Resistance to the attack of *Bactrocera oleae* (Gmelin) of some sicilian olive cultivars

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Abstract

Genetic resistance of olive germplasm could be an important tool in the control of Bactrocera oleae *(Gmelin), the key pest in the Mediterranean olive growing. Up to now, no study was carried out on olive cultivars stressed a complete resistance to the attack of* B. oleae*, and few scientific data are available on susceptibility to olive fruit fly of Sicilian cultivars, although differences among susceptibility of cultivars could be usefully considered to obtain quality productions and to reduce insecticides use both in organic and conventional olive growing,.*

The present study was carried out at Castelvetrano (Trapani province, Sicily), in the olive germplasm collection of Ente di Sviluppo Agricolo of the Sicilian Region and Dipartimento di Colture Arboree of the University of Palermo. From 2002 to 2005, infestation levels in drupes of 18 cv, representing the most widely cultivated in Sicily was recorded. Samplings were carried out every 11-20 days, starting from the second half of August to the end of October. Moreover, from 2003 to 2005 infestation levels were correlated with size and hardness of olives, while in 2004-2005 data on olive coloration were collected at different ripening stages.

Among the cultivars producing larger olives, Nocellara del Belice resulted the most susceptible to the olive fruit fly attacks, while Nocellara messinese was the less infested. Among cultivars with medium, small-sized fruits Moresca, Vaddarica, Nasitana frutto grosso, Minuta and Bottone di gallo were the less susceptible. Among the tested cultivars Nocellara del Belice was more attacked in every year of the research.

A positive correlation between infestation and olive size was found, resulting in higher infestation levels on the cultivars producing larger olives. B. oleae *showed a clear preference for green drupes, instead of reddish or blackish ones. In two out of three years a negative correlation between hardness and infestation was found in September.*

Keywords: olive fruit fly, fruit size, fruit hardness, fruit coloration, organic farming.

Introduction

The olive fly, *Bactrocera oleae* (Gmelin), is considered the olive key pest in Mediterranean Basin. As a consequence of ECC incentives, in the last five years many olive growers changed cultivation strategy from conventional to organic method, although the difficult olive fly control, because of the limited availability of effective products as permitted by Council Regulation (EEC) No. 2092/91 and its modification. Several studies were carried out on the effectiveness of allowed products and other new natural substances (Belcari & Bobbio, 1999; Tsolakis & Ragusa, 2002; Petacchi & Minnocci, 2003; Saour & Makee, 2004), or on the susceptibility of different cultivars to the olive fly attack (Donia, 1971; Neuenschwander *et al*., 1985; Iannotta, 1999). In Sicily many local cultivars are well characterized and regularly cultivated; nevertheless their resistance to the olive fly infestation is not yet deeply investigated.

The aim of the present research is to assess the susceptibility of the most widespread Sicilian cultivars, to better control the olive fly and to give useful information for new olive groves planting.

Material and Methods

From 2002 to 2005, the research was carried out on 18 Sicilian cultivars, in the experimental olive grove "Campo Carboj" of ESA (Ente Sviluppo Agricolo, Regione Siciliana), located at Castelvetrano (Trapani Province). A list of the 18 cultivars is reported in Table 1; La Mantia *et al.* (2005) now consider Pizzo di corvo as junior synonym of Giarraffa. In the different years, the cultivars with not enough drupes for the minimum sampling were not included in the research. Each thesis consisted of three untreated plants for each cultivar, subjected to the same cultural practices.

Male olive fly population was monitored by wing traps baited with the specific pheromone (1.7-dioxaspiro [5.5] undecane). During each year, two-three traps were placed in the field from the end of July-beginning of August to the end of October. Traps were checked every week, and pheromone dispensers were replaced every 30 days.

From August to October, samples of 60 drupes (20 per tree) in 2002-2004 and 90 drupes (30 per tree) in 2005 were randomly collected every 11-20 days, at a 1.70 m height and around all the tree. In the laboratory olives were examined under a steromicroscopy, to check the presence of oviposition punctures. Olives were also sectioned to record the presence of the different pre-imaginal stages. The number of eggs, larvae of the different stages, pupae and exit holes was recorded to calculate the total infestation. Furthermore, sterile stings (punctures not followed by oviposition) and empty galleries were counted.

Moreover, during 2003-2005, on 30 sampled drupes of each cultivar, the following biometric data were recorded: hardness, maximum diameter (max.D.), minimum diameter (min.D.). The

Table 1. Sicilian olive cultivars tested in the research. (Listed in descending order of average size along the years of the research)

No	CULTIVAR	2002	2003	2004	2005
1	Pizzo di corvo (= Giarraffa)	X	X	X	X
2	Giarraffa	X	X	X	X
3	Tonda Iblea		X		
4	Nocellara messinese	X	X	X	X
5	Nocellara del Belice	X	X	X	X
6	Carbucia		X		
7	Moresca	X	X	X	X
8	Vaddarica	X	X	X	X
9	Nasitana frutto grosso	X	X	X	X
10	Cerasuola di Sciacca	X	X	X	X
11	Biancolilla Caltabellota frutto grosso	X			X
12	Calatina		X		X
13	Piricuddara	X	X	X	X
14	Biancolilla Caltabellotta frutto piccolo	X		X	
15	Bottone di gallo	X	X	X	X
16	Castricianella rapparina	X	X	X	X
17	Minuta	X	X	X	X
18	Olivo di Mandanici	X	X	X	X
	TOTAL No PER YEAR	**15**	**16**	**14**	**15**

latter two measurements were used to calculate the olive volume ([(π/6) x max.D.] x min.D.2).

A visual analysis of olive colour was carried out on 30 drupes of the last sample collected on 2003 and of all the 2004 samples, and on all the 90 olives collected during 2005. Three different

coloration classes were adopted to classify olives: green, reddish (mostly during viraison), and blackish (completely mature olives).

Climatic data from the agrometeorological station located at Castelvetrano (30 m a.s.l., Trapani Province) were kindly provided by S.I.A.S. (Servizio Informativo Agrometeorologico Siciliano of Government of the Sicily Region).

Data on total infestation recorded at each sampling date were statistically evaluated by ANOVA followed by Tukey post-hoc test at confidence level $p<0.05$ and repeated measurents ANOVA. Pearson linear correlation ($p<0,05$) total infestation/olive volume and total infestation/hardness was calculated at each sampling data from 2003 to 2005.

Results

In every year of the research was carried out in all the sampling dates, except that 2003 where the *B. oleae* infestation level was very low, some cultivars characterized by large drupe size resulted more infested in comparison with those cultivars bearing small olives (Figs. 1, 2, 3).

In the group with olives of large size in 2002, 2003 and 2005 Nocellara del Belice showed the highest infestation significantly differing from Nocellara messinese and Moresca. Among cultivar with smal and medium size olives the highest statistical diferantation occurred in 25005, when Minuta and Bottone di gallo among the small sized, and Vaddarica plus Nasitana frutto grosso the medium sized. Same the consideration can makes for the other categories medium and small. Biometric analysis on hardness and size of drupes from the different cultivars showed statstically significant differences among them with few minor changes in different years. For this reason in the presentation of all data regarding cultivars (Figs. 1-3), they are grouped in three groups: small, medium and large sized olives. Also hardness of olives risulted statistically different among the different cultivars. The two cultivars with highest hardness values resulted Nocellara messinese and Piricuddara, characterized by large and small size of olives, respectively.

In 2004, in all the sampling dates, and in 2005 from September 23rd, a significant positive correlation was found between the infestation level and the olive size, indicating that olive flies prefer to oviposit on larger drupes. In 2004 correlation between infestation and hardness resulted statistically negative on the 20th of September, and positive in the last date (Tab.2). In 2005 the correlation between infestation and drupe hardness was significantly negative on the August 26th, September 8th, October 20th and 31st, while it was significantly positive on the October 7th (Tab. 3).

Table 2. Pearson linear correlation infestation/size and infestation/hardness of variously coloured drupes of 14 Sicilian olives cultivars in 2004. Values in bold indicate statistically significant correlation ($p<0,05$)

INFESTATION	SIZE	HARDNESS
3 September 2004	**0.12**	-0.07
20 September 2004	**0.21**	**-0.13**
6 October 2004	**0.14**	0.10
26 October 2004	**0.17**	**0.27**

Table 3. Pearson linear correlation infestation/size and infestation/hardness of variously coloured drupes of 15 Sicilian olive cultivars in 2005. Values in bold indicate statistically significant correlation ($p<0,05$)

INFESTATION	SIZE	HARDNESS
26 August 2005	0.09	**-0.09**
8 September 2005	-0.11	**-0.11**
23 September 2005	**0.10**	-0.04
7 October 2005	**0.25**	**0.10**
20 October 2005	**0.14**	**-0.30**
31 October 2005	**0.26**	**-0.13**

The data statistic analysis showed that inside of every dimension category of size is of fundamental importance the color of the olives (Figs. 1-3).The different results obtained in the last sampling dates of 2004 and 2005 indicates that olive fly females prefer larger and green olives or oviposition; on October 26th of 2004 and October 31st of 2005, green olives resulted statistically more infested than the reddish and blackish ones (Figs. 4,5).

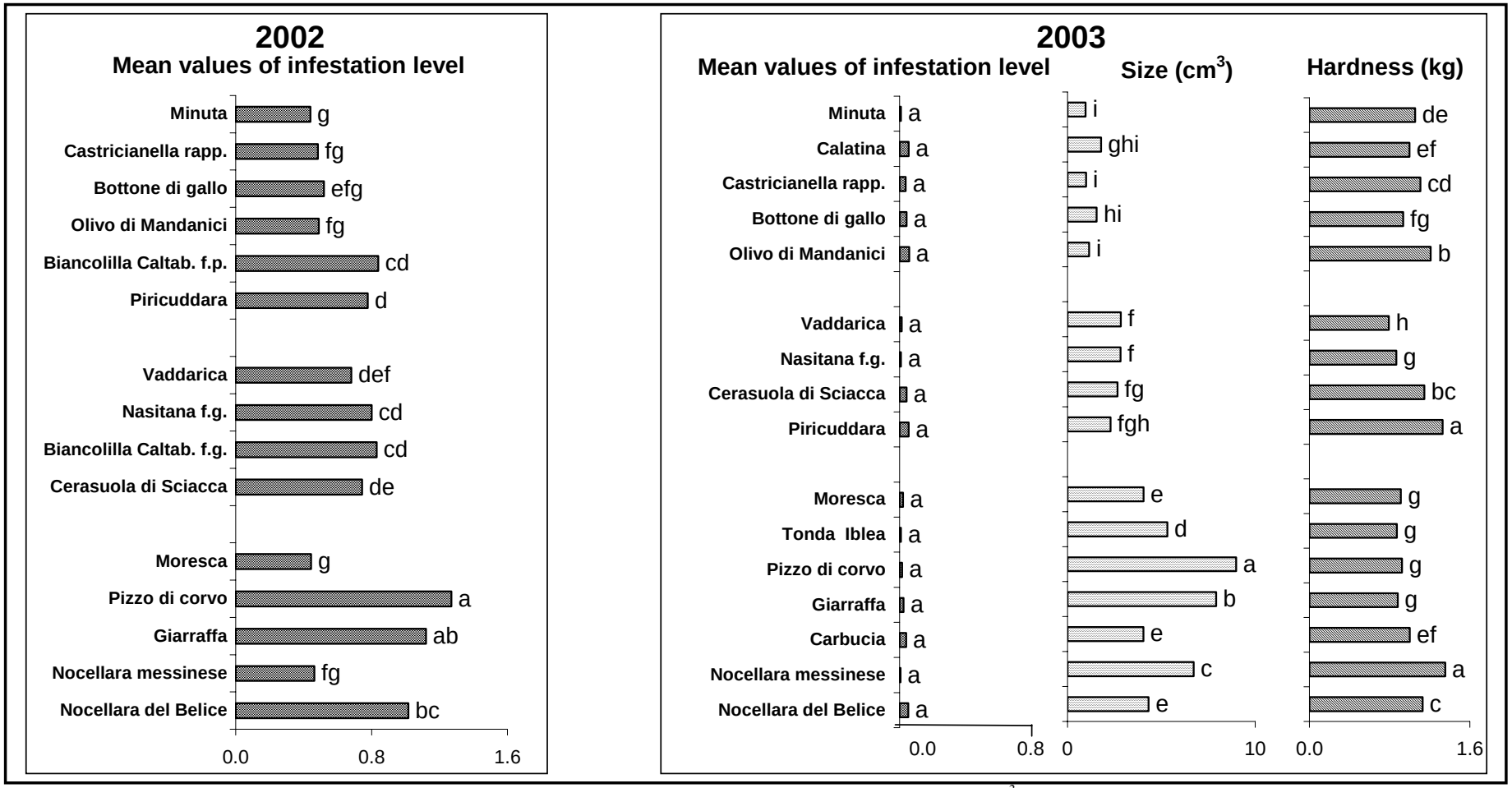

Figure 1. Mean values of *B. oleae* total infestation per olive in 2002 and 2003 in sicilian cultivar. Olive size (cm^3) and hardness (Kg) are also shown for 2003. Cultivars are grouped following olive size (small, medium and large) recorded in 2004 and 2005; inside these groups, cvs. are listed in order of descending dark coloration of olives recorded in 2005. Different letters denote statistically significant differences among all cvs. (repeated measurement ANOVA followed by Tukey test, $p<0.05$).

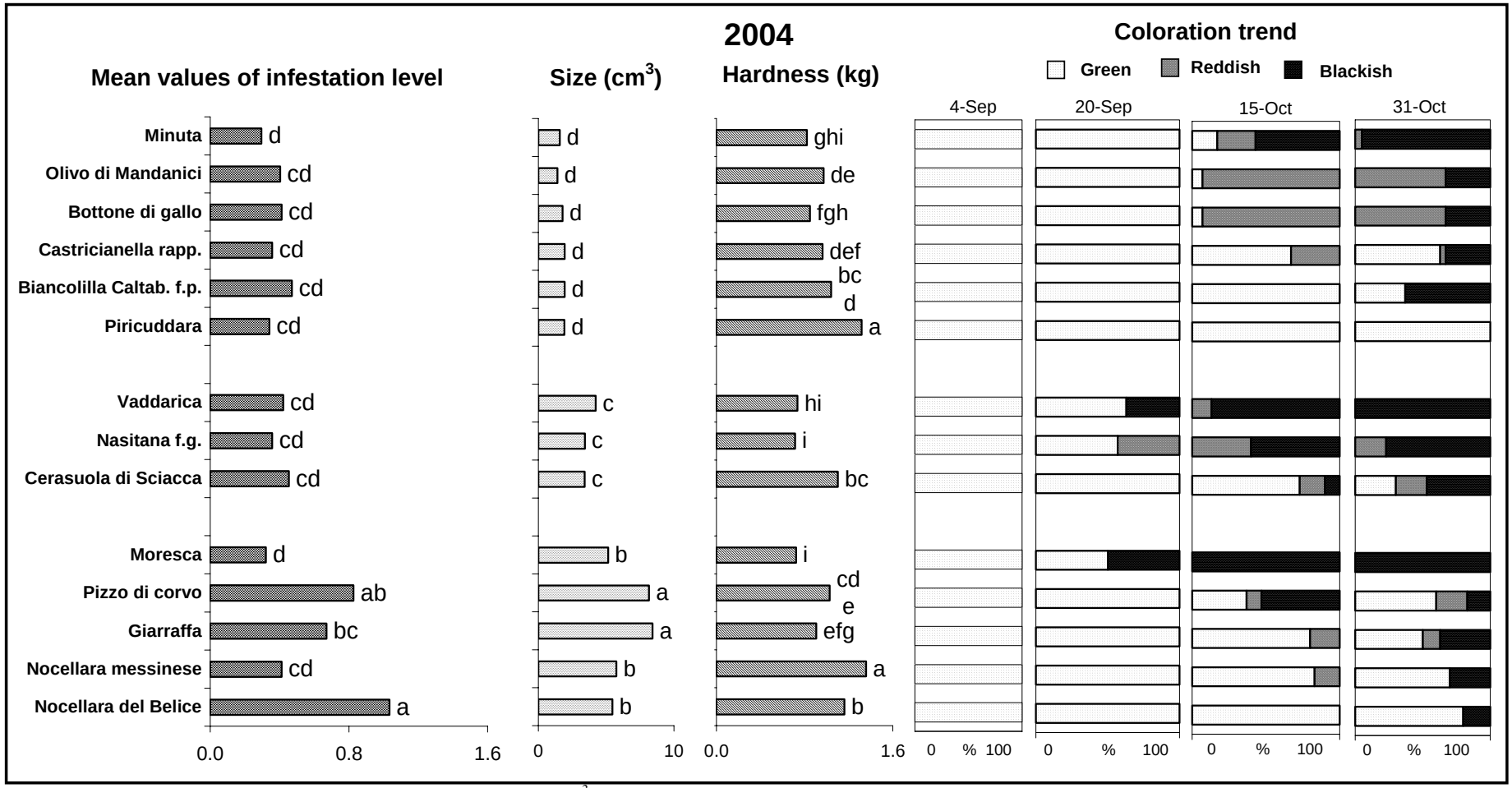

Figure 2. Mean values of B. oleae total infestation, olive size (cm^3), and hardness (Kg) and coloration trend recorded in 2004. Cultivars are grouped following olive size (small, medium and large); inside these groups, cvs. are listed in order of descending dark coloration of olives. Different letters denote statistically significant differences among all cvs. (repeated measurement ANOVA followed by Tukey test, $p<0.05$).

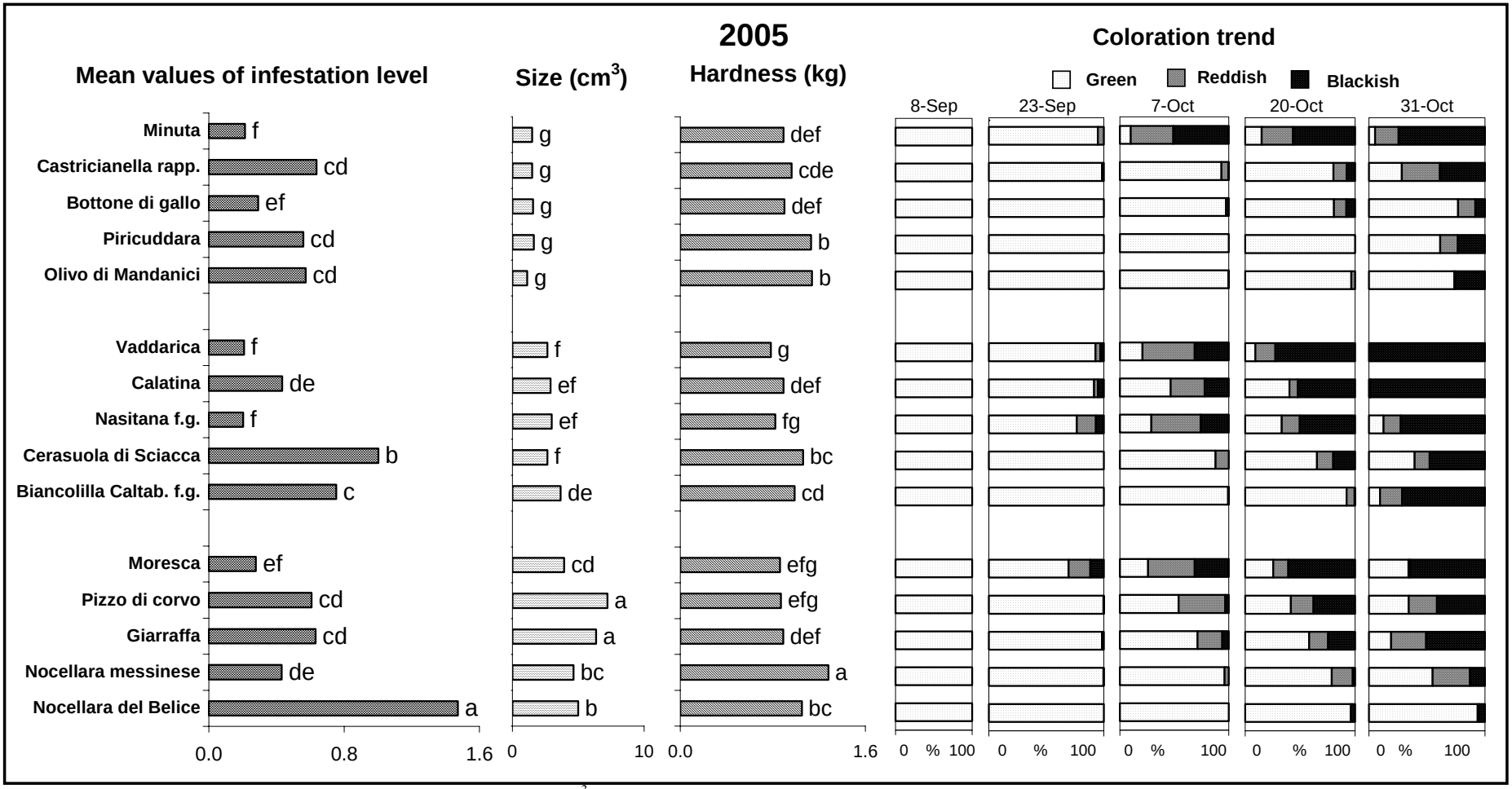

Figure 3. Mean values of B. oleae total infestation, olive size (cm^3), and hardness (Kg) and coloration trend recorded in 2005. Cultivars are grouped following olive size (small, medium and large); inside these groups, cvs. are listed in order of descending dark coloration of olives. Different letters denote statistically significant differences among all cvs. (repeated measurement ANOVA followed by Tukey test, $p<0.05$).

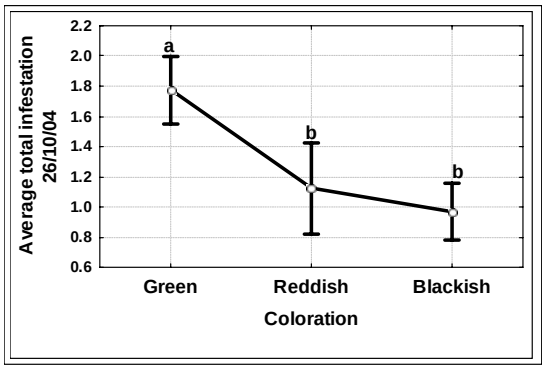

Figure 4. Total infestation of differently coloured drupes of 14 Sicilian olives cultivar (Different letters denote statistically significant differences; ANOVA 1-way followed by Tukey post-hoc test; $p<0.05$)

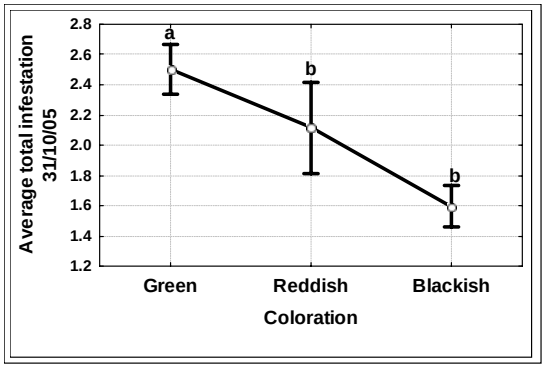

Figure 5, 6. Total infestation of differently coloured drupes of 15 Sicilian olives cultivar (Different letters denote statistically significant differences; ANOVA 1-way followed by Tukey post-hoc test; $p<0.05$)

Discussion

The results of our research confirm that none of tested Sicilian olive cultivars is resistant to olive fly attack. Nevertheless, a range of susceptibility among the different cultivars was found.

The sizes of drupes is considered by several authors one of the most important factors in the choice of olives by *B. oleae* female (Pucci & Ambrosi, 1981; Jimenez, 1988). The positive significant correlation between infestation levels and olive sizes seems to confirm this relationship. Moreover, the infestation level on cultivars characterized by large drupe size resulted usually higher than that one recorded on cultivars bearing small olives (Figs. 1-3).

Olive hardness was proved to be another important factor in determining the choice of drupes for oviposition by *B. oleae* females (Martin, 1948; Orphanidis *et al*., 1958). The occurrence of a negative significant correlation between infestation and hardness was confirmed mostly during the early developing and ripening period of the olives, when all drupes are completely green, showing that hardness play an important role until the end of August- half of September.

Afterwards, when olives reach their nearly final sizes and become softer, they turn dark-coloured. Also the olive coloration seems to play a role in females choice (Katsoyannos, 1989). Indeed, green olives resulted more infested than brown ones, as found also by Orphanidis et al. (1959) and Cirio (1971). As a result, cultivars such as Giarraffa, charachterized by large olives and early ripening period, were the most infested in September. Afterwards, the complete viraison of olives from these two cultivars, lead the olive fly females to prefer other cultivars for oviposition. In the cultivars Moresca, Nasitana f. g. and Vaddarica, characterized by large or medium size olives and early maturation, almost 50% of olives on the trees is already blackish, in the first week of October; these three cultivars thus avoided the most harmful olive fly attack, commonly occuring at the end of October.

Among the tested cultivars, Nocellara del Belice resulted the most susceptible to the olive fly attack, both for the large olive size and the still green colouration at the end of October. On the other hand, Nocellara messinese, in spite of the large olive size, resulted one of the less attacked cultivar, with infestation levels similar to the small cultivars. As Nocellara del Belice and Nocellara messinese have also in common a high fruit hardness and a green colouration until the end of October, but their susceptibility is highly different, other (physical, chemical) factors are surely involved in determing this difference.

Also in the susceptibility to *B. oleae* attacks Giarraffa and Pizzo di corvo did not show statistically significant differences in mean values of the all the years, according to La Mantia *et al*., (2005) considering them synonyms. Among the cultivars producing small olives, Minuta showed the lowest susceptibility, probably due to both the small olive size and to the brown coloration that more than 50% of olives had in the first half of October.

The wide range of susceptibility level shown by tested cultivars could be useful in organic olive growing. In the most susceptible cultivars, to limit damages due to *B. oleae* early harvest-

ing and effective interventions are necessary; less susceptible cultivars (Nocellara messinese, Moresca, Vaddarica, Nasitana f. g., Minuta, Bottone di gallo) could be suggested for new organic olive plantings for oil or table olives production.

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