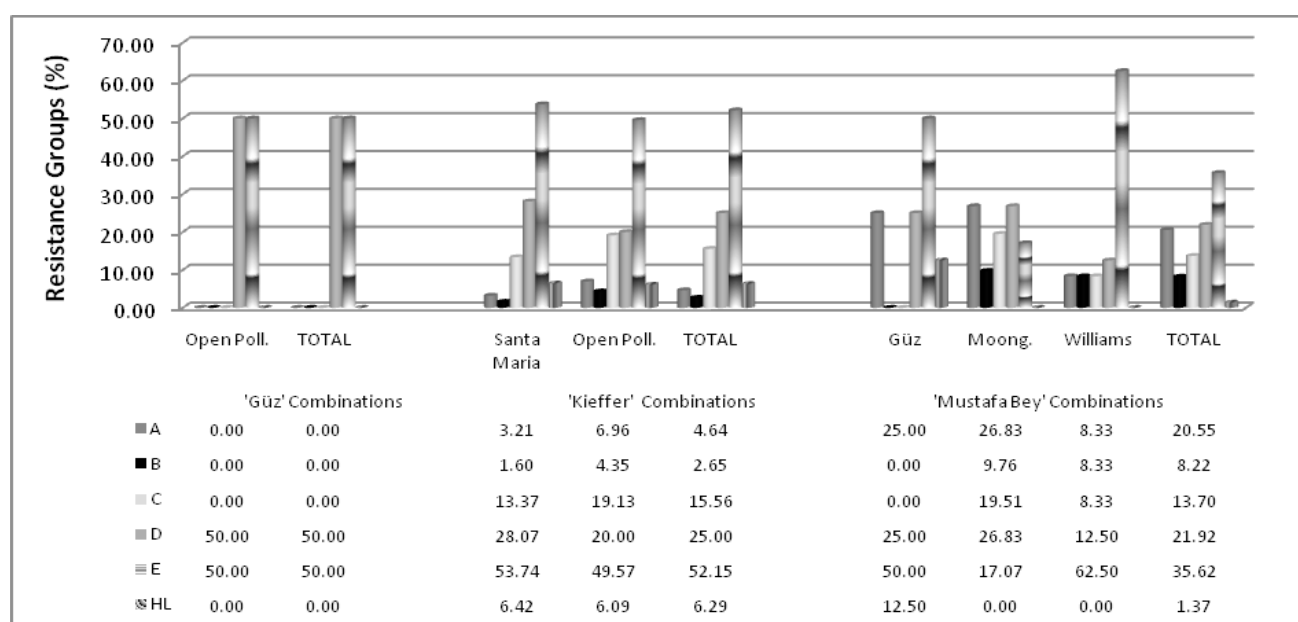


Fig. 7. Distribution of ‘Güz’, ‘Kieffer’ and ‘Mustafa Bey’ hybrids to susceptibility classes (%)

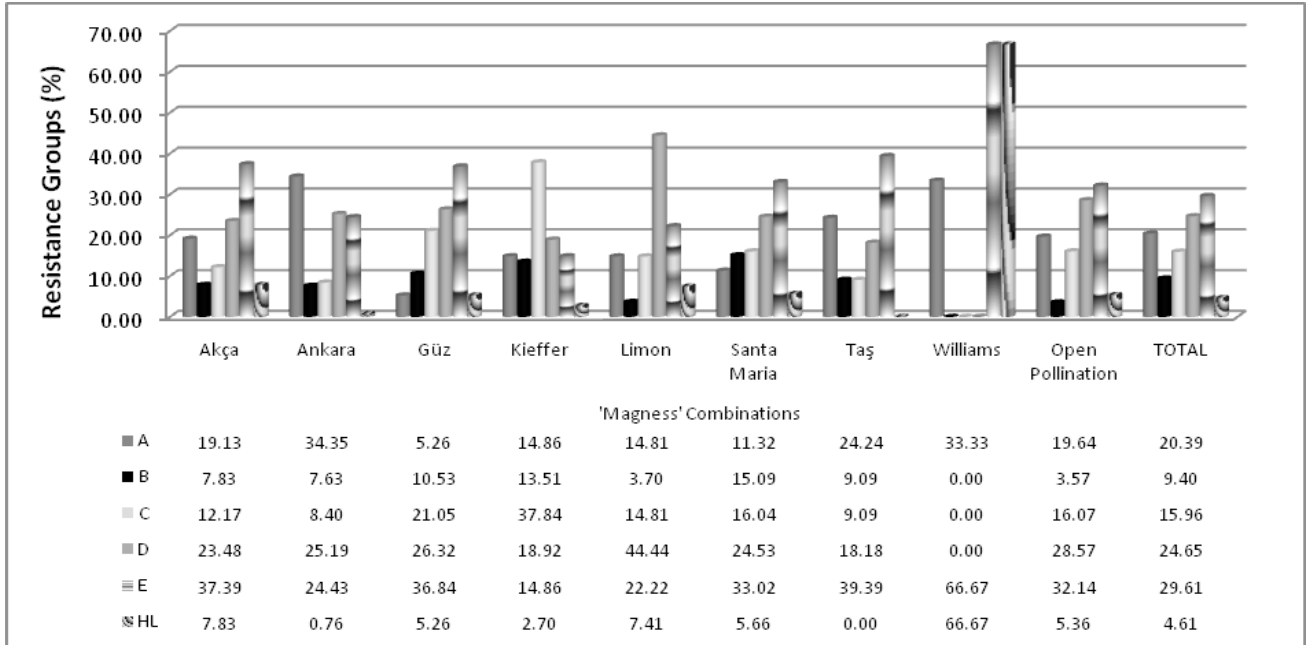


Fig. 8. Distribution of 'Magness' hybrids to susceptibility classes (%)

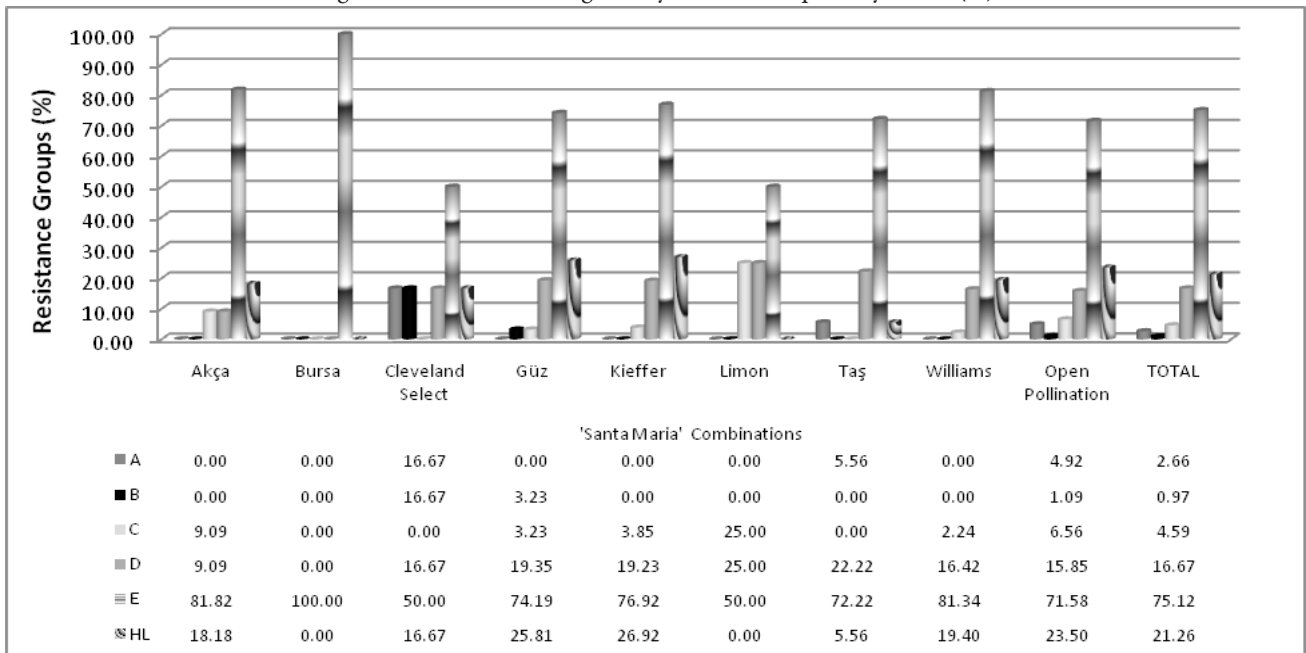


Fig. 9. Distribution of 'Santa Maria' hybrids to susceptibility classes (%)

sufficiently good results were attained with respect to class "A" hybrids.

Distribution of the hybrids through cross combinations was counted as percentage for two years together (Fig. 6, 7, 8, 9, 10). Among 'Akça' combinations, 'Kieffer' pollinator had maximum class "A" hybrids (26.67%), and it was followed by 'Kaiser Alexandre' pollinator (5%) and open pollination (4.14%). On the contrary, a minimum class "E" hybrid number was found in 'Kieffer' pollinator (53.33%) and it was followed by open pollination (55.03%). Maximum hybrid loss was detected in 'Akça' x 'Conference' combination for two years (Fig. 6).

All the 'Güz' hybrids were obtained from open pollination, and the same distribution occurred in both "D" and "E" classes. For 'Kieffer' combinations, "slightly susceptible- A" hybrid ratio of open pollination (6.96%) was much higher than of 'Santa Maria' cross combination (3.21%). As for 'Mustafa Bey' parent, 'Moonglow' pollinator possessed the first (26.83%), 'Güz' pollinator had the second (25%), and 'Williams' pollinator had the last row (8.33%) regarding class "A" hybrids as it was expected through the resistance condition of the pollinators (Fig. 7).

Distribution of 'Magness' hybrids according to susceptibility classes (%) can be seen in Fig. 8. There were "slightly

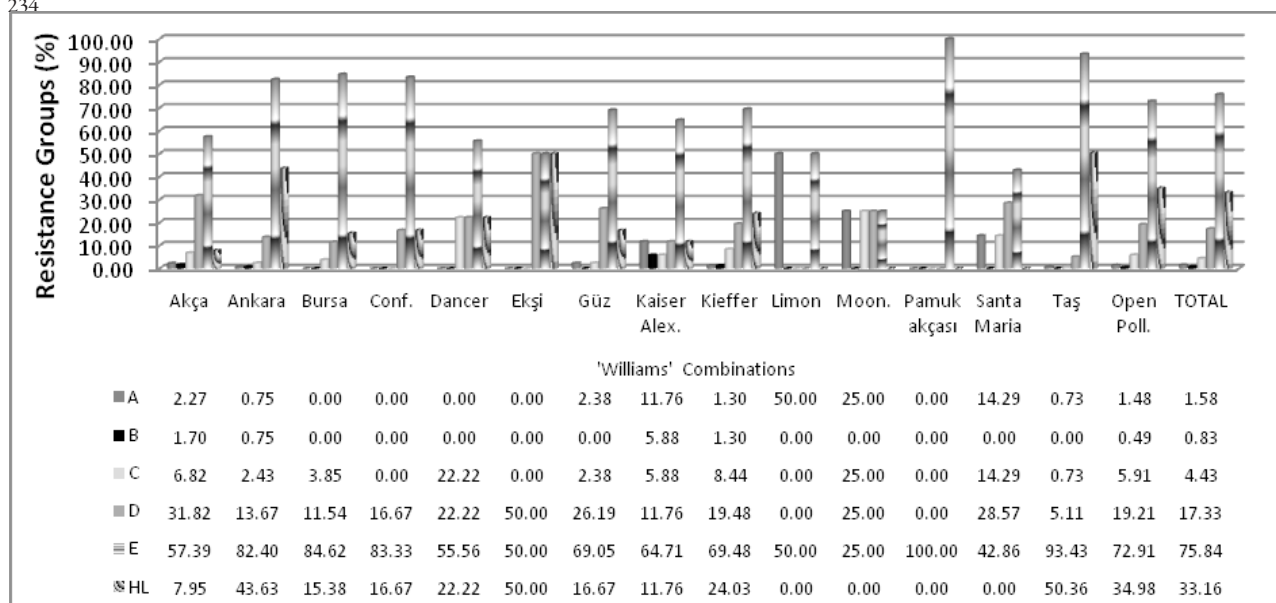


Fig. 10. Distribution of 'Williams' hybrids to susceptibility classes (%)

susceptible- A" hybrids in every combination of 'Magness' cultivar, and 'Ankara' pollinator (34.35%) ranked the first row among them. Almost in every combination (except 'Williams') there were hybrids in each susceptibility class and hybrid distribution to the classes was more balanced than the other maternal parents (Fig. 8).

In 'Santa Maria' cultivar, it was seen that 'Cleveland Select' (16.67%) and 'Taş' (5.56%) combinations, and open pollination (4.92%) possessed class "A" hybrids (Fig. 8). Most of the hybrids were detected in class "E" in every combination. There were notable class "B" hybrids in 'Cleveland Select' combination (16.67%), and class "C" hybrids in 'Akça' combination (9.09%), and open pollination (6.56%) (Fig. 9).

Similar to 'Santa Maria' cultivar, most of the hybrids were determined in "very susceptible- E" character for 'Williams' maternal parent, too. 50% of 'Limon' combination, 25% of 'Moonglow' combination, 14.29% of 'Santa Maria' combination, and 11.76% of 'Kaiser Alexandre' combination involved in class "A". Total hybrid loss for 'Williams' combinations was remarkable as 33.16% value (Fig. 10).

Although, 'Moonglow', 'Dancer', 'Taş', 'Kieffer', 'Limon', 'Conference', 'Ekşi', 'Pamuk Akçası', and 'Güz' cultigens were stated as resistant to fire blight (Aysan et al., 1999; Bell et al., 2005; Çıtır and Mırık, 1999; Honty et al., 2006; Momol et al., 1992; Sobiczewski et al., 1997; Ünal et al., 1998; van Der Zwet and Beer, 1991), any "slightly susceptible- A" hybrid could not be obtained from some susceptible x resistant combinations of these pollinator cultigens ('Akça' x 'Güz', 'Akça' x 'Moonglow', 'Akça' x 'Taş', 'Santa Maria' x 'Bursa', 'Santa Maria' x 'Güz', 'Santa Maria' x 'Kieffer', 'Santa Maria' x 'Limon', 'Williams' x 'Bursa', 'Williams' x 'Conference', 'Williams' x 'Dancer', 'Williams' x 'Ekşi', 'Williams' x 'Pamuk Akçası'). Similarly, Sestras et al. (2008) reported that some cultivars known as resistant

were defined as susceptible to fire blight attack in some conditions; for example 'Old Home' and 'Moonglow' cultivars. On the hand, 'Akça', 'Santa Maria' and 'Williams' cultivars are known as susceptible to fire blight (Aysan et al., 1999; Çıtır and Mırık, 1999; Momol et al., 1992; Öden, 1999; Sobiczewski et al., 1997; van Der Zwet and Beer, 1991), but, in some resistant x susceptible combinations of these cultivars ('Kieffer' x 'Santa Maria', 'Magness' x 'Akça', 'Magness' x 'Santa Maria', 'Magness' x 'Williams'), hybrid numbers in class "A" was high, in our investigation. Besides, some resistant hybrids were obtained from susceptible x susceptible combination like 'Williams' x 'Santa Maria'. These data are parallel to the results obtained by Sestras et al. (2008). They stated that, a certain inconstancy of the cultivars reaction to *Erwinia* attack was noticed, as some are known as resistant or tolerant being susceptible or the contrary. 'Williams' considered highly susceptible included in the no attack class. So, in this research, the resistance level of the hybrids from various combinations differed among the cultivars used for cross pollination.

In another research concerning the testing of 85 hybrids, differences were observed between crosses in terms of the degree of resistance. A stable resistance level could not be detected for any of the species owing to these variations. It was observed that, resistance could not be transferred optimally in highly resistant x highly susceptible or highly resistant x highly resistant hybrid combinations. On the contrary, when two medium resistant parents combined, a maximum resistance level could be obtained (van Der Zwet et al., 1974).

Conclusions

It can be concluded that a total of 2631 hybrids of inoculated 3284 hybrids survived and distributed to different susceptibility classes. 19.88% of the inoculated hybrids

was killed by *Erwinia amylovora* bacteria. As for total distribution of the hybrids to resistance classes, 6.18% of all hybrids involved in class "A", 3.11% of them were in class "B", 8.89% were in class "C", 20.28% were in class "D", and 61.54% were in class "E".

It was detected that the number of "slightly susceptible-A" hybrids was much higher in combinations of resistant maternal parents, when compared to combinations of susceptible maternal parents, in 2007 and 2008 hybrids. When these resistant cultivars used as pollinators, it could not be possible to get the same remarkable conclusion. Besides, when susceptible cultivars were used as pollinators for these resistant maternal parents, sufficiently good results were attained with respect to class "A" hybrids.

Additionally, a wide range of class "A" hybrids were obtained from 'Magness' x 'Ankara' combination. 'Kieffer' x 'Santa Maria', 'Kieffer' open pollination, 'Magness' x 'Akça', 'Magness' x 'Kieffer', 'Magness' x 'Santa Maria', 'Mustafa Bey' x 'Moonglow' treatments displayed successful results with respect to "slightly susceptible- A" character. Moreover, it can be asserted that more hybridization combination leads to more hybrid number, and resistant hybrids.

As a result, the testing of hybrid population by artificial inoculation is very important from the point of view of obtaining new disease resistant cultivar candidate hybrids. Advanced evaluations must be performed in gained hybrid population regarding different fruit and tree characteristics.

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