Management of Chestnut Weevil (C*urculio* spp.)[1], Insect Key-Pest in Central Italy

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Abstract

It is known that chestnut weevils [*Curculio propinquus* (Desbr.) and *Curculio elephas* (Gyll.)] are key insects in chestnut cultivation in many Italian regions. Although they have shown great variability through the years, pests can sometimes be very extensive affecting up to 60-70% of the crop. For this reason our research team has carried out a series of studies on the setting up of sampling, control and post harvest treatment methods. This paper briefly describes the biology of *Curculio propinquus* Desb. which is a serious pest in chestnut orchards in the province of Viterbo (Italy). The paper also describes techniques of sampling adult insects, methods of pest control and the consequences of the cold-water treatment technique ("*curatura*") on infestation of the commercial product.

INTRODUCTION

Italy has a leading role in the European scenario of chestnut marketing considering that the national chestnut production comes to almost half of that of the entire continent (Dono et al., 1998).

Italian and EU regulations, with the intention of increasing population in mountain areas, have led to a renewed interest in chestnut producing regions. This has highlighted the importance of "quality chestnuts" and of their natural environment.

For this reason chestnut producers are increasingly concerned about carpophagous insects which cause significant loss in their chestnut production.

There are numerous arthropods that can infest table chestnut (Pollini, 1998), but the key insect pests in Central Italy are *Curculio elephas* (Gyll.) and *Curculio propinquus* (Desbr.) Coleoptera, Curculionidae. *C. propinquus* is the major Curculionidae in the Monti Cimini area with 95% of infested fruit while only 5% is infested by *C. elephas.* For this reason we report only data about this major insect pest. We point out furthermore that literature tightly links *C. propinquus* to the oak tree (Triggiani et al., 1998).

CHESTNUT WEEVIL BIOLOGY (*C. PROPINQUUS*)

Adults appear from the end of August to mid-September. The time when adults emerge from the ground probably depends on the geographical position of the chestnut orchard and on the rainfalls of the end of summer. It is possible to discriminate sex by estimating the rostrum length as observed on *C. elephas* (Colizza, 1928). The female rostrum is longer than the length of the body, while that of the male is noticeably shorter. Females lay their eggs by piercing the husk of the nut with their rostrum and inserting an egg into the hole. There are no differences between the feeding hole and the laying hole on the chestnut fruit, as well as for oak trees, as reported by Triggiani et al. (1998). The new-born larva penetrates the fruit within the husk and feeds on the amylaceous substratum of the kernel. As many as 28 eggs and preimaginal larvae instars per chestnut fruit have been recorded, although generally each fruit hosts no more than 2 or 3 larvae. It

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is possible to find *C. propinquus* and *Cydia fagiglandana* (Zeller) or *Cydia splendana* (Hübner) larvae in the same infested chestnut fruit. At the end of the larval stage, the larva pierces the pericarp, and then emerges from the fruit through this hole and drops to the ground. In Central Italy the mature larva buries itself at a depth ranging from 5 to 15 cm. It then builds a small overwintering chamber in the soil. The pupae appear between the end of June and through the month of July. The newly emerged adults remain in the soil for a little while, and then move to the canopy of the host tree. There is a synchronism between the adult emerging from the soil and the degree of chestnut fruit ripening. The insect completes only one generation per year, although some larvae may remain in the ground in the larval state for several years (prolonged diapause), as observed on *C. elephas* (Menu, 1993).

The damage caused by this insect may be considerable in certain areas of our region with infestation rates reaching up to 90% or more.

ADULT SAMPLING METHODS

Shaking Technique

The adults of *C. propinquus* show a behaviour common to many groups of insects: thanatosis. The shaking technique takes advantage of this typical behaviour. Chestnut branches are shaken in the early morning after having placed a white sheet of material under the canopy. The adults in thanatosis fall on the length of material as observed with *C. elephas* (Cinti et al., 1993). This technique is rather expensive and underestimates insect population. This shaking technique is advisable with the more infested plants of the chestnut orchard. It allows monitoring adult presence on the chestnut tree.

Coloured Traps and "Activated" Coloured Traps

Cross traps in different colours (red, yellow, transparent), activated with toluene denaturated alcohol or not activated, have been tested. Results show a fair amount of captures which was reported in the highly infested area. The absence of significant statistical differences between all different traps and no correlation coefficient between captures and percentages of infested fruit make this methodology not valid. (Paparatti et al., 2002a).

Emerged Adult Pyramid Traps

Particular pyramid traps are put on the ground under the canopy (1 m^2 base). These are made with wire and are covered by a black net. A transparent plastic jar is placed at the top of the pyramid trap to catch adults emerging from the ground. Adults which have emerged from the ground quickly move to the top of the pyramid traps. Like the shaking technique, this technique is advisable on the more infested plants of the chestnut orchard. It allows monitoring the dynamics of adult emergence.

We are currently studying innovative and cheaper techniques of adult sampling and ways of finding the connection between adult sampling and the percentage of fruit infestation.

AGRONOMIC CONTROL SYSTEMS

Nets beneath the Canopy

This control method is mainly designed to prevent adults from emerging from the soil and to avoid burial of mature larvae in the soil. Plastic, white nets, roughly 130 m^2 wide, are used (weighing 150 gr/m^2, with 160 warp threads and 60 weft threads). These particular nets prevent adults from moving to the canopy of host trees (August) and the burial of mature larvae (October-November). From August to November, nets were carefully placed beneath the projection of the canopy of trees previously found to be severely infested. This technique was used for two years in a plot measuring roughly 2 ha;

results were found to be fairly satisfactory, reducing infestation percentage. This control method, however, must be supported by other insect control methodologies to achieve an optimum reduction of percentage of infested fruit.

Mechanized Harvesting

This harvesting system, repeated several times, prevents mature larvae still present in the fallen nuts from entering the soil. This technique makes it possible to achieve a marked decrease in the number of larvae that succeed in burrowing into the ground and overwintering, thereby reducing the overall population present in the chestnut grove (Paparatti et al., 1999).

Previous studies showed that samples collected by the harvesters show 22.5% of infested chestnuts. In the hand picked sample, instead, the infested chestnuts were only 3.5%. The infestation difference is due to the selection carried out by the hand picking person in the chestnut orchard. If we make the assumption, which is statistically likely, that levels of infestation in the crop collected with both systems are almost the same, then mechanised harvesting allows us to eliminate almost all infested chestnuts (22.5%), whereas with hand picking 19% of infested nuts remain (22.52% - 3.47%) (Fig. 1). The mature larvae which have emerged from the infested nuts and left on the ground are capable of remarkably influencing the expected infestation of the following year (Paparatti et al., 2000).

BIOLOGICAL CONTROL

The carpophagous insect are controlled by some parasitoids such as the *Scambus calobatus* (Gravenhorst) (Hymenoptera: Ichneumonidae), *Formuca rufa* L. (Hymenoptera: Formicidae) that prey upon the mature larvae of the chestnut weevil (Triggiani et al., 1998). The predators of the genus *Vespula* spp. are able to kill the over-wintering preimaginal instars.

MICROBIAL CONTROL

Entomopathogenic Fungi

Two entomopathogenic fungi, *Beauveria bassiana* (Balsamo) Vuill. and *Metarhizium anisopliae* Metch (Deuteromycotina, Hyphomycetes), are able to kill the overwintering preimaginal instars (Triggiani et al., 1998; Paparatti et al., 1999). Our team has studied the *B. bassiana* microbiological control. Preliminary trials have shown high larval mortality (Paparatti et al., 1999). We are currently studying the effectiveness of this methodology in open fields and the interaction between the *B. bassiana* treatments and the natural soil fungi.

CHEMICAL CONTROL

The active ingredients (a.i.) licensed for the chestnut tree in Italy are: Parathion, Malathion, Fenitrothion and Carbaryl (Valmori, 2001). Fenitrothion and Carbaryl, frequently used against the chestnut weevil, should be applied with caution in as much as they have been shown to encourage the swarming of phytophagous mites, and especially the *Oligonychus bicolor* (Banks) which causes, at high levels of infestation, the premature falling of the leaves (Cinti et al., 1995). Parathion is not advisable in this ecosystem because of its high level of toxicity and its significant impact on the environment. Preliminary tests using Malathion a.i. to control the phytophagous insect have not shown much effectiveness (Pucci, pers. commun.). Therefore, there is a very limited choice and there are operating difficulties for farmers who do not want to use a.i. which are not registered for the chestnut fruit.

Our team has carried out some tests to control adults of *C. propinquus* and *Cydia* spp. with the active biological ingredient Rotenone (*Derris elliptica*) and with the pyrethroid Lambda-cyhalothrin not yet licensed for the chestnut orchard in Italy. As shown in Fig. 2, it is possible to see some positive results using these two a.i. The lesser

effectiveness in chestnut weevil control shown by Rotenone can be counteracted by the higher value of organic chestnuts on the market.

Post-Harvest Management

The commercial product has a percentage of infested nuts. "Curatura" is a cold-water technique which involves both removing the fruit with chestnut weevil mature larvae and killing the eggs and preimaginal stages in chestnut fruit which seemingly have not been infested Our team has carried out some tests to evaluate the "Curatura" effectiveness on killing the eggs and the preimaginal instars on commercial product (Paparatti et al., 2002b).

CONCLUSIONS

Chestnut fruit consumers require good production without active ingredient residues. It is necessary to integrate all techniques to control the chestnut carpophagous insects in order to answer the primary requirement of the consumer. It is no longer possible to control chestnut weevils with calendar treatment chemicals using active ingredients which are not selective and have a very heavy impact on the environment. The high complexity of the chestnut ecosystem (Vitagliano et al., 1993), which shares some of the features of an agro-ecosystem but also those of a forest ecosystem, leads to considerable risk in applying chemical control using the active ingredients currently registered for chestnut crops.

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Figures

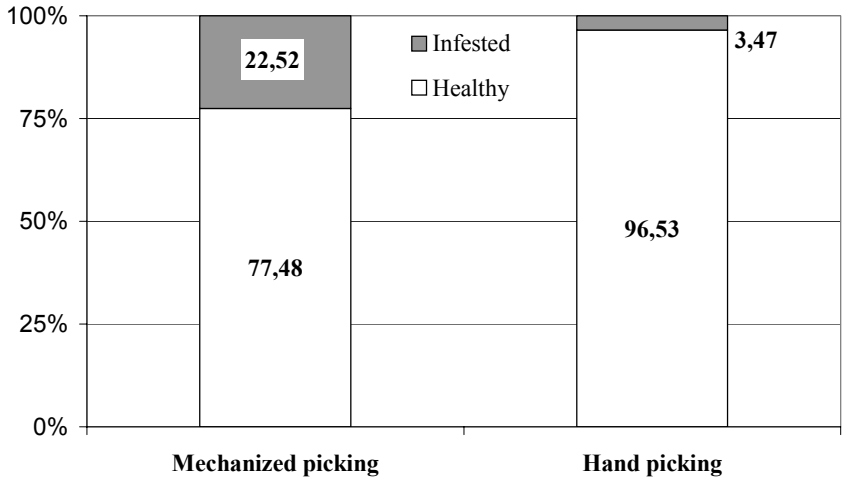

Fig. 1. Percentage of infested nuts with mechanized and hand picking harvesting.

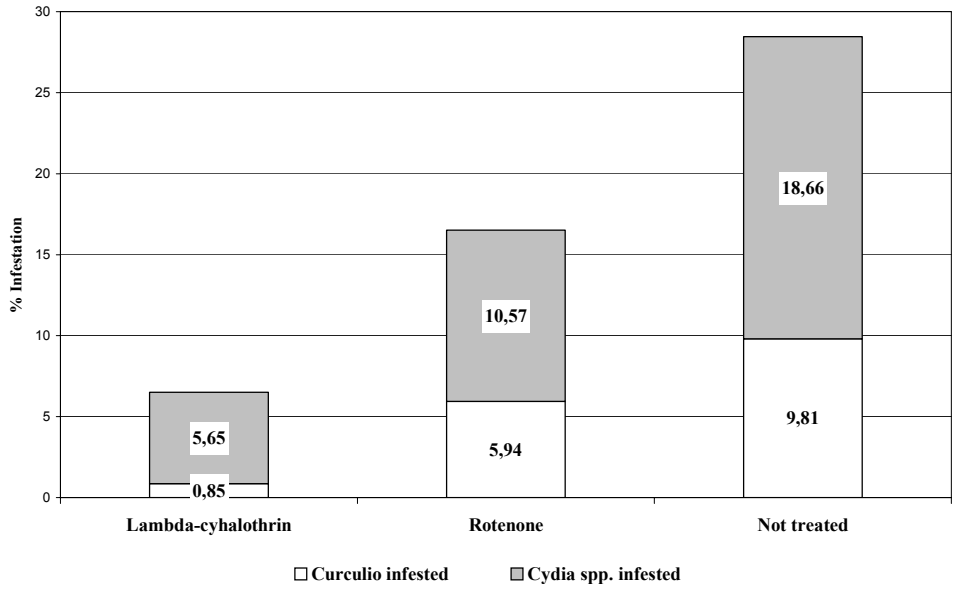

Fig. 2. Percentage of infected nuts in three chestnut orchards (treated with Lambda-cyhalothrin, treated with Rotenone, untreated).