Rationalisation of the use of plant protection products in the control of *Alternaria* in apple trees using risk prediction models and crop management techniques

Summary

The emergence of new pests and diseases disrupts the treatment strategy designed to achieve quality and productivity standards with low residue levels and low environmental impact. In this context, apple tree alternariosis, caused by the fungus *Alternaria*, is a new disease first described in Girona in 2013, and which has been gaining importance, to the point that it requires specific treatments to ensure the productivity of the orchards. This disease consists of foliar necroses that can lead to premature defoliation of the trees, but most critical is the effect on the fruit. Thus, alternariosis causes small, highly visible necrotic lesions that reduce the quality of the fruit and compromise its marketability. This disease can cause losses of between 10 and 40% of production depending on the year and the farm. The disease has been spreading to affect around 20% of commercial apple farms in the province of Girona in 2017. In the framework of the project, different farm management strategies have been assessed to reduce disease pressure, a treatment programme has been designed based on the most effective products and to maintain low residues, and a predictive model of the risk of alternariosis infection has been implemented to advise farmers on the positioning of treatments. All these improvements in the control of alternariosis developed in the project are already being used by the sector with a coverage of more than 90% of apple farms in the Girona area. The implementation of these improvements has led to better control of this disease.



Objectives

The main objective of this project was to improve the control of *Alternaria* by minimising the use of plant protection products. For this reason, two priority lines were identified. On the one hand, to validate and assess different models for predicting the risk of *Alternaria* infection in order to reduce the number of fungicide treatments by improving their positioning. On the other hand, to influence the primary inoculum source of *Alternaria* in order to reduce the inoculum pressure on farms to reduce the incidence of the disease.

Description of the actions carried out in the project

Task 1. Validation of different models for predicting risk of *Alternaria* infection

Pathogen spore release and symptom occurrence were monitored on different farms with a history of *Alternaria* located in different agro-climatic zones. Spore monitoring and symptom monitoring data were correlated with the infection advisories issued by the different models in order to identify the model that

is most accurate in predicting risk. In parallel, the *Alternaria* species involved in the infections were studied and their pathogenicity has been determined.

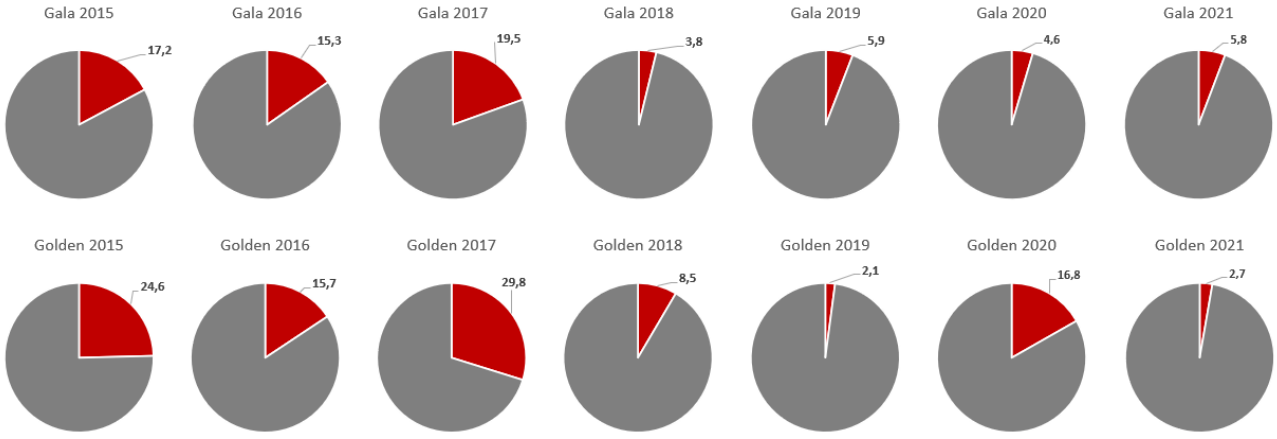
Task 2. Assess the *Alternaria* control strategy based on the different risk prediction models
The activity of a battery of fungicides against the different *Alternaria* species was assessed, and efficacy tests were carried out in the field with the most effective products in both conventional and organic production. Two risk prediction models for *Alternaria* were also validated in the field: (1) Model *Alternaria mali* on apple trees. (2) Model *Alternaria alternata* on citrus fruits. In the tests, the control strategy based on the corresponding model has been compared with the reference strategy for the area.

Task 3. Study of the effect of inoculum reduction by leaf removal on *Alternaria* spore dispersal and infection
The impact of winter inoculum reduction was studied using different strategies: (1) Leaf collection using specific machinery. (2) Mechanical leaf breakage and incorporation with the soil. (3) Treatment of leaves with *Trichoderma*. Each strategy of fallen leaf removal or inoculum inactivation was compared with the standard strategy on the basis of the presence of spores and *Alternaria* infection.

Task 4. Implementation of the risk prediction model for *Alternaria* in the plant protection warning service
Once the risk prediction model best suited to our conditions was selected, it was integrated into the ATLANT platform to obtain the prediction in real time. In this way, technicians and growers had it available to design their strategy for plant protection treatments, eliminating unnecessary treatments and optimising farm productivity and reducing residues in the fruit.

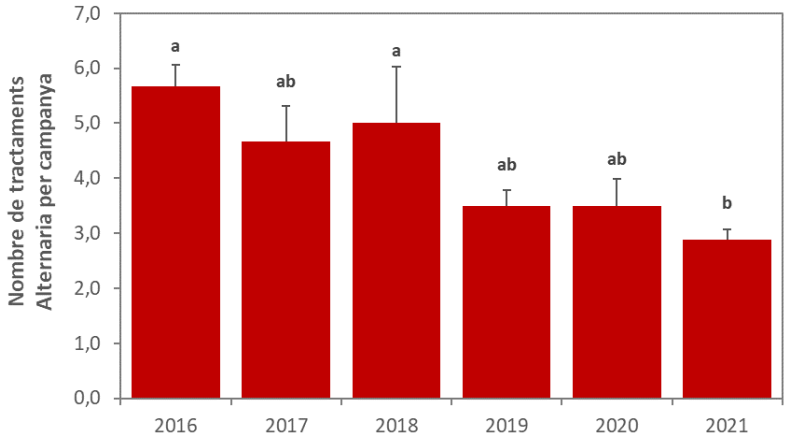
Final results and practical recommendations

The plant protection strategy established within the operational group, based on effective products applied according to the risk prediction model, has made it possible to bring the disease under control, significantly reducing its spread, while at the same time reducing by approximately 55% the number of fungicide treatments specifically aimed at controlling alternariosis. The implementation of this plant protection strategy guided by a decision support system has proven to be a very useful tool for the sustainable control of alternariosis. On farms with many problems and on farms in organic production, this plant protection strategy must be accompanied by farm sanitation based on the elimination or inactivation of the primary inoculum consisting mainly of fallen leaves in autumn/winter.



Evolution of Alternaria *affected farms of Gala and Golden varieties from 2015 to 2021*

◀ Evolution of the number of specific treatments applied per season to control *Alternaria* from 2016 to 2021



Conclusions

1. Morphological characterisation of the strains has shown that there are differences in conidia and conidiophore structures between various morphological groups, but these are not sufficiently conclusive to determine species accurately. However, morphological characterisation has allowed the strains to be put into three groups, those similar to *A. alternata*, those similar to *A. tenuissima* and those similar to *A. arborescens*.
2. Treatment strategies based on risk prediction models can reduce the number of treatments while maintaining good levels of control of *Alternaria* spp. infection. The use of the infection risk prediction model of *Alternaria* enables a reduction of the number of treatments achieving a similar efficacy to treatments scheduled according to the calendar, and is therefore a tool to be considered for a more sustainable control of alternariosis.
3. From the results obtained we can conclude that removing leaves significantly reduces the available inoculum and that rain has a very important effect on the release of *Alternaria* spores. At the same time we can say that the risk period would be from the end of May until mid-September, and that from this period onwards the risk of infection drops drastically, which would make it possible to eliminate some of the treatments that are currently carried out during this period. The period of maximum risk is associated with rainfall between May and June.
4. Removal of winter inoculum, either by leaf removal or by application of *Trichoderma*, has had a significant effect in reducing *Alternaria* damage to fruit, and therefore both would be recommended techniques for integrated control of apple alternariosis.
5. The plant protection strategy established within the Operational Group, based on effective products applied according to the risk prediction model, has made it possible to bring the disease under control, significantly reducing its spread, while at the same time reducing the number of fungicide treatments specifically aimed at controlling alternariosis.

Leader of the Operational Group

ORGANISATION: GIRONA FRUITS, SCCL

Coordinator of the Operational Group

ORGANISATION: IRTA - Institute of Agrifood Research and Technology

Other members of the Operational Group (grant recipients)

ORGANISATION: GIROPOMA COSTA BRAVA, SL

ORGANISATION: FRUCTICOLA EMPORDÀ, SCCL

ORGANISATION: FLORENCI BOSCH

ORGANISATION: ADV Independent producers of sweet fruit of the Empordà region

Other members of the Operational Group (not recipients of the grant)

ORGANISATION: -----

Geographical area(s) of application

PROVINCE(S)	REGION(S)
Initially in Girona, but as in the case of *Stemphylium*, the disease is expected to spread to other fruit-producing areas.	Baix Empordà, Alt Empordà, Selva, Gironès

Dissemination of the project (publications, conferences, multimedia, etc.)

Various results transfer activities have been carried out throughout the project included in the PATT. Of particular note are the follow-up meetings of the Fruit Tree Technical Commission, the Summer Fruit Growing Congress organised at IRTA Mas Badia in 2022, attended by more than a hundred fruit growers, technicians and other specialists involved in the apple sector, the Autumn Fruit Growing Congress organised at IRTA Mas Badia in 2019 and 2021, attended by almost 200 participants each year, and also the FRUIT.NET congresses in 2020, 2021 and 2022, with an average of 50 attendees. The documentation submitted is available on the RuralCat website.

Project website

https://www.gironafruits.com/racionalitzacio-de-lus-de-fitosanitaris-en-el-control-de-lalternaria-en-pomera/

More information on the project

PROJECT DATA	TOTAL BUDGET
Start date (month-year): July 2020	Total budget: €117,180.00
Completion date (month-year): September 2022	DACC funding: €47,862.90
Current status: Completed	EU funding: €36,107.10
	Own funding: €33,210.00

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