Incidence of damage by nut weevil on different hazelnut cultivars in northwestern Italy

Incidence of Damage by Nut Weevil on Different Hazelnut Cultivars in Norhwestern Italy

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Abstract

The nut weevil *Curculio nucum* L. (Coleoptera: Curculionidae) is one of the major hazelnut pests, responsible for high yield losses in Europe and Turkey. However, some hazelnut varieties seem to be more resistant to the nut weevil attacks, even if mechanisms involved in the resistance are not yet altogether known. In a previous study on two cultivars and four selections of hazelnut, the susceptibility to nut weevil appeared to be related to the timing of shell hardening. Therefore, a three-year study on 15 hazelnut cultivars was carried out to assess their susceptibility to the nut weevil. In addition, nut and kernel development stages and shell hardening were detected. At harvest, nut weevil damage was significantly different between the cultivars. Despite their different earliness, 'Hall's Giant', 'Tonda di Giffoni' and 'Tonda Gentile delle Langhe' were the less damaged (<5.0%), whereas the latest 'Cosford' showed the highest damage (35%). Thus, the earliness of nut development resulted not to be the only factor affecting the rate of nut weevil damage at harvest.

INTRODUCTION

The nut weevil *Curculio nucum* L. (Coleoptera: Curculionidae) is one of the most harmful hazelnut pests responsible for heavy yield losses in Europe and Turkey. However, some hazelnut cultivars seem to be more resistant to the nut weevil attacks, even if the mechanisms involved in the resistance have been poorly investigated so far. Previous studies correlated cultivar susceptibility to the nut weevil with endocarp tissue composition (Piskornik, 1992; 1994) or with shell thickness (Caramiello et al., 2000), but none of these factors can altogether explain the different varietal responses to the pest attacks.

In a previous study conducted in Piedmont (NW Italy) on two cultivars ('Tonda Gentile delle Langhe' (TGdL) and Ennis) and four selections ('Daria', sel. 101, sel. L35 and sel. B6) of hazelnut, the susceptibility to nut weevil attacks appeared to be related to shell hardening earliness (Guidone et al., 2007). Therefore, a three-year study on 15

hazelnut cultivars was carried out to assess the damage rate caused by *C. nucum* at harvest. Moreover, nut and kernel development stages and shell hardening were detected to assess the correlation between damage by nut weevil at harvest and cultivar earliness in fruit development.

MATERIALS AND METHODS

A three-year study (2008-2010) was carried out on 15 hazelnut cultivars in an orchard with plant spacing of 4 × 4 m and bush training system, located in Cravanzana (latitude 44°34', longitude 8°07', altitude 550 m a.s.l.) in the hilly area of Langhe (Piedmont, NW Italy). The orchard is a hazelnut germplasm collection where each cultivar is represented by three adjoining plants. No pesticide treatments were applied in the orchard during the trials.

In order to estimate earliness of development, samples of 15 nuts for each cultivar (five nuts plant^{-1}) were collected directly from the plants every 10 days from mid-June until late August in 2008 and 2009. The three nut and kernel dimensions (length, width, and thickness) were measured, and the volumes were calculated using the ellipsoid formula (Valentini et al., 2006); shell hardness was also measured using Universal Testing Machine TA.HD® Texture Analyser (Stable Micro System, Godalming, Surrey, UK). The maximum force (N) required to obtain shell puncture was recorded using the Texture Expert® software, which is associated with the instrument. The puncture was carried out in the median zone of the nut as described in Guidone et al. (2007). Hazelnut cultivars were divided in five classes of earliness (class 1 = very early to class 5 = very late) considering nut development stages and shell hardening. The time in which seed began to develop and shell began to harden was used as a reference.

To assess weevil damage at harvest, the whole yield of each plant was harvested manually from the ground, from mid-August to late September in 2008 and 2010. In laboratory, nuts healthy and damaged by *C. nucum*, showing larval exit holes or still larvae (Fig. 1), were separated and counted. Hazelnut cultivars were divided in seven classes in relation to the damage rate (class 1 <5% to class 7 >30%).

Data of nut weevil damage at harvest were statistically analysed by ANOVA and Tukey's test using the SPSS version 17.0 (Chicago, IL, USA).

RESULTS AND DISCUSSION

The seed development and the shell lignification started when the nut had reached full size, according to Thompson (1979). Then, seed growth proceeded for approximately 5-6 weeks when full size was reached; shell hardening was strictly related to seed development, and the maximum values of force measured to penetrate shell were registered when seed had reached full size (data not shown).

In relation to the beginning of seed development and shell hardening, considered as the reference time, TGdL was the earliest cultivar reaching this stage in late June or early July, while Cosford was the tardiest one, reaching the same stage approximately 5 weeks later (Table 1).

At harvest, damage by nut weevil was significantly different between the cultivars (Fig. 2). The damage at harvest varied considerably between the two years, with higher rates in 2010, but the susceptibility level of each cultivar did not change. However, in 2008 and 2010, 'Camponica', 'Hall's Giant', 'Tonda di Giffoni' and 'TGdL' had lower values of damage than 5.0% on average, while Cosford had the highest values of damage (on average 35.4%) (Table 2). 'Daria' and 'TGdL' showed values of damage similar to

those previously observed in the same area (Guidone et al., 2007), as well as 'Hall's Giant' and 'Cosford' resulted not very and very susceptible cultivar, respectively, consistent with Piskornik (1994).

Although the latest cultivar 'Cosford' was the most highly damaged by *C. nucum*, damage at harvest was not always related to earliness of nut development. In fact, 'Hall's Giant' showed low values of damage in both years, despite its lateness in comparison with TGdL. At the same way, the early cultivars 'Mortarella' and 'Nocchione' showed high values of damage (class 4 = 15.1-20.0%), whereas the late cultivar 'Closca molla' showed low values of damage (class 2 = 5.1-10.0%) (Tables 1 and 2).

Therefore, cultivar earliness in fruit development and shell hardening seems not to be the only factor affecting the rate of damage by nut weevil at harvest. Preliminary observations on oviposition rates showed significant differences between the cultivars (data not shown), as well as a different behavioural response of the cultivars to the presence of weevil eggs.

All these factors will need to be further studied to improve our comprehension on the mechanisms involved in cultivar susceptibility to *C. nucum* attacks. Indeed, the knowledge about factors affecting the susceptibility is fundamental to address new breeding programmes towards cultivars more resistant to nut weevil.

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Literature Cited

Caramiello R., Me G., and Radicati L., 2000. Structure and characteristics of the hazelnut shell in different cultivars and their agronomic and industrial influence. Acta Hort. 517, 195-205.

Guidone L., Valentini N., Rolle L., Me G., and Tavella L., 2007. Early nut development as a resistance factor to the attacks of *Curculio nucum* (Coleoptera: Curculionidae). Ann. Appl. Biol. 150, 323-329.

Piskornik Z., 1992. Observation on the resistance of hazelnut (*Corylus avellana* L.) to the hazelnut weevil (*Curculio nucum* L., Coleoptera, Curculionidae). Acta Hort. 317, 163-170.

Piskornik Z., 1994. Relationship between the resistance of hazelnut cultivars to the hazelnut weevil and the content of sugars, amino acids, and phenols in the endocarp tissue of growing nuts. Acta Hort. 351, 617-624.

Thompson M.M. 1979. Growth and development of the pistillate flower and nut in Barcelona filbert. J. Amer. Soc. Hort. Sci. 104, 427-432.

Valentini N., Rolle L., Stevigny C., and Zeppa G., 2006. Mechanical behaviour of hazelnuts used for table consumption under compression loading. J. Sci. Food Agric. 86, 1257-1262.

Tables

Table 1. Grouping of the 15 cultivars investigated in Piedmont (NW Italy) in 2008 and 2009 in relation to their nut development.

Class	Time of nut development	Cultivar
1	very early	TGdL
2	early	Camponica, Mortarella, Nocchione, Tonda di Giffoni
3	middle	Casina, Culplà, Daria, Du Chilly, Hall's Giant, Jaan's, Pauetet
4	late	Closca molla, Negret
5	very late	Cosford

Table 2. Grouping of the 15 cultivars investigated in Piedmont (NW Italy) in 2008 and in 2010 in relation to the percentage of damage by *Curculio nucum* at harvest.

Class	Damage rate by nut weevil (%)	Cultivar
1	< 5.0%	Camponica, Hall's Giant, TGdL, Tonda di Giffoni
2	5.1-10.0%	Closca molla, Du Chilly, Jaan's
3	10.1-15.0%	Casina, Culplà, Negret
4	15.1-20.0%	Mortarella, Nocchione
5	20.1-25.0%	Daria
6	25.1-30.0%	Pauetet
7	> 30.0%	Cosford

Figures

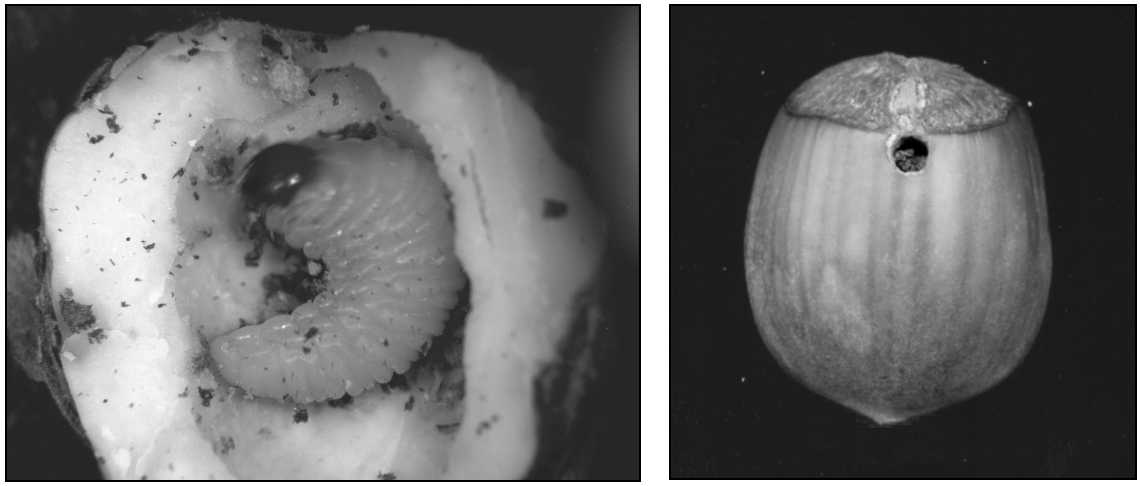

Figure 1. *Curculio nucum*: larva feeding on the kernel (left) and larval exit hole (right).

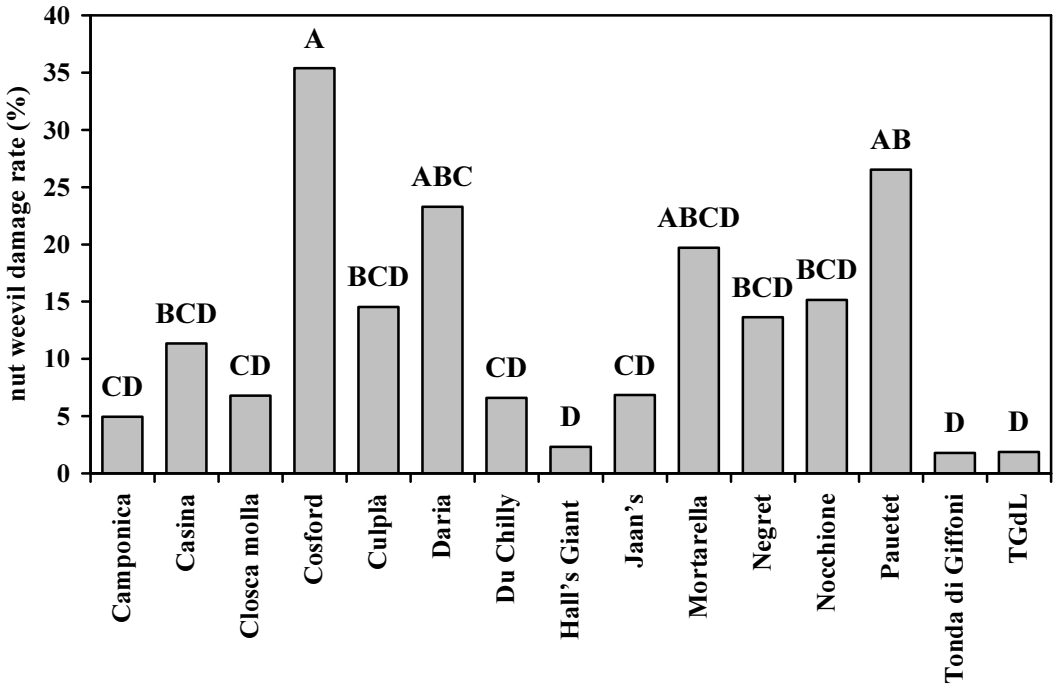

Figure 2. Mean values of damage rate by *Curculio nucum* at harvest in the 15 cultivars investigated in Piedmont (NW Italy) in 2008 and 2010. Bars with the same letter are not statistically different (Tukey test, $P<0.01$).