

Palms (*Phoenix canariensis*) infested by red PALM weevil (*Rhynchophorus ferrugineus* Olivier): insecticidal efficacy tests of chipping treatment

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Abstract

The provision n° A6505/29-11-2010 of the Lazio Region Agricultural Department states that the plant material resulting from the felling of palms infested by RPW (*Rhynchophorus ferrugineus* Olivier) must be disinfested by heat treatment or fine mechanical chipping, ensuring that the resulting materials obtained are of a size smaller than 2 cm. This paper describes changes made on one machine chipper FARMi mod. FOREST CH260 for use in the cutting of trees and palm leaves in accordance with the above mentioned provision. The analyzes carried out on the plant material shredded, according to methodology UNI CEN/TS 15149-1 - 2006, show that 94,78% of the fragments is smaller than 16 mm and a water content of 52.5%. In all fragments of the material shredded at least one of the three dimensions was less than 2 cm. A mix of chipped stipes and leaves of palm tree was tested at ENEA facilities to evaluate the ability of RPW larvae to feed and survive on this substrate. Ten plastic containers (130 liters) were filled up with 26 kg each of chipped matter and infested with larvae grouped by weight into 3 classes ranged from < 0.15 g, 0.15 -; 0.35 g and > 0.35 g till 2 cm (3 containers for

each class and 1 as control; 30 larvae for each container). Containers, covered with a metallic net, were kept in an isolated chamber, controlling temperature in order to maintain the substrate around 30°C. The substrate was inspected at 45 dd after infestation. No survival was recorded on the larvae, indicating that chipping technique could be a suitable method to destroy infested palm avoiding potential risks of re-infestation from the disposal sites.

Introduction

The introduction of *Rhynchophorus ferrugineus* in Italy in a few years has caused great damage to the wealth of palms that characterizes many Italian areas, causing problems for the landscape changes and the implications for economic issues related to the abatement of the plants affected by the infestation of the pest and the proper and effective disposal of waste material that is difficult to manage in relation to the anatomical and physiological characteristics of the *Arecaceae*. The implications of the recent epidemic spread of the weevil, now configured as a real biological invasion, have been exacerbated by the difficulties of early diagnosis of insect infestation and the difficulties of operating in an environment often strongly anthropic (Roversi, 2013). It is increasingly necessary to implement preventive measures, such as chopping of trees felled by suitable means to eliminate the pest and then be able to limit the spread, linking the use of biocides synthetic or naturally derived. This aspect is an important element for the protection of the palm trees in the immediate term.

Materials and methods

The tests were conducted in November 2012, at the Research Unit for Agricultural Engineering (CRA-ING) in Monterotondo (RM) and the ENEA Research Center of Rome. At the laboratories of the CRA-ING tests have been carried out mechanical chopping of trees felled because of the infestation of red weevil.

On samples of the chopped material were carried out laboratory tests to determine the density, moisture content and particle size with the European standard method established by CEN (European Committee for Standardization).

For chopping machine was used a wood chipper Farmi CH260 FOREST. A quota of the chopped material was sent to Entomology laboratories of the ENEA, where a bioassay was set up in order to evaluate the ability of RPW larvae to survive and feed on this substrate. Ten plastic containers, 130 lt of capacity, were filled up with 26 kg of chopped matter

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Figure 1. The wood chipper FARMI model - CH260 FOREST Block diagram of workstations.

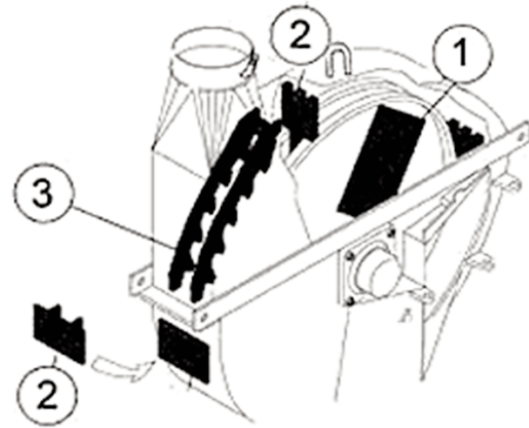


Figure 2. Chipping in 3 stages (for wood chips basis): 1. Double knife on the rotor disk 2. Fixed knives 3. Final knives. (source: <http://www.deangeli.bz.it>)

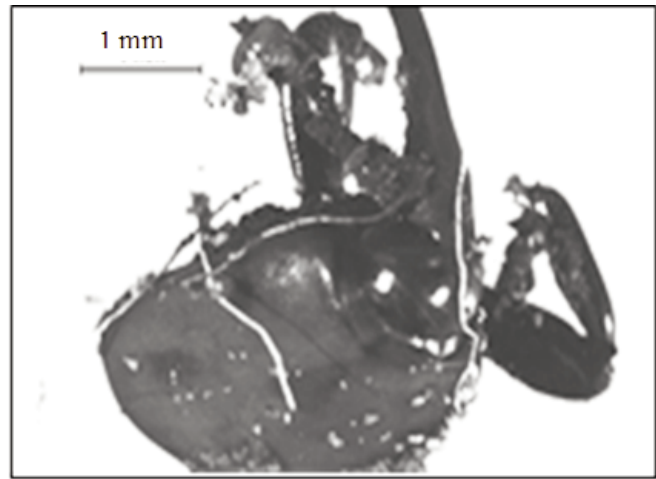
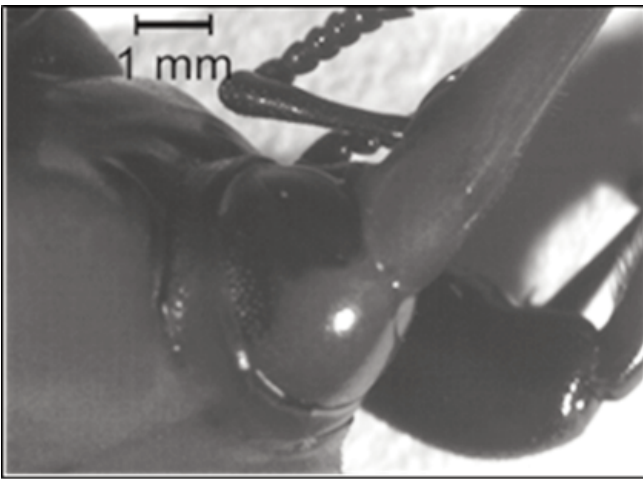


Figure 3. Adult found after 45 days (right) in comparison to normal sized individual.

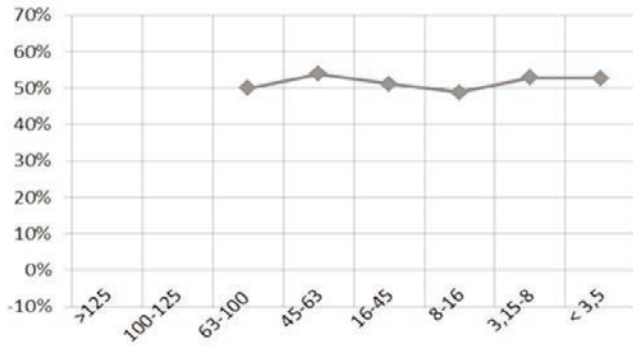
and infested with larvae. Larvae were obtained in laboratory from eggs laid on pieces of apple by RPW females, reared on apple and grouped into 3 classes as following: less than 0,15 g; from 0,15 g to 0,35 g; from 0,35 to 2 cm of length that is the lowest limit of the size of the chopped material. Each container was infested with 30 larvae, each class of larvae was replicated three times and one container with no larvae was used as control. After infestation, containers were covered with an anti-insect plastic transparent net and kept in climatic chamber in dark conditions. Temperature inside the containers was checked (and temperature control in climatic chamber eventually activated) in order to assure that suitable conditions for larval survival or development were maintained (28° - 32°C). Humidity in the chamber was always close to 100 %.

Since total larval duration in laboratory conditions can range from 70 to 90 dd at 30° C on apple (Cristofaro et al., 2011), or 103 dd and 69 dd at 21°C, respectively on apple and on palm crown (Salama et al., 2009), in order to verify larval survival in our experiment, all the containers were carefully inspected after 45 days. The presence of survived larvae and/or of the eventually developed stages of them (mature larvae, cocoons or adults) was observed.

Machine and work yard description

The wood chipper Farmi CH260 FOREST is constituted by a rotor knife characterized by the ability to adjust the size of the wood chips and the specific allocation of various accessories (Fig. 2) which ensure the correct size and homogeneity of the product. the rotor has the maximum rotational speed of 1000 rpm, has a diameter of 1050 mm and a mass of 240 kg. To avoid the clogging of the machine caused by the compaction of the fragments of palm that adhere to the inner walls of the machine and cause the obstruction, by the chipper has been eliminated a grid which performs the function of retaining the larger pieces of chopped material. The chipper is operated by a tractor 100 kW connected with a drive shaft. The chipper power system is hydraulic and consists of two toothed rollers: the upper roller with greater diameter is installed on a mobile frame with a spring that keeps the roller in contact with the incoming material, ensuring efficient power and high productivity.

The chipping occurs with adjustable knives attached to the rotor by means of screws. Knives are installed into the chipper in a fixed position and participate in the cutting of the material. The maximum size of plant material that can be introduced into the machine is 260 mm,



Graph 1. Water content: frequency distribution in classes of wood chips size (at 22 days after felling)

so the stems of palm trees have been previously cut with chainsaw into pieces of appropriate size. Using the machine described chipper is possible to obtain chips with average size between 7 and 25 mm. The resulting material was ejected from the launcher tube and stored in a trailer on the side of the machine.

Results

To allow the machine to perform the work, it was necessary to cut the stems of palm with additional charges for labor.

The distribution in frequency classes of the size of the wood chips shows that over 90% of the sample is in the range between 3.5 and 16 mm. (Fig. 4).

With a mass of about 0.7 t obtained from palm trees, were produced 970 kg of wood chips with a water content of 50% (at 22 days after felling) (Graph 1). The 81.86% of the sample had dimensions of less than 3.5 mm, the 5.22% is in the range between 16 mm and 100 mm, and 0.31% is between 45mm and 100 mm.

A natural increase of the temperature was observed in few days inside all the containers, without any appreciable differences with the control, probably due to the fermentation process of the chopped material. In a week temperature reached a value ranging from 36.9 to 37,1°C. Afterwards a progressive decrease during the experiment was recorded.

When temperature ranged from 22.7 °C to 27.7 °C, it was artificially maintained at about 30 °C.

Results regarding the insect bioassays show that this kind of chopping could be useful for the treatment of stipe and leaves of infested palms

destined to disposal sites, avoiding potential risks of re-infestation.

As regard the minuscule adult found, it is known that in unfavorable environments (e.g. unsuitable feeding substrates), the ecdysteroids and JH hormone balance is altered and the chances of untimely metamorphosis processes increases under severe stress conditions (Peri-Mataruga et al., 2006). However, the risk of adult survival and spreading in this form seems very unlikely. Nevertheless, further trials will be set up in order to confirm these results.

Conclusions

The test results show that the chipped material meets the requirements of national and regional legislation. It is possible to enhance the product for direct use in composting or for use as a fuel in a mixture with other waste material (pruning) in the production of thermal energy in small-medium heating systems.

With regard to the quality of work performed, it is observed that the additional operations of cutting of the palm stems represents a further cost increase of chipping.

On a total of 270 individuals, any survived larvae or pupae were found after 45 days from infestation for all the three sized larvae used. However, few hints of very small and empty cocoons were individuated inside the containers infested with the biggest larvae (from 0.35 g to 2 cm of length).

Furthermore, in one of these containers, only a dead minuscule adult was found (Fig. 3). It sized about one third in length (about 1 cm) in comparison to the average of the adults grown on the whole palm.

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