

CLIMATRUF



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Improving water management and effect of cultural techniques on soil truffle mycelium, truffle production and soil water balance: pilot experiences toward adaptation of truffle orchards to climate variations

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Context — Truffles are Ascomycete fungi forming ectomycorrhizal symbiosis with numerous trees and shrubs. The fructification of some truffle species is particularly interesting for their organoleptic qualities such as the Black truffle (*Tuber melanosporum*). The harvesting of black truffle ascocarps occur mainly in orchards implanted with seedlings previously inoculated with truffles in nurseries. Among the black truffle production process, two bottlenecks seems important: 1) the initiation of the sexual reproduction and 2) the growth of the truffle below ground several months. The climate and mainly the summer hydric regime are key factors to overcome both bottlenecks. Irrigation is known to allow truffle overcoming the summer hydric deficit but it is realized using empirical knowledge since clear guidelines for truffle orchards watering are not yet available. In this context, it is critical to better understand the link between climate and truffle life cycle.

Objectives — ClimaTruf emerged from a truffle industry request of innovative tools to overcome drought effects and adapt truffle cultivation to climate change. The improvement of suitable tools for monitoring water availability is also requested by truffle industry. The objectives of ClimaTruf are to 1) inventory the available metadata and sites where it will be possible to break down the soil hydric regime; 2) develop diagnostic kits to trace truffles in the soil as new and innovative services provided by ALCINA and 3) analyse annual variations of truffle mycelia in the soil and soil moisture in two different sites.

Key results — ClimaTruf is an innovative valorisation project involving three Labex ARBRE units (BEF, EEF and IaM), one non-Labex ARBRE unit (LAE), one recognized Italian laboratory (IBBR-CNR), society associations (FFT: French truffle growers' federation) and a private company (ALCINA). ALCINA co-funded 30% of the total cost of the project. The main outputs are:

- A publication in an international Journal: Le Tacon et al. 2014 (Mycorrhiza).
- Three publications in the truffle industry journal : (Le Trufficulteur, 87, 18 ; Le Trufficulteur, 88, 13-19 ; Le Trufficulteur, 94, 13-14).
- A book chapter in Le Tacon, 2017, Les Truffes.
- The results were valorised as a know-how licence between INRA and ALCINA.
- Six scientific divulgation seminar and five presentation of the project to the press.
- ClimaTruf allowed us to get a larger project financed by FranceAgrimer: CulturTruf (200 893 € en 2016 ; 164 379 € en 2017 et 164 339 € demandés pour 2018).

Main conclusions including key points of discussion — To summarize the main conclusions of the project it is important to highlight the summer hydric deficit that is the main cause of production variability among seasons. The importance of summer hydric deficit was known since a long time but thanks to long-term production data provided by truffle industry this effect was quantified. This challenge the importance of watering that is the main technique to overcome summer hydric deficit but other techniques can also be applied such as mulching. The collaboration with ALCINA allowed developing a kit that is now commercialized in the frame of a know-how licence. This kit allows identifying and quantifying the DNA of both *T. melanosporum* mating-types from root types, ascocarps and soil. Thanks to ClimaTruf truffle industry has now tools allowing to better understanding the functioning of truffle orchards. Finally, we also install one experimental site in which soil regime hydric and *T. melanosporum* soil mycelium is follow monthly.

Future perspectives — The main perspectives of ClimaTruf is to define new experimental sites in different French regions in order to define watering guidelines and also to assess the effect of hydric regime and orchard managements on truffle life cycle. Thanks to ClimaTruf we obtained a financial support from FranceAgriMer for a project entitled CulturTruf aiming to define the optimal hydric regime to produce truffle (*T. melanosporum*, *T. aestivum*, *T. aestivum* var *uncinatum* and *T. magnatum*) and also to optimize the orchards management in different climate.

Valorization —

International review

Le Tacon, F., Marçais, B., Courvoisier, M., Murat, C., Montpied, P., Becker, M. (2014). Climatic variation explain annual fluctuations in French Périgord black truffle wholesale markets but do not explain the decrease in black truffle production over the last 48 years. *Mycorrhiza* 24 (1): 115-125

Books

Le Tacon, F. (2017). Les Truffes, édition AgroParisTech

Conference and seminar

Murat C. (2015) Maps of maternal and paternal genotypes in the long term experimental *T. melanosporum* plantation of Rollainville (Northern France). Second Pezizomycete pan-genomic workshop. Alba (Italy), 16-17 October 2015.

Murat, C. (2014). New insight in the truffle life cycle. 1st international conference on truffle research '14, Vic-Barcelona (Spain), 9-12 Mars 2014 (Invited lecture).

Murat, C. (2014). Truffle researches: JTT2014, ControlTruf, ClimaTruf. Conseil scientifique international du labex ARBRE. Nancy (France), 11-12 décembre 2014.

Murat, C. (2014). Dynamic of the sexual reproduction in a black truffle orchards and comparative genomic in the Tuberales. University of Turin (Italy). 15 July 2014

Economic valorisation

Licence de savoir faire entre INRA et ALCINA pour le kit de diagnostic des types de compatibilité

Publication de vulgarisation

Murat C., De la Varga H., Todesco F., Barry-Etienne D., Diette S., Le Tacon F., Martin F (2016) Des nouvelles de ClimaTruf. Le Trufficulteur, 94, 13-14

Le Tacon, F., Marçais, B., Courvoisier, M., Murat, C., Montpied, P., Becker, M. (2014). Le climat et la commercialisation des truffes sur les marchés de gros. Le Trufficulteur, 88, 13-19

Murat, C. (2014) Journée de lancement du projet ClimaTruf. Le Trufficulteur, 87, 18

Séminaires de vulgarisation

Murat, C. (2016). Contribution des nouvelles technologies à la compréhension des plantations truffières. 10ème anniversaire d'ALCINA, St Matthieu de Tréviers (France), 22 septembre 2016

Murat, C. (2015). Il y a moins de truffes noires depuis 150 ans... à cause du climat? Foire aux truffes de Pulnoy, le 8 Novembre 2015

Murat, C. (2015). Les recherches sur les truffes à l'INRA de Nancy: programmes de recherches passés et futurs. Claveyson, le 13 février 2015

Murat, C. (2015). Les recherches sur les truffes à l'INRA de Nancy. Assemblée générale de l'association marnaise des trufficulteurs (AMPT), Martougues le 30 janvier 2015

Murat, C. (2014). La reproduction sexuée de la truffe noire. Séminaire pour la fédération régionale des trufficulteurs PACA. Manosque le 18 Septembre 2014

Murat, C. (2014). Dynamique de la reproduction sexuée. Villers les Nancy. 4 avril 2014

Media

Murat, C. (2015). Interview avec Ariane Puccini pour un article dans Le Chasseur Français.

Murat, C (2015). Interview avec Valentina Murelli pour "Meridiani"

Murat, C. (2014). Interview pour le Dauphiné libéré, article "Secret des truffières" publié le 21 décembre 2014 dans l'édition Hautes-Alpes

Murat C. (2014). Interview avec Loïc Chauveau pour Sciences et Avenir hors série n°179 "Le monde extraordinaire des champignons". 1 juillet 2014

Murat C. (2014). Tournage avec Cuisine plus. 17 avril 2014