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Truffle farming in the United States of America

Pierre Sourzat - *Translated by Fabrice Caporal*

My participation in the North American Truffle Growers Association (NATGA) annual congress gave me the opportunity to discover multiple aspects of truffle farming in the US. The congress was held at the beginning of October in Santa-Rosa, north of San Francisco, in Sonoma County (California). Parts of this information shared in this article can be found on the association’s site (<https://trufflegrowers.com>).



The conference room in Santa Rosa, California. Photo by Pierre Sourzat.

The North American Truffle Growers Association (NATGA) was founded in North Carolina in 2005. NATGA is a non for profit organization. On the East Coast truffle farming started in Hillsborough, North Carolina, as the result of the work of Franklin Garland (Garland Truffles) in the late 1970's. In the second half of the 1990's other companies were created to produce truffles.

In 2005, the number of truffle producers in North Carolina had increased to such proportions that it became a necessity to create an organization where producers could share ideas, exchange information, and more generally to learn about the truffle industry. Several of the pioneering producers, realizing that the exchange of ideas was beneficial to the industry as a whole, got organized and created NATGA. All founding members had orchards in North Carolina. Garland Truffles (Franklin and Betty Garland) in Hillsborough, became an industry pioneer and was the first to plant trees inoculated with *Tuber melanosporum* mycorrhizae in North Carolina. Other founding members are: Keep Your Fork Farm (Jane Morgan Smith), Piedmont Valley Truffles (Jack and Aron Ponticelli with Franklin Garland) and Acres of Truffles Truffiere (Craig Magill and Krista Hansen).



Karen Passafaro, NATGA's President

With time, membership grew to include truffle producers from the states of Tennessee, Virginia, South Carolina, Iowa, Kentucky, Arkansas, Idaho, California and Oregon. Today, we count more than 200 truffle orchards just in North Carolina, at least two in Tennessee, more than a dozen in Virginia and a handful in the other states. NATGA's first annual meeting was held in Hillsborough, North Carolina, on September 23, 2006. This meeting was the opportunity to establish the board of directors, to share technical information, and to visit a member's orchard. Subsequent meetings were held in Pilot Mountain, North Carolina, on January 19th 2008, then in January 2009, 2010, 2011, 2015 and 2016 at the Hawthorn conference center in Winston-Salem, North Carolina. NATGA is run by volunteers, and is led by a member-elected executive board with a 2 year mandate. The President is Karen Passafaro and the Vice-President Richard Franks . The group of experts and consultants is composed of eight

internationally renowned scientists: Shannon Berch (Canada), Greg Bonito (USA), Alexis Guerin (New Zealand), Inga Meadows (USA), Marcos Morcillo (Spain), Claud Murat (France), and Olivia Taylor (USA).

The goals of the association are:

- To improve its reputation and to expand its reach throughout North America.
- To promote truffle farming best practices
- To establish standards for truffle commercialization
- To educate the general public and truffle farmers about truffles.



Ken Fry in his orchard of trees inoculated with *Tuber melanosporum*. (Photo by Pierr Sourzat)

Truffle farming in Idaho

Before the congress I was hosted by Ken Fry, truffle farmer in Eagle, Idaho. In Eagle, which is about 15 miles from Boise airport, there are three truffle orchards. Together they represent about 10,000 truffle trees. These three orchards are the base of the creation of the Idaho Truffle Growers Association. Idaho is well known for its production of potatoes in the West. Ken Fry, owner of the Eagle Groves Farm is passionate about truffles. He traveled to Europe, to learn about truffle farming, he even came to the Lot region and is planning to create on his farm a center for the discovery of truffles along with its museum.

Together we visited his orchards aiming to produce three different truffle species: *Tuber melanosporum*, *Tuber aestivum* and *Tuber borchii*. The *Tuber borchii* orchard is far from the *Tuber melanosporum* and *Tuber aestivum* orchards. Most host trees are English white oaks (*Quercus robur*), holly oaks (*Quercus ilex*) and hazels (*Corylus avellana*). As for the *Tuber borchii* orchard, it is about 10 years old and is exclusively planted with English white oaks. The orchards are well maintained and equipped for irrigation.

We tested the root levels of mycorrhization for the three truffle species. The *Tuber borchii* mycorrhization is remarkably strong and foretells abundant crops in the coming years. The *Tuber melanosporum* mycorrhization is well established with rare traces of Hebeloma contamination. The *Tuber melanosporum* orchard follows the same truffle farming techniques used in Europe. A good water supply for watering, a good control of the soil maintenance and tree pruning, should allow Ken Fry to meet his production goals with *Tuber borchii* as well as with *Tuber melanosporum* and *Tuber aestivum*.

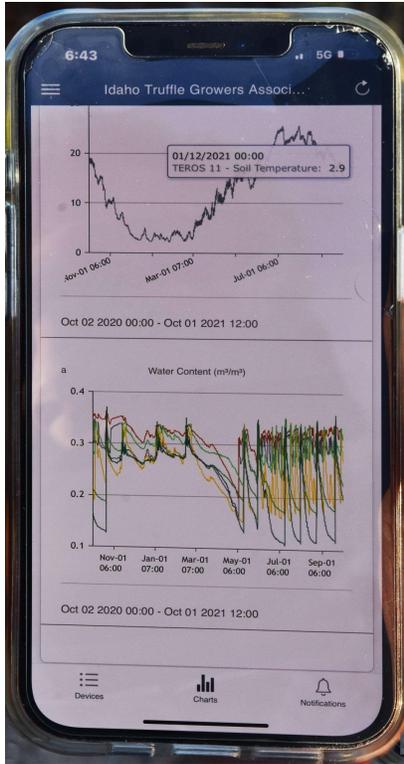
[Photo] Paul Beckman and his Lagotto truffle dog.

Neighboring Ken's orchard, Paul Beckman owns a 10 acres truffle orchard (2007) in his Bella Vista farm. On its website <http://bellavistafarms.com> we can read an introduction to his ranch. "On February 12, 2012, the first Western Hemisphere cultivated Bianchetto truffle (aka *Tuber borchii*, Italian spring white truffle or Tuscany white truffle) was harvested in a truffle orchard near Boise, Idaho. This was harvested under a tree that was planted in the spring of 2008. Paul Beckman and Brad Sprenger were hunting for truffles with Sophia (a Lagotto Romagnolo or Italian Truffle Dog) on Beckman's farm. While Mr. Beckman is testing five different truffle varieties in his orchard, they were specifically focused on hunting the Bianchetto truffle because this variety matures in the spring. Sophie identified the Bianchetto truffle at a depth of about 8" underground. Beckman, Sprenger and several other Boise area farmers have planted thousands of trees inoculated by Dr. Charles Lefevre at New World Truffieres in Eugene, Oregon."



Mark Coleman Coleman (photo by Pierre Sourzat)

During the NATGA congress Dr. Mark Coleman (PhD) presented the results from the Paul Beckman orchard which is divided into three parts. The biggest part is dedicated for the production of *Tuber melanosporum*, a smaller part for the production of *Tuber aestivum* and two rows (filberts) for the production of *Tuber Borchii*. The irrigation system is at the top of the technical advancement, with in particular Teros by Meter probes to measure the soil water potential and temperature. Paul showed us how he monitors his probes directly from his iPhone.



The data from the Teros probes on Paul's iPhone

Paul has abandoned the idea of producing *Tuber melanosporum* as he found only one since he planted the trees. The same with *Tuber aestivum*. However, his *Tuber borchii* production is remarkable.

Dr. Mark Coleman explained, with graphs to illustrate the result of his work, that *Tuber borchii* has a strong response to irrigation regimens (Americans are indeed talking of irrigation, and not of watering). Further, Mark Paul Coleman shows that this truffle species is not impacted by the ground cover. Paul Beckman harvests *Tuber borchii* as soon as January. However, in Idaho the summer drought ends in October. Thus it is easy to farm this truffle species without relying on the precise watering techniques necessary to produce *Tuber melanosporum* and *Tuber aestivum*.

Paul Beckman is also interested in beekeeping, in raising horses for dressage and show jumping, and in raising Angus-Wagyu mix steers that he compares to the Kobe steer. I was surprised to learn that he was inspired to use horse manure in his orchard following my observations on the benefits of sheep and horse on the truffle production.

In the Sierra Nevada

Following my visit to the orchards of Eagle, Idaho, we went to Placerville, California, in the Sierra Nevada, to visit the orchards of Staci O'Toole. Staci's farm is called Tesoro Mio Truffle Ranch. This older orchard, established at the beginning of the year 2005 was planted with English white oaks, holly oaks and cork oaks. The trees were very tall (more than 20 feet tall)

and spaced between 13 and 20 feet. Production is declining due to the lack of virgin ground between the brûlés [“burnt area” produced by the truffle fungus] which are barely visible. Mila, Staci’s Lagotto Romagnolo dog, marked and found some truffles which may have been *Tuber rufum*.



The older orchard on top and the hazelnut tree orchard below which is producing (photo Pierre Sourzat).

Downhill from the older orchard, there is a filbert-based truffle orchard which was the subject of a presentation by Scott Oneto (University of California) during the NATGA congress. The scientist measured in 2019 the impacts of multiple variables on the *Tuber melanosporum* production on these trees inoculated with *Tuber melanosporum* and planted in 2007. The variables measured the impact of soil amendments, water potential and the connection between the soil temperature and watering.

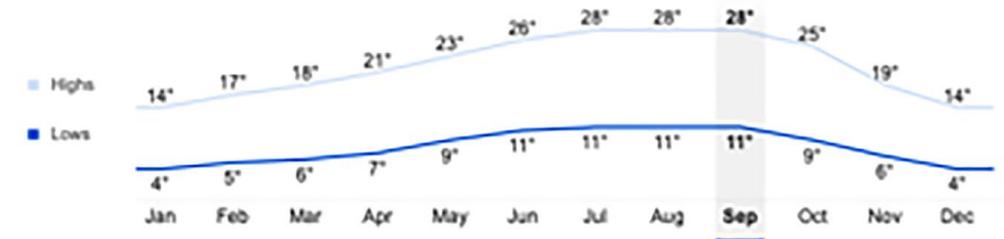
It is possible to get an idea of the California weather patterns by looking at the weather data from the Santa Rosa region (Bennett Valley).

Bennett Valley

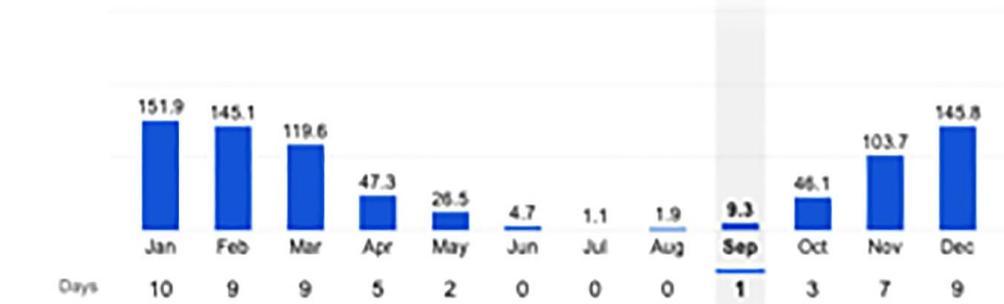
Weather averages

Overview **Graphs**

Temperatures (°C)



Rainfall (millimeters)



California climate: average temperature and precipitation

In summary, in addition to an average temperature of 82 degree Fahrenheit in summer, it does not rain from May to October, which represents 6 months without precipitation and requires irrigation. Lots of data along with the various treatments was collected on Staci's orchard which does produce truffles.

Scott Oneto presented his findings during the NATGA congress. The addition of biochar and compost resulted in a strong increase in the total soil organic matter and its Nitrogen content. Biochar is a charcoal-like substance that's made by burning organic material from agricultural and forestry wastes (also called biomass) in a controlled process called pyrolysis. At this point, says Scott Oneto, we can't draw conclusions on the impact of the amendments on the truffle production. An increase of the soil pH was observed following the addition of 1.3 tons per acre of lime. Brûlés seems to be more pronounced in areas that were amended. The shadow experiment to measure its impact on the soil temperature was divided between summer and winter. During the summer months we observed temperatures up to 15 degree Fahrenheit cooler in the shade. It is still too early to draw conclusions on its impact on the soil water potential and on the truffle production.

I have provided Staci with my analysis of the reasons for limited production. The orchard is perfectly maintained and the filbert trees are vigorous and are not constrained in their growth,

particularly the soil is deep (a minimum of 12 inch of topsoil on top of a draining soil) and that they don't miss water. Staci's choice for irrigation is overhead sprinklers. A Teros by Meter probe was installed to measure the water potential of the soil. At the beginning of October we could not see signs of a brûlé under the trees. My conclusion is that the *Tuber melanosporum* truffle stays in a vegetative growth state resulting in the absence of the brûlé. The brûlé is an indication of the fungus virulence and should spread beyond the tree's drip line. In other words, as long as the growth of the filbert trees is optimized, particularly through watering, the truffle fructification will remain unlikely. Truffle farming is not about raising trees, but is about raising a fungus which must become more vigorous than the host tree to produce fruits.

I think that a solution to the lack of production would be, after confirming that the roots are still mychorized with *Tuber melanosporum*, to reduce the filbert tree vigor with a severe pruning and a water management that will accommodate for drought periods. We know that in France with an end of spring (April-May) or a beginning of summer (May-June) with 15 to 20 days without rain slows down the start of vegetation and favors the development of the brûlé, which apparently is linked with the start of the truffle fructification.



Staci and Mila hunting for truffles in the old orchard (photo by Pierre Sourzat)

Truffle traps

The day before the congress we visited the orchard of the Three Creeks Estate next to Santa Rosa. One of the current owners was freely sharing technical information. It first started with

1,900 filbert trees coming from Dr Charles Lefevre nursery in Oregon. Planted in 2009 and 2010 it is well maintained.

The soil amendment of the orchard was done at first just after the installation of a drainage system. The soil was amended with 40 tons of lime per acre in order to bring the pH to 7.9. Two inches of perlite from Idaho was added and mixed in by tilling in order to favor moisture retention during the hot summer months. The orchard is equipped of a fixed irrigation system consisting of 6 miles of pipes and 17 control valves installed shortly after planting. The irrigation heads spray on a 270 degree radius. In 2021, they dug a second well. The filbert trees are watered from two wells and one watering station delivering a water pressure of 90 PSI.

At first and until 2013 maintenance and care of the orchard was limited to mowing regularly, irrigation and weed control using chemicals (glyphosate). The original owners did not make further change to the soil, nor did he till or re-inoculate the orchard with spores. In October 2013 a root analysis of the hazelnut trees determined that the colonization of the root was an average of 75% for such a young orchard from 2009 (4 year old). In February 2014, the current owner bought the property and started to rehabilitate the truffle orchard. They started by consistently trapping moles and gophers (an American rodent), which had started to become invasive. Today they continue with weekly trapping sessions. In 2015 they stopped applying Roundup herbicide, in favor of manual weeding and regular mowing to control weed growth. The area of the Bennett Valley in Sonoma county, California, has only seasonal rainfall from October through April with the main downpour from December to March. The climate is dry in summer, without significant precipitation, making irrigation during the vegetative season a requirement. The regional average precipitation is 803 millimeters per year with an average high temperature of between 57 and 82 degree Fahrenheit and average lows of 39 to 51 degree Fahrenheit (see graph). The region is experiencing a serious drought with less than half the typical precipitation last winter and less than normal the previous year. The orchard has Clay-Loam soil with strong compaction risk. To fight compaction, tillage and harrowing was done in 2017, in addition to supplemental amendments.

Since spring 2017, the new owners completely changed cultivation practices, by applying more intensive techniques such as soil amendments, tilling and reinoculation at the end of the harvest season. They started to prune the hazelnut trees every other year to maintain a height of about 6 feet in addition to the removal of suckers every year. This work started after a DNA analysis of *Tuber melanosporum* mycorrhiza on the roots of the trees was conducted in the spring 2017 revealed that the mycorrhization was excellent. Only one sample did not have truffles. All the others were colonized between 30% and 90% by the black truffle. Some samples also showed signs of Sclerotinia.



Watering in the Three Creeks Estate orchard

In 2017, in addition to the changes of farming techniques, the orchard was re-inoculated by adding to each of the 1,650 trees 1 liter of rehydrated lyophilized truffle spores mixed in 5 liters of hydrated vermiculite. To address compaction, in 2018, the soil was amended with 12 tons of gypsum which was spread with the help of an electrical spreader mounted on the tractor. They created truffle traps (Spanish wells or “poze de trufa”) by digging by hand at the foot of each hazelnut tree four holes in which was added 1 liter of rehydrated truffle spores mixed in a substrate composed of half vermiculite and half perlite and water. In 2019 they again dug by hand 4 spanish per hazelnut tree, but this time around, used a product called TRUF-UP combined to a substrate made of vermiculite, perlite, rice hulls and lava gravel. TRUF-UP is a mixture of truffle spores, which have been microscopically analyzed and confirmed by DNA analysis, at the optimum concentration, mixed with beneficial bacteria and organic compounds known to facilitate the mycelium growth and the development of truffle primordias. Each tree received 10 milliliters of TRUF-UP mixed in 8 liters of substrate. In 2020, the tree roots were re-inoculated with the TRUF-UP mixture following the same protocole.

The owner that we’ve met is not happy with the results. He confides that the first truffle was found in December 2018, and that it was confirmed to be *Tuber melanosporum* by a DNA test. No truffles were found in the 2018-2019 season. The following year during the 2019-2020 season about 3 small truffles were found in the orchard. Finally during the 2020-2021 season only a piece of a truffle was found. He believes that the irrigation regimen is appropriate. Watering usually starts in April/May until the first rains at the end of October/start of November.

They have defined 17 irrigation zones, each watered at night 3 times a week for 1 hour and 20 minutes (that is a total of 4 hours per week per zone).

This orchard is a good example of how difficult it is to master the parameters triggering truffle production. As I explained about the Placerville orchard, my analysis is that as long as the growth of the hazelnut trees is optimized, particularly through watering, truffle fructification will remain unlikely or rare. The brûlé are very small around the hazelnut trees, and I think that the absence of spring droughts as it is in the Mediterranean climate, the truffle production cannot occur. The culture of mycorrhized plants in greenhouses in France (Station trufficole du Montat in the years 1980-90) in order to control the pedoclimatical factors never started production.

Is *Tuber borchii* the winner?

During the congress, I met Richard Franks, truffle farmer in Burlington, North Carolina.

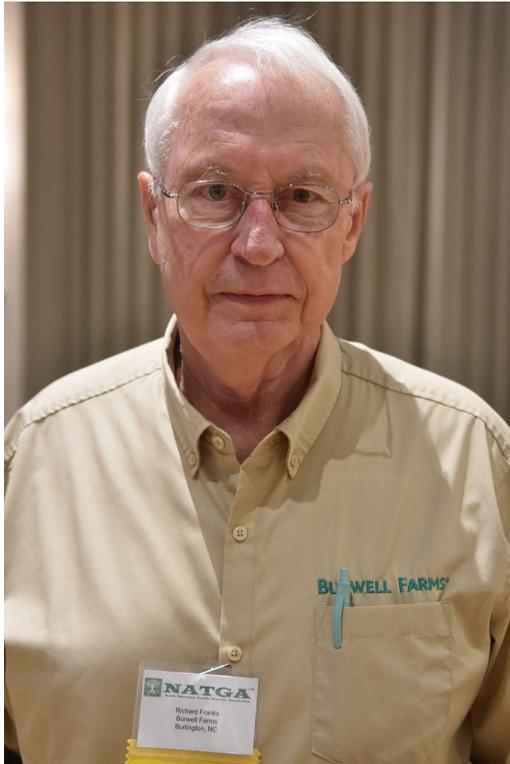
Richard Franks became a producer of *Tuber borchii* for which he became a champion for its farming potentials and its culinary qualities. Richard Franks introduced me to the history of *Tuber borchii* production in North Carolina (<https://www.burwellfarmsnc.com>).



***Tuber borchii* harvest (photo by Richard Franks)**

Located in the east of North Carolina, Burwell Farms experiences a mild climate and soil conditions to the production of quality Bianchetto. It's in the summer 2014 that the first inoculated pine trees, *Pinus taeda* were planted. The good quality trees were imported from

Europe. After three year of careful care, the first “delicious” *Tuber borchii* truffles were available to refine kitchens. This first harvest was earlier than expected, and because of its success, Burwell Farms was launched into the world of high quality truffle producers. Following this great success, others got interested. Furthermore, Burwell Farms started to sell inoculated *Pinus taeda* seedlings to whoever wanted to farm Bianchetto truffles.



Richard Franks

Richard Franks is the Chief Scientific Officer for the *Tuber borchii* truffle production at Burwell Farms. He contends that the Bianchetto truffle (white spring truffle), which is harvested in North Carolina from February first through the beginning of April, is absolutely delicious. His chef clients are very happy to use this truffle which is, according to him, at par with the *Tuber melanosporum* truffle. He confided that it was sold at \$700 per pound to restaurants that are more and more looking for it. Due to the world sanitary crisis or not, is *Tuber borchii* truffle in the process of overcoming *Tuber melanosporum* in the US? This question is relevant as in the West coast, Paul Beckmann has the same position toward this species.



Fabrice Caporal, french and truffle farmer in California

This trip to the US was an opportunity to meet other truffle farmers and historical characters of the truffle world. Amongst the truffle farmers I have to mention a French man living in California who has created a 26 acres truffle orchard. Fabrice Caporal and his wife Claudia are very much involved with truffle farming, and he is NATGA's webmaster. We surely will have the opportunity to talk further about his orchard located in Upper Lake with 1,000 trees planted in 2018 and 2,600 in 2019 after adding a large quantity of lime (40 tons per acres). It is mostly planted with *Quercus robur* oaks inoculated with *Tuber melanosporum*. Aziz Turkoglu, who used to be a professor at the University of Mugla in Turkey, became a truffle farmer and nursery man in Seattle while teaching at Washington University. Brian Farrell, his wife Denise and their son, are producing excellent California wines and are truffle farmers at the Caelesta Ranch north of Los Angeles. John Martin, who came for an internship at "la Station de Montat", is farming truffles with his wife at the Domaine de la Rabasse in Virginia. The truffle world is in full evolution. Historical personalities were present at the Santa Rosa congress, only Jim Trappe, almost 90 year old and still in good health in Corvallis was missing.



Three historical personalities of the North American truffle industry: Tom Michaels, Franklin Garland, Charles Lefevre (Photo Pierre Sourzat)

We could not end this report without mentioning the NATGA project called the “North American Truffle Growers Association Grading Standard Concerning the marketing, culinary, and commercial quality control of truffles” . The official goals of this normalizing project is to facilitate international commerce, to promote high quality production, to improve returns and to protect the consumers. The standards proposed by the workgroup are based on the United Nation’s agricultural quality standards, CEE-ONU FFV-53 which is used by governments, producers, traders, import and export organizations and other international organizations. We find the same truffle classification that are common in France: Extra, 1st Class, 2nd Class, 3rd Class which includes pieces and shavings.

It concerns the following 10 species:

1. *Tuber aestivum* (Wulfen) Pers. (1801)
2. *Tuber aestivum* var *uncinatum* Vittad. Aka ecotype *Tuber uncinatum* Chatin (1892)
3. *Tuber borchii* Vittad. (1831)
4. *Tuber canaliculatum* Gilkey. (1920) (Appalachian truffle)
5. *Leucangium carthusianum* (Tul. & C. Tul.) Paol. (1889)
6. *Tuber gibbosum* Harkn. (1899)
7. *Tuber lyonii* Butters. (1903) (Pecan truffle)
8. *Tuber magnatum* Picco. (1788)
9. *Tuber melanosporum* Vitad. (1831)

10. *Tuber oregonense* Trappe, Bonito & P. Rawl (2010)

Americans also express interest in other species listed on the site

<https://trufflegrowers.com/truffles/truffle-species/>

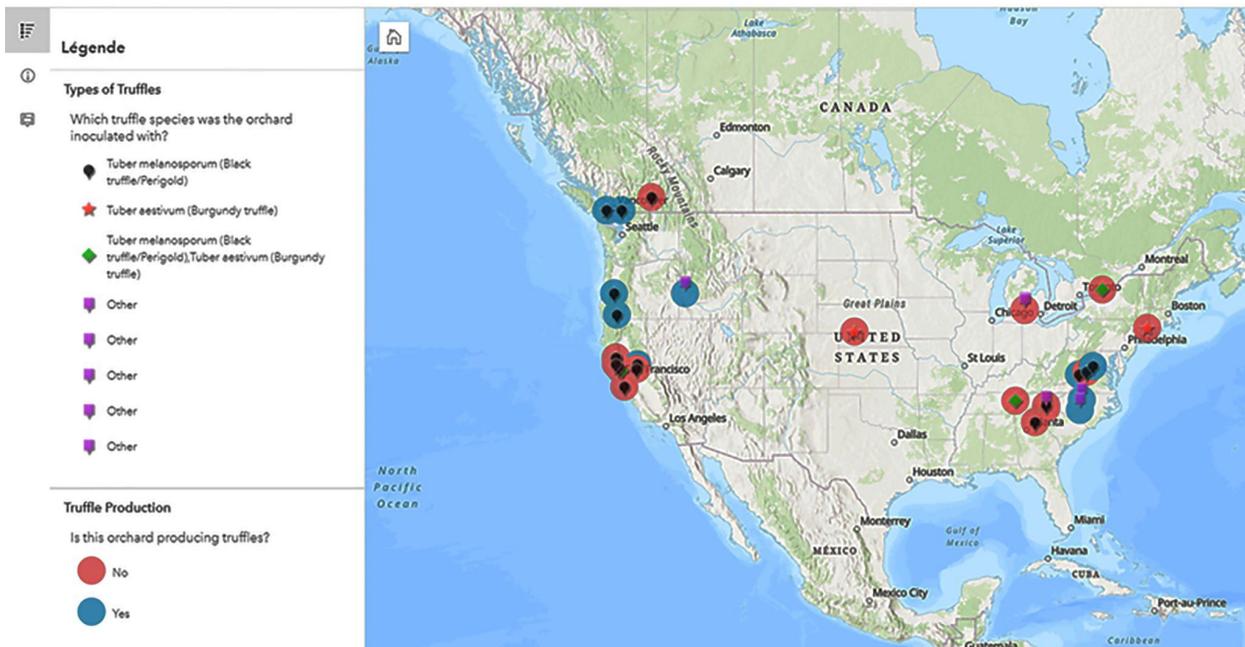
Kalapuya brunnea (brown oregon truffle)

Tuber indicum (Chinese truffle)

Tuber mesentiricum (Mesentericum Truffle).

Finally to get an understanding of its membership, NATGA started a survey which Fabrice Caporal qualified as incomplete. The map herein shows the results of this survey. In the other category we find *Tuber borchii* inside a blue circle to mark producing orchards.

Truffle Producer Survey for North America



Map of the United States showing the repartition (incomplete) of the truffle farmers who are members of NATGA.