

To prevent the productions from **insects directly attacking the fruit** (tortrix and weevils), it is essential to apply agronomic techniques and biotechnology along with the biological control.

Collection and destruction of the leaves and fruits or burrs fallen to the ground allows to limit the density of pest populations, therefore reducing damages in the following year.

Fruit control should be carried out during the cleaning through the formation of "burrs bulk" on concrete basement to avoid larvae survival through pupation in the soil.

Use of pheromone traps for the monitoring of the main pest species (*P. fasciana*, *Cydia splendana* and *Cydia fagiglandana*). Such practices, together with the identification of the pest actually present in the chestnut plantation, allow to estimate the extent of the population (based on the number of catches) and the possible damage at harvest.

Biological control of pests and diseases of chestnut

Prevention: the key for disease control

Some agronomic practices are essential to avoid the occurrence of economically important diseases such as Ink Disease and Chestnut Blight.

Ink Disease (*Phytophthora cambivora* and *P.cinnamoni*):

- facilitate soil drainage and improve water run-off;
- avoid any soil water-logging;
- perform only light tillage to avoid soil compaction;
- avoid burning leaves and burrs since they are an important source of organic matter, essential to promote the vitality of tree roots and soil microflora;
- apply poultry manure (25-30 kg / plant) to the soil under the tree canopy alone or in combination with organic fertilizers and microelements.

Chestnut blight (*Cryphonectria parasitica*):

Chestnut trees should be periodically inspected for the presence of cankers.

A prompt evaluation of the initial symptoms greatly reduce the likelihood of future heavy damages. Once disease symptoms is observed the following solutions should be adopted:

- promptly remove dried branches due to early infections (recognizable as blighted or yellowing leaves still attached to the branches);
- pruning affected branches with cuts at least 10-15 cm below the canker. All tools used for cutting should be disinfected with sodium hypochlorite or ethyl alcohol;
- after the cut, the material should be carefully removed and burned;
- each wound after cutting should be brush-painted with 3% Bordeaux mixture.

All healed infections should be left in order to promote the maintenance and dissemination of hypo-virulent fungus strains.



Torymus sinensis dissemination
(Plant Protection Service)

The chestnut plantations in Emilia-Romagna are generally located on steeply sloping land and characterized by irregular stands and high volume canopy. Such stands characterize our typical forest ecosystems, have their own complexity, and at the same time, guarantee the ecological stability and quality of chestnut production. However, on the other hand, they make the pest and disease control difficult to achieve.

Application of chemical fertilizers and pesticides, on the long run, could alter the biological component of the chestnut growing ecosystems, favoring directly or indirectly their pest and pathogen populations.

With such premises, protection of chestnut trees from harmful insects and pathogens must be achieved through organic and biotechnological techniques, integrated with appropriate agronomic practices in order to allow the ecosystem to keep parasites under control.

Therefore, **avoiding any chemicals plant protection products, insecticides in particular, is a prerequisite in all the chestnut trees infested by the gall wasp after the introduction of its natural antagonist *Torymus sinensis***. The use of chemical pesticides would inevitably affect the parasitoid, nullifying the great effort and investment made so far to control this invasive pest.

Pest	Presence	Monitoring	Severity	Direct control tools	Indirect control tools	Notes
Chestnut leafroller <i>Pammene fasciana</i>	Adults fly July to september (flight peak in July)	Pheromon traps	*		Remove and burn the damaged burrs	
Beech moth <i>Cydia fagiglandana</i>	Adults fly from end of July to beginning of October	Damage observation at harvest Pheromon traps	***	Entomopathogenic nematodes <i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	Mating disruption. Remove and burn the damaged burrs	Apply in spring with T > 10°C and rainfall or sprinkle irrigation
Chestnut tortrix <i>Cydia splendana</i>	Adults fly from end of August to beginning of October	Damage observation at harvest Pheromon traps	***	Entomopathogenic nematodes <i>Bacillus thuringiensis</i> var. <i>kurstaki</i>	Mating disruption. Remove and burn the damaged burrs	Apply in spring with T > 10°C and rainfall or sprinkle irrigation
Chestnut weevil <i>Curculio elephas</i>	Adults fly from July to end of September	Damage observation at harvest	*		Remove and burn the damaged burrs	
Oriental chestnut gall wasp <i>Dryocosmus kuriphilus</i>	Adults fly from end of May to end of July (in relation to climatic conditions)	Presence of galls on the plants	****	Biological control by <i>Torymus sinensis</i> release	Avoid any chemical application and destruction of dry galls to favour the action of <i>T. sinensis</i>	<i>T. sinensis</i> gets out from the dry galls end of March to end of April in relation to climatic conditions
Wood borers <i>Xyleborus dispar</i>	Pest is active all spring and summer	Presence of feeding holes with wood residues on the trunks and wilting shoots	*		Keep trees in good physiological conditions; Increase water and the organic matter availability in the soil.	
Ink disease <i>Phytophthora cambivora</i> <i>Phytophthora cinnamomi</i>	Soil-borne pathogen spreading with water and favourable climatic conditions	Browning areas under the cortex of the crown. Canopy weakening (leaf yellowing)	****		Avoid water-logging Apply organic fertilisers on affected plants	Eliminate dead or severely affected plants
Chestnut Blight <i>Cryphonectria parasitica</i>	Wound-borne pathogen	Cankers on branches or trunks, bark reddening, leaf blight of the shoot closed to the canker	**	Protect pruning cuts with brush paint copper or biological product	Remove and burn branches and shoots with initial symptoms of the disease (blighted leaves still attached to the plant)	On stressed plants (prolonged dry periods, storms, and heavy cinipids infestations) symptoms of the disease may increase
Rust <i>Mycosphaerella maculiformis</i>	End of summer	Leaf brown spots, early leaf and burrs fall	*	Copper application in nursery only	Improve air movement through the canopy	Infections are strictly related to wet and warm climatic conditions
Powdery mildew <i>Microsphaera quercina</i>	Summer	White powdery micelium on the leaves	*	Sulphur application in nursery only		
Fruit Rots <i>Penicillium</i> spp., <i>Ciboria batskiana</i> , <i>Phomopsis endogena</i>	Caused by different fungal species, some of which infecting during storage	Fruit moulds, rots and mummification (in relation to each causal organism)	***	Promptly collect and burn the fallen fruits	Avoid fruit storage in humid or poorly ventilated rooms Appropriate cleaning operation	

* slight damages

** occasional damage

*** significant direct or indirect damages

**** severe damages up to plant death