Life Project Specific Indicators Table

D.1 – Project performance indicators

LIFE17 CCA/ES/000030

LIFE

RESILIENCE

LIFE17 CCA/ES/000030

Deliverable Name: Life Project Specific Indicators Table

Action D.1: Project performance indicators

Compiled by: GALPAGRO

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Table of content

1. Summary 1

Chapter I. Life RESILIENCE Specific Indicator Table 4

1. Life RESILIENCE Specific Indicator Table 5

Chapter II. Life RESILIENCE Specific Indicators Table Results (Sep-19) 7

2. Specific Indicators Table (Sep-19) 8

1. Summary

The following report describes all the indicators that have been measured throughout the entire project on the demo farms. The objective of this report is to collect all the information about project indicators performance that have been carried out by the project partners to achieve the proposed objectives.

2. Introduction

The following report describes all the indicators that have been measured throughout the entire project on the demo farms. The objective of this report is to collect all the information about project indicators performance that have been carried out by the project partners to achieve the proposed objectives.
In all the farms described 5 treatments were established to achieve best agricultural practices against XF.
All farms have a control treatment in which standard procedures needed were done as irrigation, prune, harvest, etc. Four treatments were also established in which the same standard procedures were done and additionally, a specific treatment was implemented. In each farm every treatment and dates of application is described.
Standard procedures in each crop were done and the additional application of procedures/products depending on the treatment. Five treatments were established, Table 2 describes each treatment, product, dose, timing and mode of application. The schedule and doses described in table 2 were done in the entire project. Moreover, in Image 1 is located treatment's distribution in the demo farms. In Table 3 treatments and corresponding products are described, dates of applications in 2019, 2020 and 2021 is also included.

Table 1Treatments, products, dose, timing and mode of applications

Treatment	Product	Dose	Date	Mode
T0	Conventional management			
T1	MST -NP	1 kg/ha	June	Irrigation
	ProCrop ISR	0.5 l ha/week	15 days after MST-NP	Irrigation
T2	Deficit irrigation			
T3	Cover crops	30 kg/ha	September	
T4	T1 + T2 +T3			

Image 1 Distribution of the treatments in El Valenciano Farm, Herdade do Charqueirão and La Traversagna farm

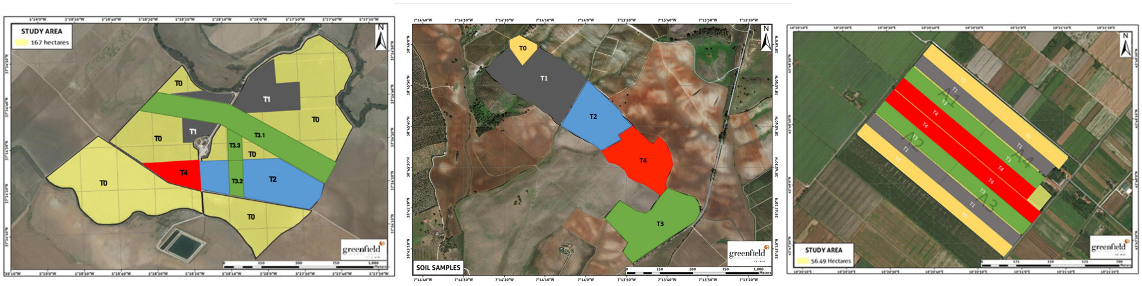

Table 2 Treatments, products, dose and dates in El Valenciano Farm

<table>
<tr><th>Action C2</th><th>T0 - control</th><th>T1 -</th><th>T2 - Deficit irrigation</th><th>T3- Cover crops</th><th>T4</th></tr>
<tr><td></td><td>Traditional management</td><td>T1 - IBNP +ISR</td><td>Déficit irrigation</td><td>Cover crops</td><td>combination T1-T2-T3</td></tr>
<tr><td>El Valencian o - SP</td>
<td>1.Soil: tillage (3 times/year) and herbicide (3 times/year).

2.Irrigation: on demand (March-November; 2-3 days/week)

3.Pests: Prays oleae, Bactrocera oleae, Palpita unionalis. Total treatments 5/year.

4.Diseases: Spilocea Oleagina, total treatments 3/year.

5.Nutrition: Soil (19/year) and Foliar (8/year).

6.Pruning: Formation pruning (1/year) and Top and bottom pruning (2 times/year)

7.Harvest: Nov/Dic (1 year)</td>
<td>1.Soil: tillage (3 times/year), herbicide (3 times/year) and
<table>
<tr><td></td><td>IBNP (1 time/year; dose: 1 kg/ha)</td><td>ISR (4/year; dose 0.5 L/ha)</td></tr>
<tr><td>Year 1</td><td>12/06/2019</td><td>4/07/2019; 07/08/2019; 21/08/2019 and 11/09/2019</td></tr>
<tr><td></td><td></td><td>ISR (2/year; dose 1 L/ha)</td></tr>
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3.Pests: Prays oleae, Bactrocera oleae, Palpita unionalis. Total treatments 5/year.

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6.Pruning: Formation pruning (1/year) and Top and bottom pruning (2/year)

7.Harvest: Nov/Dic (1 year)</td></tr>
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Table 3 Treatments, products, dose and dates in Herdade do Charqueirão Farm

<table>
<tr><th>Action C2</th><th>T0 - control</th><th>T1 -</th><th>T2</th><th>T3-</th><th>T4</th></tr>
<tr><th></th><th>Traditional management</th><th>IBNP +ISR</th><th>Déficit irrigation</th><th>Cover crops</th><th>combination T1-T2-T3</th></tr>
<tr>
<td>H. Charqueirao - PT</td>
<td>1.Soil: tillage (3/year) and herbicide (3/year).

2.Irrigation: on demand (March-October)

3.Pests: Myzus persicae, Tetranychus urticae, Monosteira unicostate, Capnodis tenebrionis, Anarsia lineatella, Empoasca spp. Total treatments (4/year)

4. Diseases: Fusicoccum amygdali, Monilia laxa, Polystigma ochraceum, Gloesporium amygdalinum, Phythopthora sp. Total treatments (4/year)

5.Nutrition: soil (1/year), fertigation (12/years) and foliar (6/year)

6.Prunning: Formation pruning (1/year)

7.Harvent: August (1 /year)</td>
<td>1.Soil: tillage (3 times/year) and herbicide (3 times/year) and
<table><tr><th></th><th>IBNP (1 time/year; dose: 1 kg/ha)</th><th>ISR (2/year; dose 1 L/ha)</th></tr><tr><td>Year 1</td><td>27/06/2019</td><td>12/06/2019; 31/07/2019;</td></tr><tr><td>Year 2</td><td>2/06/2020</td><td>16/06/2020; 29/06/2020</td></tr><tr><td>Year 3</td><td>30/07/2021</td><td>13/08/21</td></tr></table>
2.Irrigation: on demand (March-October) .

3.Pests: Myzus persicae, Tetranychus urticae, Monosteira unicostate, Capnodis tenebrionis, Anarsia lineatella, Empoasca spp. Total treatments (4/year)

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2.Irrigation: On demand (March-June)-(September-October) and deficit irrigation (July-August).

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<td>1.Soil: tillage (1/year), herbicide (2/year), cover crop: sow (10/2019); (11/2021), and weed (1/year).

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5.Nutrition: soil (1/year), fertigation (12/years) and foliar (6/year)

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6.Pruning: Formation pruning (1/year)

7.Harvest: August (1/year)</td>
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</table>

Table 4 Treatments, products, dose and dates in La Traversagna Farm

<table>
<tr>
<td>La Traversagna - IT</td>
<td>1.Soil: tillage (3 times/year) and herbicide (3 times/year).

2.Irrigation: not irrigation

3.Pests: Prays oleae, Bactrocera oleae, Palpita unionalis. Total treatments 5/year.
4.Diseases: Spilocea Oleagina, total treatments 3/year.

5.Nutrition: Soil (19/year) and Foliar (8/year).

6.Pruning: Formation pruning (1/year) and Top and bottom pruning (2/year)

7.Harvest: Nov/Dic (1 year)</td>
<td>1.Soil: tillage (3 times/year), herbicide (3 times/year) and IBNP (1/year) 18/02/2020 + ISR (4 times/year; dose: 0.5 L/ha) 18/02/2020.
<table>
<tr><th></th><th>IBNP (1 time/year; dose: 1 kg/ha)</th><th>ISR (2/year; dose 1 L/ha)</th></tr>
<tr><td>Year 1</td><td>18/02/2020</td><td>18/02/2020;</td></tr>
<tr><td>Year 2</td><td>01/04/2020</td><td>01/04/2020;</td></tr>
<tr><td>Year 3</td><td>20/04/2021</td><td>23/04/21</td></tr>
</table>

2.Irrigation: not irrigation

3.Pests: Prays oleae, Bactrocera oleae, Palpita unionalis. Total treatments 5/year.

4.Diseases: Spilocea Oleagina, total treatments 3/year.

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<tr><td>Year 3</td><td>20/04/2021</td><td>23/04/21</td></tr>
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2.Irrigation: not irrigation

3.Pests: Prays oleae, Bactrocera oleae, Palpita unionalis. Total treatments 5/year.

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5.Nutrition: Soil (19/year) and Foliar (8/year).

6.Pruning: Formation pruning (1/year) and Top and bottom pruning (2/year)

7.Harvest: Nov/Dic (1 year)</td>
</tr>
</table>

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Chapter I. Life RESILIENCE Specific Indicator Table

Chapter developed in collaboration with the External Agronomist: Ideagro

1. Life RESILIENCE Specific Indicator Table

Ten groups of indicators were selected for monitoring of the impact of the Project actions. In these groups we evaluated the benefits that the actions of this project has on tree health, soil quality, biodiversity, among others with 18 parameters (see Table 1). Table show the parameter´s name, when this parameter should be measured and the responsible partner. The methodology to evaluate each indicator was described in 11. MR Annex: A2 Deliverable A2_Training course material.

Table 5. Parameters to be measured for monitoring of the impact of the Project actions

Factor	Parameter	When	Amount in project	Partner responsible
(I) Tree Health	(01) Nutritional State (Foliar Analysis)	1 time a year: after full Bloom	5 strategies / Every demonstration (demo) site (Spain, Portugal and Italy)	GALPAGRO (SAHC, SALOV)
	(02) Tree Temperature	1 time a year: pre-harvest		AGRODONE
	(03) *Vegetative development* (NDVI, NDWI)	5 times a year: Blossoming, core hardening, oil production initiation, pre-harvest and post-harvest		
(II) Soil Quality	(04) Soil microbiological activity	1 time a year	Every demo site (Spain, Portugal and Italy)	AGRODRONE
	(05) Available Water Capacity (AWC)	First 6 months of the project (1-time project)		
	(06) Physicochemical analysis (SOM/SOC)	First and last 6 months of the project (2 times project)		
(III) Disease prevalence	(07) *Xylella fastidiosa* disease control	Once a year (*September*)	Every demo site	GALPAGRO
	(08) Insect vector trap	Every season (4 times a year)		Nutriprado
(IV) Weather	(09) Climatic and atmospheric data	Once a year	Every demo site	AGRODRONE
(V) Quality	(10) Olive Oil (organoleptic characteristics)	Every harvest (1 time a year)	5 strategies / Every demo site	GALPAGRO (SAHC, SALOV)
	(11) *Almond (size and USDA grades)*			
(VI) Water use	(12) Water Use Efficiency (WUE)	Every year after harvest	5 strategies / Every demo site	GALPAGRO (SAHC, SALOV)
	(13) Irrigation Water Productivity (IWP)			
	(14) Stem Water Potential (SWP)	1 time a week: every year from April to October	Replication: Spain (2 strategies)	GALPAGRO
(VII) Carbon Footprint	(15) CO_2 emitted (agricultural processes)	At the end of project	Every demo site	GALPAGRO
(VIII) Biodiversity	(16) Auxiliary fauna (insect populations)	Once a year	Every demo site	GALPAGRO
(IX) Production Value	(17) Money saved	At the end of the Project	Every demo site	GALPAGRO
(X) *Xf* Resilience	(18) Resilient Rate	Spring/Summer 2021 and 2022	Authorized laboratory	UCO (IVALSA)

Chapter II. Life RESILIENCE Specific Indicators Table Results

Chapter developed in collaboration with the External Agronomist: Ideagro

2. Specific Indicators Table (Jun-20)

I. Tree Health

1. Nutrient state through foliar analysis

Foliar analysis is a technique that determines the content of nutrients at a specific time or stage of development in plant tissues. To determine foliar nutrient content, leaves were sampled in each season in preharvest (early July). To determine differences between treatments one foliar analysis per treatment was done.

Table 6 Foliar analysis sampling and results

Farm	El Valenciano	Herdade de Charqueirao	La traversagna
Sampling data: Year 1 Year 2 Year 3	18/07/2019 20/07/2020 22/07/2021	15/07/2019 18/07/2020 28/07/2021	12/12/2019 15/08/2020 12/08/2021
Results	Improved Nitrogen, Potassium and Phosphorus content and microelements	Improved Calcium, Magnesium and Boron content	Improved Nitrogen, Magnesium and Cooper content and microelements

In early September 2021 foliar analysis was done on El Valenciano Farm. Measured parameters had normal levels for the crop. However, T1 treatment increased nutrient assimilation by the crop in comparison to T0 treatment. In fact, T1 nutrient assimilation as phosphorus and potassium increment was measured. Phosphorus and potassium are key elements in crop development so an increment in these elements in the plant has a great impact in crop productivity. However, T2 treatment increased calcium, magnesium, and potassium levels due to probably to water stress situation. With respect to microelements, increases in all microelments levels were observed in all the treatments respect to control.

Foliar analysis in Herdade de Charqueirao Farm shows an increase in calcium content in treatment T1 with respect to the control treatment. Also, in the T1 treatment, the content of magnesium and boron increased with respect to the control treatment. However, a reduction in nitrogen content was observed in treatment T1 and T4.

Foliar analysis in La Traversagna Farm shows an increase in nitrogen content in treatment T1 with respect to the control treatment. Also, in the T3 treatment, the content of nitrogen increased with respect to the control treatment. However, a reduction in nitrogen content was observed in treatment T4 where the foliar content of elements such as, magnesium and cooper were increased, but to a greater extent compared to the increment observed in treatment T3 and T1.

In view of the results obtained in the three demo farms, we can conclude that in all farms increases of different nutrients were observed, especially in the T1 and T4 treatments. The variations observed from one farm to another are due to the soil factor, as the soil texture favors the release of some nutrients and the blocking of others. However, beyond the soil factor, an increase is observed in all cases of very important elements for crop development, such as nitrogen, phosphorus and potassium and different microelements. This reinforces the starting hypothesis of this project, where using sustainable strategies to fertilize the soil, such as biostimulants and soil microorganisms, a positive effect is observed in the crop in terms of enrichment of fundamental nutrients for correct development.

2. Tree temperature

Table 7Canopy temperature dates and results

Farm	El Valenciano	Herdade de Charquierao	La traversagna
Sampling data	Preharvest	Preharvest	2019 Italian operator, weather cold and rainy data could not be processed to differentiate trees from vegetation. 2020 and 2021 flights pandemic situation impossible to carry out
Results	No variations in temperature were identified with risk of Xf No areas of anomalous behavior were observed (high Tº)		

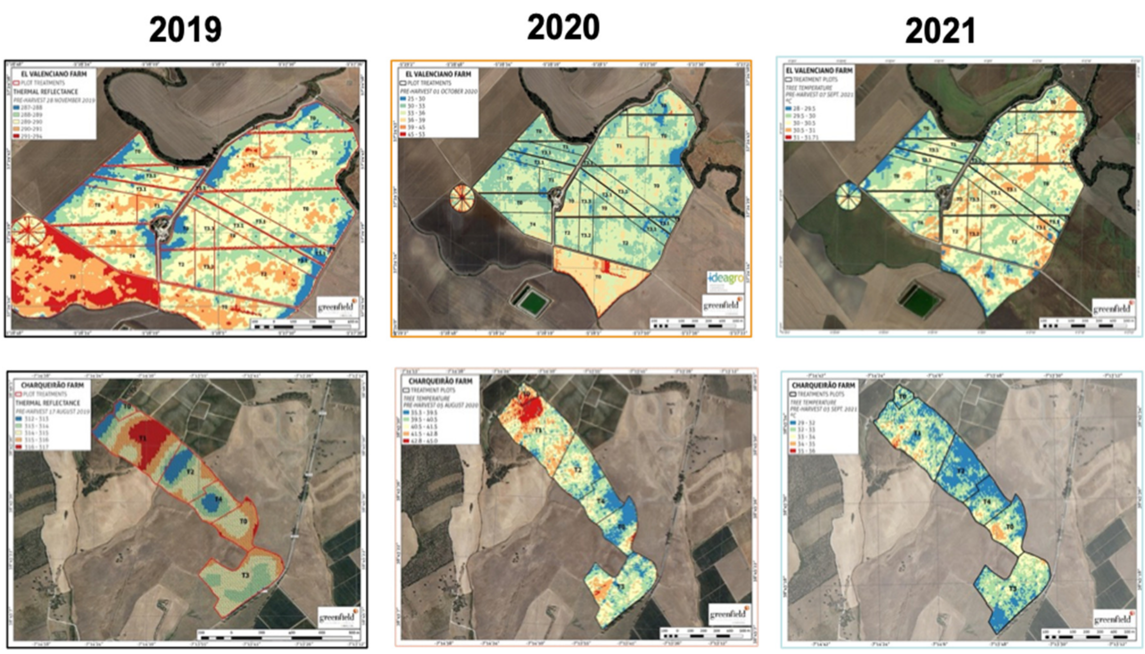


Figure 1Canopy temperature spatial variability in El Valenciano and Herdade do Charqueirão Farm

3. Vegetative development

The study of periodic satellite images has not shown incidence of continuous anomalous development based on the results of the NDVI and NDWI vegetation indices of specific areas that are visualized in the field as symptomatic of disease.

La Traversagna farm was the only farm with significant changes but were observed with straight lines and specific geometric figures, which translates into changes caused by human actions and not a pattern of disease behavior.

Table 8 Vegetative development samples and results

Farm	El Valenciano	Herdade de Charqueirao	La traversagna
Sampling data: Year 1 Year 2 Year 3	Post Blooming Pit hardering Pre-Harvest Post-Harvest	Post Blooming Pit hardering Pre-Harvest Post-Harvest	Post Blooming Pit hardering Pre-Harvest Post-Harvest
Results	Physiopathies and diseases were not detected		

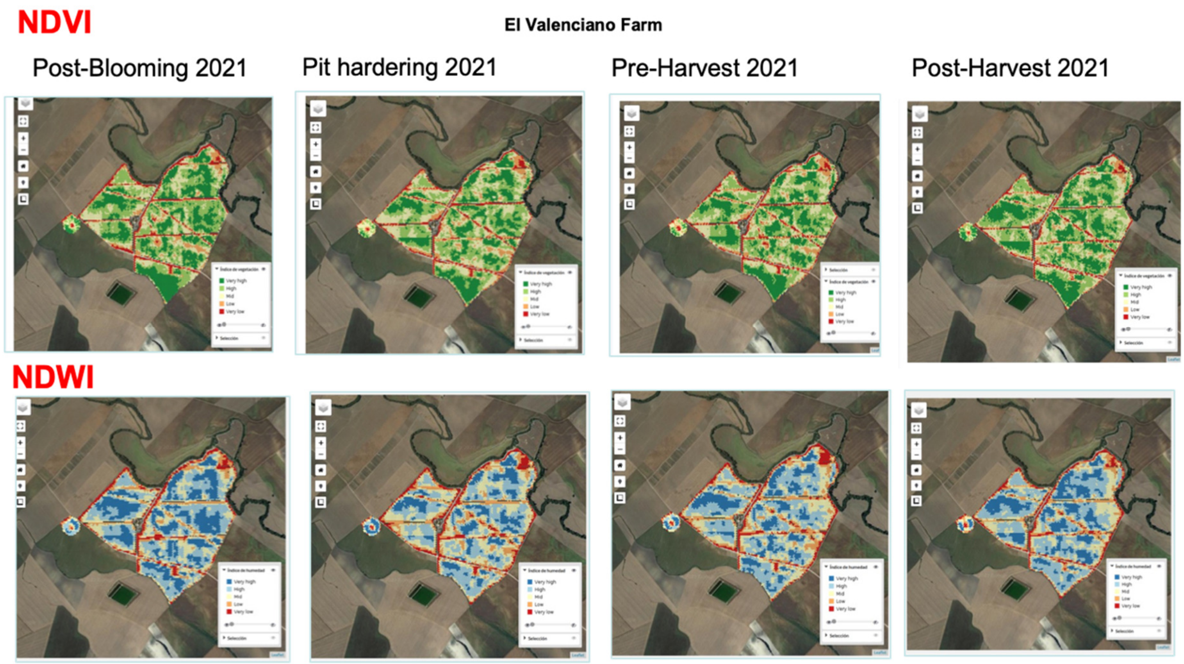


Figure 2Vegetative development relative spatial variability in El Valenciano Farm

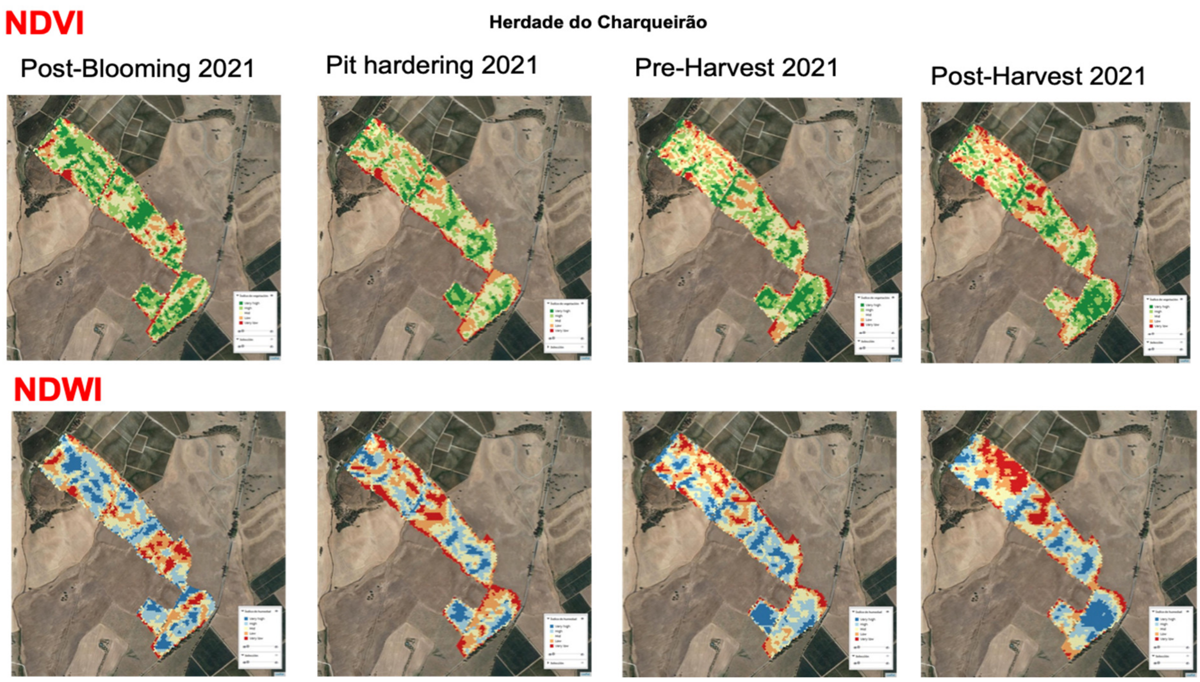


Figure 3Vegetative development absolute spatial variability in Herdade do Charqueirão Farm

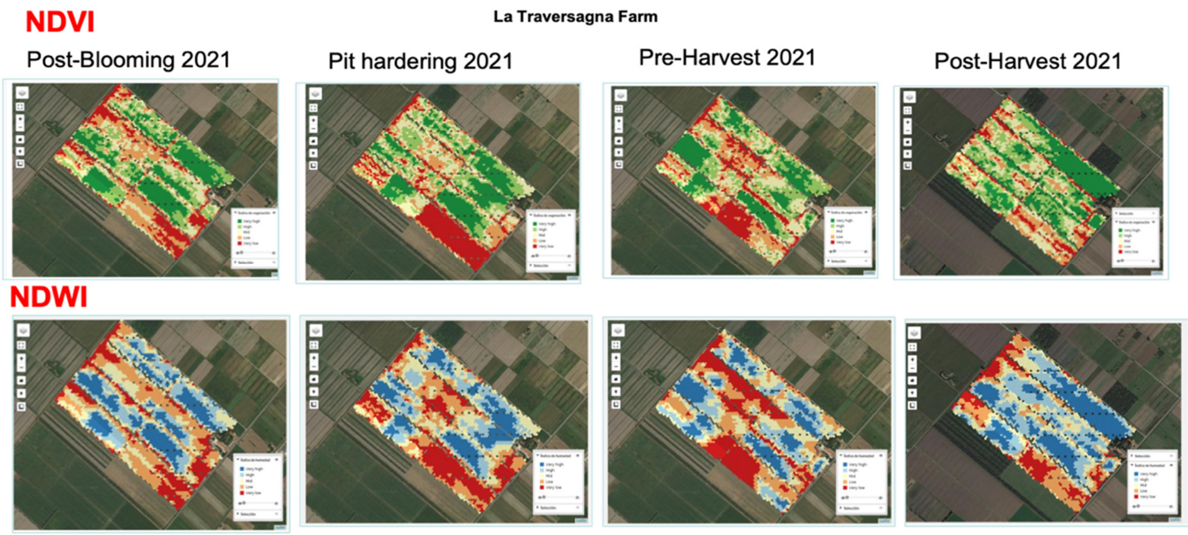


Figure 4 Vegetative development relative spatial variability at pit hardening stage in La Traversagna Farm

II. Soil quality

4. Physicochemical analysis (SOM/SOC)

This indicator is closely linked to indicator 06. Soil microbiological activity. For a better understanding of the impact, both indicators are analyzed together in the indicator 06 section.

5. Available Water Capacity (AWC)

The AWC was measured at the beginning of the project before treatments application and at the end of the project to evaluate treatments effects.

The results of the soil analyses carried out in 2021 at the El Valenciano farm about available water capacity show no differences about this parameter at the beginning of the project in 2018. However, a reduction in the organic matter content was observed compared to the results of 2018, not exceeding a reduction of 0.5%. The organic matter content reduction has not caused a visible reduction of the AWC in the different treatments, which may be mainly due to the high clay content of the soils of this demonstration farm.

The result of the soil analyzes carried out at the Herdade do Charqueirao farm show a general increase in the average content of soil organic matter in the different treatments, being the majority in treatments T1 and T3. These increases have caused increases in the water retention capacity of around 10 mm of water per meter of soil depth. That is, an increase of 0.75% of organic matter in treatment T1 and an increase of 0.73% in T3 have increased the retention capacity by 10 liters per 1000 liters of soil volume. The rest of the treatments have also increased the organic matter content, but they have not significant changes in the AWC.

The soil organic matter content in 2021 season at La Traversagna farm have also been reduced compared to the results obtained in 2018. Only treatment T0 increased its organic matter content, with an average increase of 0.23%. The rest of the treatments (T1, T3 and T4) show an average reduction of 1.5% in the organic matter content. The results obtained have caused the T3 treatment to reduce its AWC by 10 mm/m, that is, 10 liters of water for each cubic meter of soil.

Table 9 Evolution of AWC in El Valenciano Farm (2018-2021)

Treatment	T0	T1	T2	T3	T4
Mean AWC (mm/m) 2018	140	130	130	130	140
Mean Organic Matter (%) 2018	1.43	0.95	1.26	1.45	1.65
Mean AWC (mm/m) 2021	140	130	130	130	140
Mean Organic Matter (%) 2021	1.1	0.8	1.1	1.1	1.2

Table 10 Evolution of AWC in Charqueirao Farm (2018 – 2021)

Treatment	T0	**T1**	T2	**T3**	T4
Mean AWC (mm/m) 2018	140	140	150	130	150
Mean Organic Matter (%) 2018	1.6	1.55	1.24	1.47	1.76
Mean AWC (mm/m) 2021	140	**150**	150	**140**	150
Mean Organic Matter (%) 2021	1.9	**2.3**	2.1	**2.2**	1.8

Table 11 Evolution of AWC La Traversagna Farm (2018-2021)

Treatment	T0	T1	T3	T4
Mean AWC (mm/m) 2018	140	140	150	140

Mean Organic Matter (%) 2018	5.27	4.5	6.08	4.79
Mean AWC (mm/m) 2021	140	140	**140**	140
Mean Organic Matter (%) 2021	5.5	3.9	**3.5**	3.5

Soil water-holding capacity is an important component of the water and energy balances of the terrestrial biosphere. It controls the rate of evapotranspiration and is a key to crop production. It is widely accepted that the available water capacity in soil can be improved by increasing organic matter content. However, the increase in amount of water that is available to plants with an increase in organic matter is still uncertain and may be overestimated. Changes in rainfall due to global climate change may affect the surface moisture availability, which becomes important for germination and crop stand establishment in the rainfed areas. Having this context of climate change and water scarcity in mind an improvement of 7% in AWC that was observed in general in this project is very important not only for soil health but also for crop productivity. The water availability for plant growth and important soil processes are governed by a range of soil properties including porosity, field capacity, lower limit of plant available water (thus excluding osmotic potential), micro pore flow and texture (Jarvis, 2007; Reynolds et al., 2002). Plant available water capacity has been used as part of integrative soil health tests to assess management impacts. Further, more the soil available water and distribution may respond rapidly to climate change, especially to variable and high intensity rainfall or drought events and thus management strategies, could be planting of cover crops, conservation tillage and incorporation of organic matter, that maintain or even enhance water infiltration and available water in soil may help in mitigating the impact of severe rainfall and drought events or severe erosion events.

6. Soil microbiological activity + 4.Physicochemical analysis (SOM/SOC)

Measurement of extractable nutrients may provide indication of a soil's capacity to support plant growth; conversely, it may identify critical or threshold values for environmental hazard assessment. Nutrient cycling, especially N, is intimately linked with soil organic carbon cycling and hence drivers of climate change such as elevated temperatures, variable precipitation and atmospheric N deposition are likely to impact on N cycling and possibly the cycling of other plant available nutrients such as phosphorus and sulphur.

At the beginning and at the end of the project a physicochemical analysis of the soil was done to determine the effect of the treatments on soil nutrients in a context of climate change. Soil samples were taken from georreferenced points in each demo farm and after that soil samples were analyzed in laboratory. Moreover, to determinate fertility biological index and soil enzymatic activity such as, B-glycosidase, dehydrogenase, catalase, phosphodiesterase (phosphatase) and urease activities were determined.

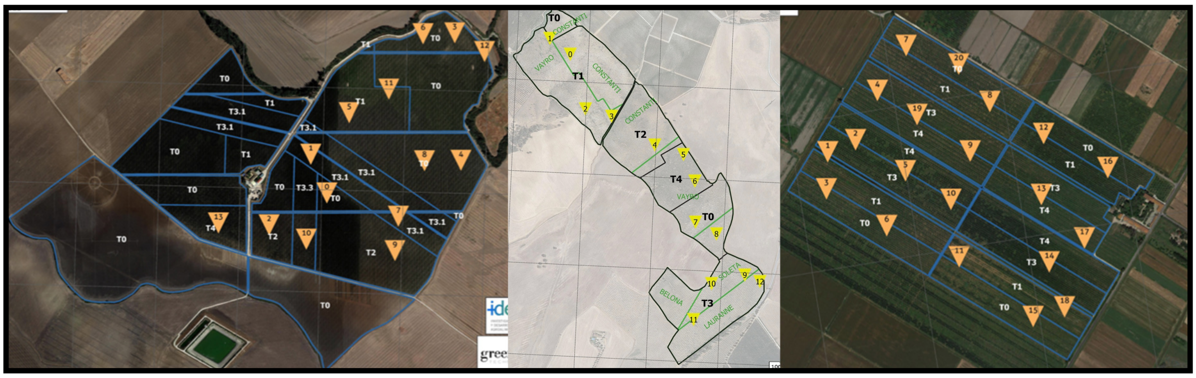


Figure 5. Treatments and georeferenced soil samples location in El Valenciano Farm, Herdade do Charqueirão Farm and La Traversagna soil simple points

Table 12. Soil chemical analysis El Valenciano Farm 2018 and 2021.

	T0	T1	T2	T3
Comparison 2018 to 2020				
% CaCO3 active	-5.2%	-14.7%	-47.9%	11.0%
% CaCO3 Total	3.8%	-0.7%	63.3%	-14.6%

% O.M. Oxidable	1.2%	8.8%	-21.5%	4.2%
%N Total	0.0%	-10.0%	-15.0%	7.4%
%C Total	1.2%	8.8%	-21.7%	4.3%
B (ppm)	41.2%	74.7%	123.2%	61.3%
C/N	6.6%	22.2%	-6.8%	0.2%
Ca (meq/100 g)	-17.0%	-8.8%	-15.5%	-0.9%
Cl- (meq/100 g)	-3.0%	1.3%	208.6%	246.8%
Cu (ppm)	47.3%	-37.7%	-3.4%	37.0%
Fe (ppm)	-38.1%	-21.6%	-45.3%	-27.8%
K (meq/100 g)	4.0%	16.1%	11.2%	-11.6%
Mg (meq/100 g)	-19.6%	-17.0%	-28.7%	-11.7%
Mn (ppm)	-59.2%	-16.2%	-76.7%	-29.6%
Na (meq/100 g)	18.2%	38.3%	116.6%	180.0%
SO4-2 (meq/100g)	52.5%	112.0%	135.3%	377.5%
Zn (ppm)	-33.7%	-39.3%	-23.2%	43.7%
NO3- (mg/kg)	-78.8%	<25	<25	-53.5%
P (ppm)	-34.3%	-83.2%	-24.7%	-67.0%
E.C. (dS/m)	15.7%	25.7%	119.6%	167.7%

Regarding the nitrogen content, all the treatments showed very similar values. On the contrary, as far as NO_3 is concerned, a much higher value was observed in T2 with respect to the remaining treatments. The phosphorus content in the soil was much higher in the T4 treatment, the same was observed for the potassium content. Very similar values were observed between treatments regarding the content of calcium, magnesium and sulfur. About micronutrients, a slightly higher content of Fe and Mn was observed in T1 treatment.

Soil enzyme activities may serve to indicate change within the plant-soil system, since these are closely linked to the (1) cycling of nutrients and soil biology, (2) are easily measured, (3) integrate information on both the microbial status and the physicochemical soil conditions, and (4) show rapid response to changes in soil management. Furthermore, altering the quantity and quality of below ground Carbon input by plants, elevated CO_2 may stimulate microbial enzyme activities, abundance of microbial enzymes and C turnover possibly affecting microbial community functioning in soil. It is still to be known how soil microbial enzyme activities involved in organic C turnover, nutrient cycling and greenhouse gas emissions.

Regarding soil enzymatic activity, ß-glycosidase activity was greater in all the treatments respect to 2020 season. However, in T4 treatment a decrement in the enzyme activity was observed in comparison to 2020. The dehydrogenase activity indicates that soil fertility that is due to the activity of microorganisms in the soil. A slightly increase was observed in 2021 season in comparison to season 2020. The treatment that experienced a slighter reduction in dehydrogenase activity was T1, probably because the greater metabolic activity in the soil due to bioestimulant treatment. In comparison with previous seasons catalase activity increased in all the treatments in El Valenciano Farm in season 2021. Treatments with a larger increment were T1 and T4 in which biostimulants were applied. Regarding to phosphatase activity a higher activity of this enzyme indicates a greater mobilization of phosphorus in inorganic form in the soil and a greater availability of this element to the plant. An increased in phosphatase activity was observed in all the treatments in 2021 respect to 2020, in El Valenciano Farm.

Urease activity indicates the conversion of urea to ammonia by soil microorganism. As can be seen in the graph urease activity was strongly increased in season 2021 in all the treatments respect to 2020 campaign. A great increment in the biological fertility index was observed in T1 treatment in 2021 in comparison to previous campaign in El Valenciano Farm. On the contrary, T0, T3 and T4 treatments values were very similar in comparison to 2020 values. Hence, a slight decrement was observed in T2 treatment respect to previous year.

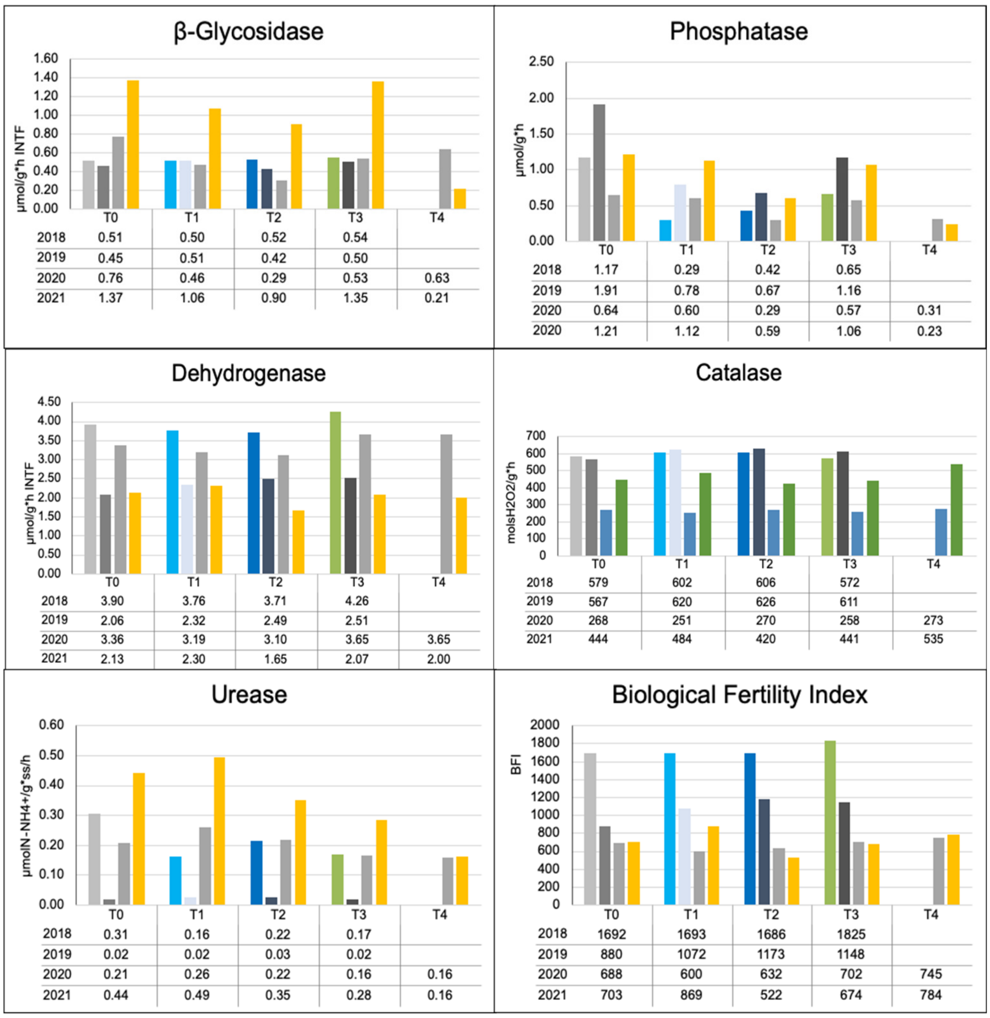


Figure 6.El Valenciano Farm soil enzymatic activity

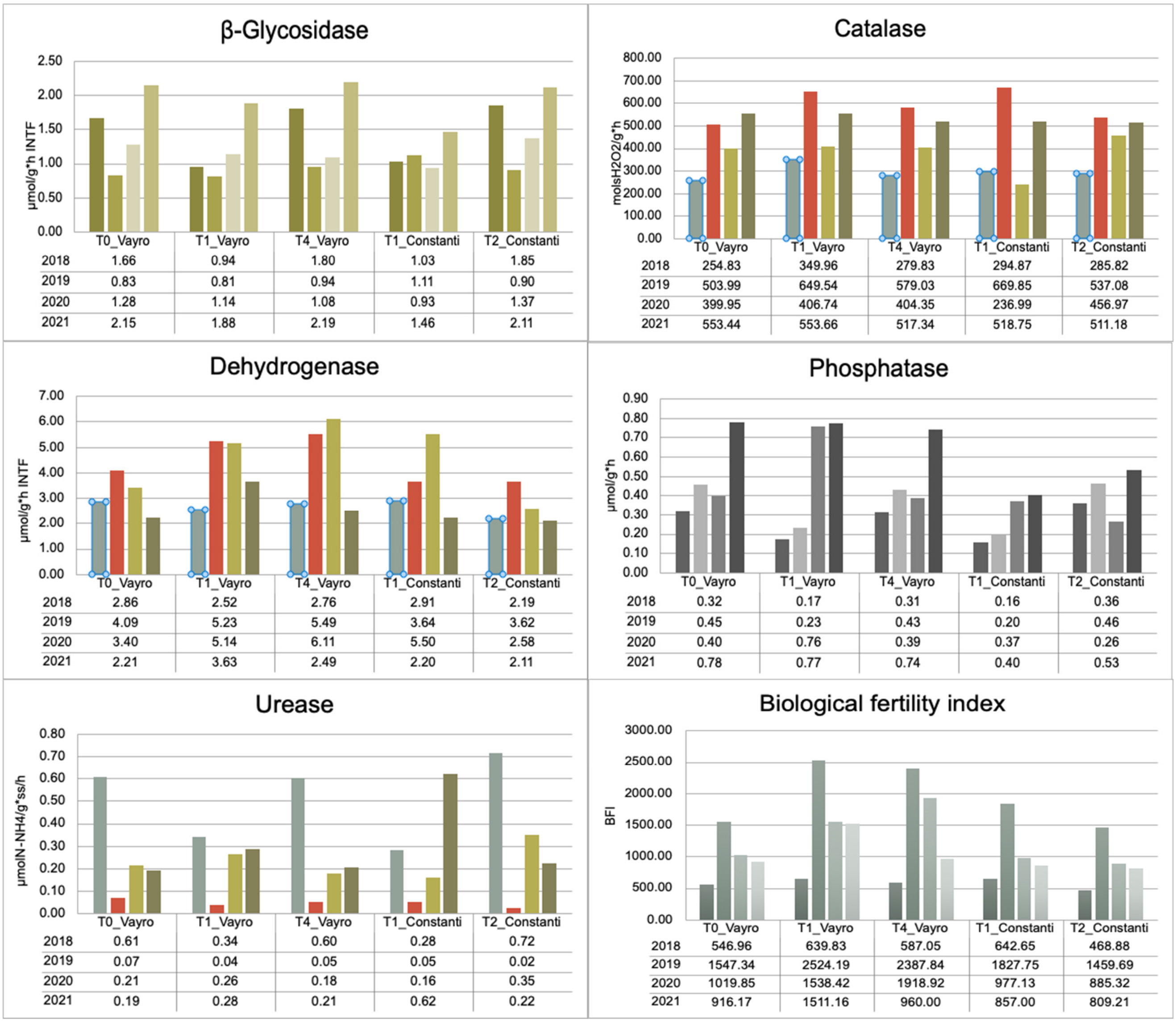
Table 13 Soil chemical analysis Charqueirao Farm 2018 to 2021

	T1_Constanti	T2_Constanti	T0_Vayro	T1_Vayro	T4_Vayro
Comparison 2018 to 2021					
E.C. (dS/m) (extract 1:5)	24.71%	-34.84%	3.20%	55.00%	16.36%

%N Total	42.14%	46.53%	21.37%	115.46%	46.67%
NO3- (mg/kg)	125.83%	43.44%	-25.44%	70.18%	9.36%
P (ppm)	846.43%	860.00%	264.00%	882.38%	3248.65%
K (meq/100 g)	-18.58%	150.64%	135.14%	113.10%	146.44%
Ca (meq/100 g)	40.35%	-4.90%	-34.10%	170.56%	-13.75%
Mg (meq/100 g)	105.52%	14.04%	107.86%	143.12%	29.09%
SO4-2 (meq/100g)	6.22%	-53.26%	-41.95%	86.31%	-35.80%
Fe (ppm)	-66.75%	0.12%	-10.46%	-65.32%	-28.58%
Mn (ppm)	-54.46%	155.41%	10.82%	-47.98%	3.09%
B (ppm)	67.50%	557.78%	162.78%	163.33%	300.35%
Cu (ppm)	-72.99%	93.90%	128.30%	199.06%	152.65%
Zn (ppm)	625.91%	40.61%	143.92%	893.28%	668.80%
Cl- (meq/100 g)	232.03%	-1.74%	6.58%	79.43%	50.37%
Na (meq/100 g)	395.32%	-86.00%	25.37%	227.52%	97.95%
% O.M. Oxidable	41.98%	83.18%	62.98%	117.77%	52.12%
%C Total	-17.27%	6.94%	-5.65%	25.99%	-11.61%
C/N	-1.17%	32.92%	29.90%	-0.85%	3.65%
% CaCO3 Total	113.33%	6.67%	45.00%	61.82%	10.00%
% CaCO3 active	-32.89%	-79.92%	-71.26%	-64.54%	-66.56%

About macronutrients an important increment was observed in N% in all the treatments respect to control. in NO_3 content was observed in T1 Vayro. Regarding phosphorus the content increased in all the treatments.

ß-glycosidase is related to soil organic carbon content and organic matter degradation. What it is mean a contribution of micronutrients to the crop. An important increment was observed in ß-glycosidase activity in 2021 respect to 2020 in T0, T1 and T4 Vayro treatments and T1 and T2 Constanti. Catalase enzyme activity increased generally in all treatments. Dehydrogenase activity was markedly reduced in the all the treatments respect to previous year in both varieties. The phosphatase activity was considerably increased in the T4 treatment in the Vayro variety and in T2 Constanti. The urease activity experienced a considerable increase in all treatments regardless of the variety.



ß-Glycosidase

	T0_Vayro	T1_Vayro	T4_Vayro	T1_Constanti	T2_Constanti
2018	1.66	0.94	1.80	1.03	1.85
2019	0.83	0.81	0.94	1.11	0.90
2020	1.28	1.14	1.08	0.93	1.37
2021	2.15	1.88	2.19	1.46	2.11

Catalase

	T0_Vayro	T1_Vayro	T4_Vayro	T1_Constanti	T2_Constanti
2018	254.83	349.96	279.83	294.87	285.82
2019	503.99	649.54	579.03	669.85	537.08
2020	399.95	406.74	404.35	236.99	456.97
2021	553.44	553.66	517.34	518.75	511.18

Dehydrogenase

	T0_Vayro	T1_Vayro	T4_Vayro	T1_Constanti	T2_Constanti
2018	2.86	2.52	2.76	2.91	2.19
2019	4.09	5.23	5.49	3.64	3.62
2020	3.40	5.14	6.11	5.50	2.58
2021	2.21	3.63	2.49	2.20	2.11

Phosphatase

	T0_Vayro	T1_Vayro	T4_Vayro	T1_Constanti	T2_Constanti
2018	0.32	0.17	0.31	0.16	0.36
2019	0.45	0.23	0.43	0.20	0.46
2020	0.40	0.76	0.39	0.37	0.26
2021	0.78	0.77	0.74	0.40	0.53

Urease

	T0_Vayro	T1_Vayro	T4_Vayro	T1_Constanti	T2_Constanti
2018	0.61	0.34	0.60	0.28	0.72
2019	0.07	0.04	0.05	0.05	0.02
2020	0.21	0.26	0.18	0.16	0.35
2021	0.19	0.28	0.21	0.62	0.22

Biological fertility index

	T0_Vayro	T1_Vayro	T4_Vayro	T1_Constanti	T2_Constanti
2018	546.96	639.83	587.05	642.65	468.88
2019	1547.34	2524.19	2387.84	1827.75	1459.69
2020	1019.85	1538.42	1918.92	977.13	885.32
2021	916.17	1511.16	960.00	857.00	809.21

Figure 7 Herdade do Charqueirão Farm soil enzymatic activity 2018-2021

Table 14 Soil Chemical Analysis La Traversagna Farm 2018- 2021

	T0	T1	T3	T4
Parameter	Comparison 2018 to 2021			
C.E. (dS/m) (extract 1:5)	16 %	-4 %	-35 %	-12 %
%N.total	4 %	-12 %	-21 %	-15 %
NO3- (mg/kg)	97 %	-35 %	-35 %	-52 %
P (mg/Kg)	-21 %	-18 %	-51 %	-19 %
Ca (meq/100 g)	-16 %	-5 %	-12 %	-6 %
K (meq/100 g)	40 %	12 %	-23 %	22 %
Mg (meq/100 g)	36 %	-25 %	-5 %	-19 %
SO4-2 (meq/100g)	66 %	-11 %	-52 %	-26 %
Fe (mg/Kg)	50 %	-42 %	-50 %	-36 %
Mn (mg/Kg)	-40 %	-48 %	-53 %	-51 %
B (mg/Kg)	9 %	-48 %	-37 %	-34 %
Cu (mg/Kg)	-3 %	-28 %	-47 %	-43 %
Zn (mg/Kg)	7 %	-19 %	-35 %	-31 %
Cl- (meq/100 g)	48 %	39 %	-22 %	29 %
Na (meq/100 g)	206 %	85 %	156 %	121 %
% M.O. Oxidable	20 %	0 %	-8 %	0 %
%M.O. total	20 %	0 %	-8 %	0 %
%C total	20 %	0 %	-8 %	0 %
C/N	14 %	17 %	17 %	18 %
% CaCO3 Total	6 %	17 %	-8 %	16 %
% CaCO3 active	237 %	46 %	49 %	36 %

About ß-glycosidase activity a slight decrement was observed in all the treatments respect to 2020. Catalase activity indicates a great soil capacity to degrade organic debris. Although an increment by 21% was observed in T0 respect to 7% observed in T1 respect to 2020, T1 values are still superior. On the contrary a decrease in the activity of this enzyme was observed in the T4 treatment. While in the T3 treatment there is an activity very similar to that observed in 2020. The dehydrogenase activity is linked to the metabolic activity of the soil. A decrease in the activity of this enzyme is linked to the activity of the enzyme catalase and the mobilization of certain soil bacteria. In this sense a slight decrease in the activity of this enzyme was observed in 2021 in all treatments.

With regards to phosphatase activity a higher activity of this enzyme indicates a greater mobilization of phosphorus in inorganic form in the soil and a greater availability of this element to the plant. In this sense a slightly increase in phosphatase activity was observed in all the treatments in 2021 in comparison to 2020, this is probably linked to phosphate mobilization in soil. Urease activity indicates urea conversion to ammonia by soil microorganism. In 2021, the activity of the urease enzyme increases in all treatments respect to 2020. About biological fertility index the same pattern was observed in 2021 in all the treatments.

T4 treatment include an application of bioestimulants in a similar way than in T1, also a deficit irrigation period and cover crops that were sowed in 2021. To be able to contrast the effect of the plant cover crops on soil biological and microbiological activity, soil samples were taken from each of the cover crops and analysed separately at Herdade do Charqueirão Farm.

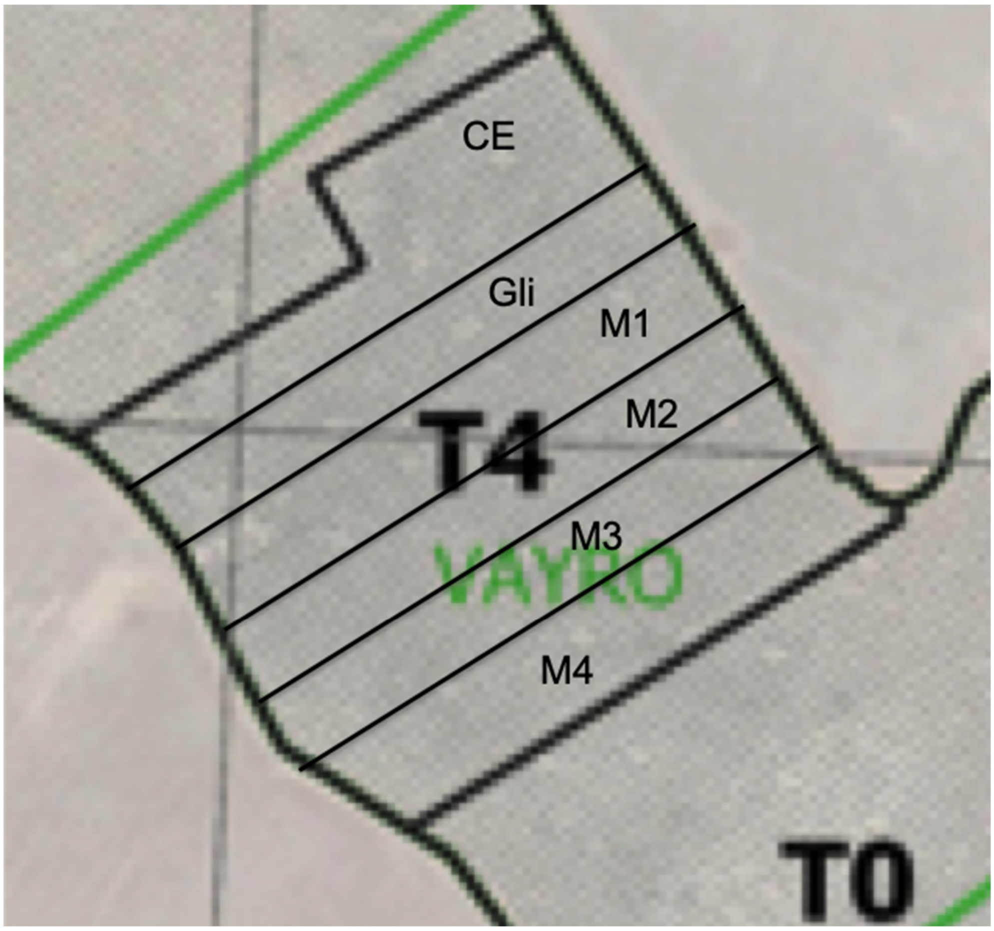
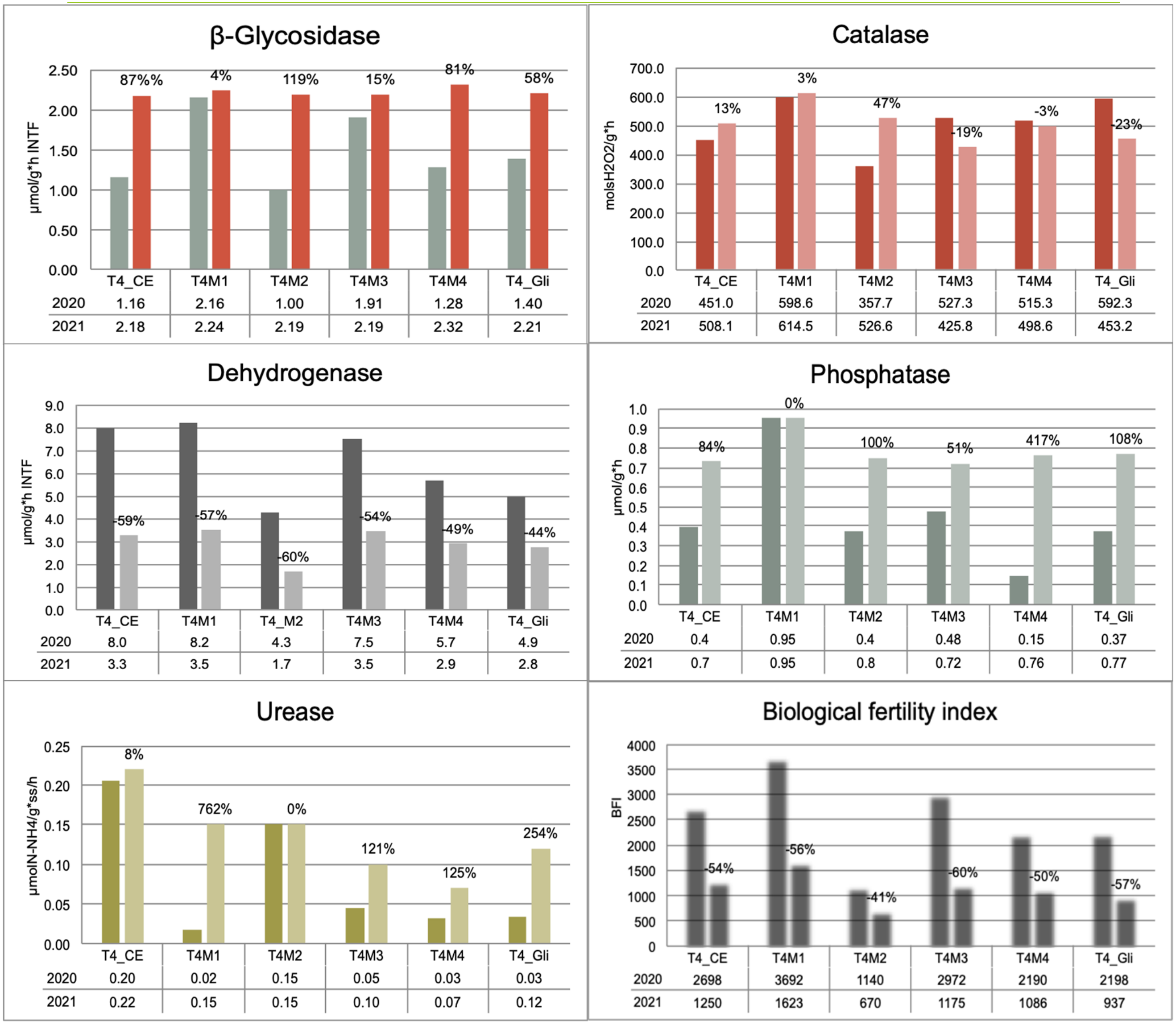


Figure 8Cover crops locations in Herdade do Charqueirão Farm

ß-glycosidase is related to soil organic carbon content and organic matter degradation. What it is mean a contribution of micronutrients to the crop. Respect to the activity of the ß-glycosidase enzyme, a higher enzymatic activity was observed in treatment cover crop called mix 1(T4-M1) indicating a greater metabolic activity in that treatment.

In the case of catalase activity, a higher activity of this enzyme was observed in the M1 cover again, the cover crop with the lowest activity of this enzyme was T4 M2.



On the one hand, dehydrogenase activity was quite similar in the spontaneous cover crop (T4-CE) and the T4-M1 cover crop. On the other hand, cover crop that presented the lowest dehydrogenase activity was again mix 2 (T4-M2). Regarding to phosphatase activity a higher activity of this enzyme shows a mobilization of phosphorus in inorganic form in the soil and a greater availability of this element to the plant. Phosphatase activity increased again in the M1 cover, being very low in the M4 cover.

Urease activity indicates urea transformation to ammonia by soil microorganism. Urease activity was higher in the spontaneous cover (T4-CE) and in the M2 (T4-M2). The lowest urease activity was observed in mix M1 (T4-M1).

Regarding biological fertility index, this was increased in the case of M1 cover crop (T4-M1) in comparison to remaining treatments.

III. Disease prevalence

7. Xylella fastidiosa disease control

Since no symptoms of disease had been observed in years 2019, 2020 and 2021 in El Valenciano and Charqueirao Farm and insects' vector had not been detected on the farms, these disease control measures were not carried out. Moreover, in Spain The Junta de Andalucía is conducting a disease-tracing program throughout the autonomous community. Whenever an alert will be detected in a nearby area, sampling will be carried out in El Valenciano farm to determine the disease as soon as possible. In this sense, plant tissues will be sampled at a specific time or stage of development following the protocol of the laboratory (refer to Guidelines for the survey of Xf in the Union territory, European Commission, 2015) in case of alarm about XF will be detected.

The Villa Filippo Berio is located in a *Xylella*-free area (Pisa province), although this pathogen was detected in Tuscany in 2018. Since the risk of a new outbreak of *X. fastidiosa* in Tuscany, plant tissue and vector specimens were sampled in 2020 and 2021 in order to monitor and eventually detect the presence of the bacteria in the experimental olive grove. In this sense, the collection of samples was carried out following the protocol established by the European Union and applied by the Tuscany Regional Plant Health Service (EPPO Standard – Diagnostic PM 7/24).

Briefly, sample of mature tissues (from 4 to 10 branches with attached leaves) were collected from different parts around the canopy of four olive plant (per year), during the period of active growth, in order to maximize the likelihood of detection. After the collection, refrigerated samples were brought to Tuscany Regional Plant Health Service laboratory where molecular analysis was conducted. **All the collected samples of plant and vector were tested negative to *X. fastidiosa* in both years 2020 and 2021.**

8. Insect vectors trap

The phytosanitary emergency caused by the spread of *Xylella fastidiosa* in the Mediterranean has raised demands for a better understanding of the ecology of its presumed and candidate insect vectors. *X. fastidiosa* is transmitted by insects that feed exclusively or almost exclusively on xylem vessels. Xylem "specialists" belong to the order Hemiptera, suborder Cicadomorpha, superfamilies Cercopoidea (spittlebugs or froghoppers) and Cicadoidea (cicadas), and the subfamily of Cicadellidae Cicadellinae (sharpshooters). Species that may occasionally feed from the xylem, but are non-xylem feeding specialists, have never been shown to be capable of transmitting *X. fastidiosa*.

In 2020, several field trials have been carried out in three olive groves in Italy: Azienda Agricola Fabio (Prato), Villa Filippo Berio (Pisa) and Azienda Sperimentale Santa Paolina of CNR (Grosseto) to evaluate the attraction of different color sticky traps towards spittlebug adults. In each olive grove seven traps were tested (transparent, white, yellow, green, brown, red and blue). Each chromotropic trap consists in two faces: one southeast oriented and one northwest oriented. To determine the efficacy of the traps, every week collected specimens were counted and the color order was changed. At the time of the counting, a sampling of adult specimens has been carried out (by a sweep net) to assess the presence and the density of spittlebug population in the olive groves.

For Villa Filippo Berio, yellow traps captured significantly more males than the other colors and significantly more females than red and white traps. These results are partially consistent with those reported in the only one previous study concerning color attractiveness in *P. spumarius*.

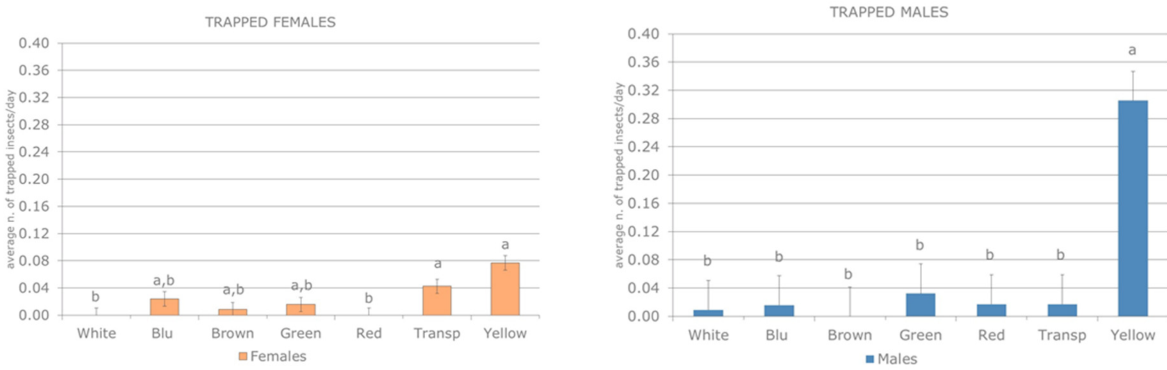


Figure 9Comparison of average number of trapped females and males per day.

This project has been able to determine the usefulness of chromotropic traps for detecting insect vectors of XF. Furthermore, we have gone further by determining which colour is preferred by these insects, i.e. which colour traps could be used in the field to accurately determine the presence of XF vectors. This is a major step towards sustainability, as these traps allow us to capture the individuals and eliminate them without having to use chemicals that are harmful to the ambient, animals and human beings.

IV. Weather

9. Weather conditions

Climate change alters both average and extreme temperatures and precipitation patterns which in turn influence crop yields, pest and weed varieties and the length of the growing season. To test climate change parameters that could affect crop yield or quality, annual information on the parameters were measured in darsky climate stations, including: Temperature Maximum (ºC), Average Wind Speed (m/s), Temperature Time Maximum, Middle Wind Direction (º), Temperature Minimum (ºC), Radiation (MJ/m^2), Temperature Time Minimum, Precipitation (mm), Temperature Average (ºC), ET_0 (mm/day), Maximum

Relative Humidity (%), Minimum Relative Humidity (%), Accumulated Precipitation (mm), Relative Medium Humidity (%), and Cumulative ET_0 (mm).

Regarding the climatic data recorded, no extreme meteorological phenomena have been observed that may have affected the treatments applied on El Valenciano farm, Charqueirao and La Traversagna. Indeed, the water needs of crops were far exceeded by the precipitation that had occurred since flowering in low latitudes.

The semi-arid climate conditions of Charqueirao and El Valenciano, promote that farmers must start irrigation from the beginning of the vegetative development. On the other hand, La Traversagna only required special attention in the central months of the year.

Considering that warm temperatures enhance the growth of populations of *Xyllela fastidiosa*, location of the farm must be considered. Locations at low latitudes (Charqueirao and El Valenciano) present higher values of maximum, average and minimum temperature, which causes better conditions for the proliferation of the bacteria. In addition, crops at low latitude maintains suitable temperatures for a longer period per year, reinforcing the growth of the bacteria.

In conclusion, although the weather conditions in Spain and Portugal have been favourable for the proliferation of the bacterium causing the disease, no new cases of Xf have been reported. This could indicate that the sustainable olive and almond tree management strategies implemented in this project have been effective in making the crops more resilient.

V. Quality

10. Organoleptic characteristics (olive oil)

The olive tree fruits, and olive oil obtained were annually evaluated to determine its quality by means of the following parameters: content of fatty acids and volatile compounds present in green olives and their oil; total phenolic compounds; and sensory analysis.

The majority fraction of the oil (95%) is constituted mainly by triglycerides and to a lesser extent by diglycerides, monoglycerides and free fatty acids. The fatty acid composition is characterized by being high in monounsaturated fatty acids, oleic being the main fatty acid, whose concentration varies between 60-80%. The application of the treatments did not have a negative effect on the profile of fatty acids in which, in all the samples, the majority acid was oleic acid, with values higher than 60% in both El Valenciano and La Traversagna Farm. The second most important acid is palmitic acid, which appeared in the highest concentration in T2 in El Valenciano Farm and in very similar concentrations in all the samples in La Traversagna. Regarding the groups of fatty acids, the majority were monounsaturated fatty acids, oleic acid being the most important, with values greater than 75% in all the treatments in La Traversagna Farm.

Phenolic compounds are the main responsible for the antioxidant capacity of olive oil, which is why they provide stability against oxidation and autoxidation, in addition to generating benefits for the consumer. After analyzing the oils, significant differences were observed in the antioxidant activity analysis, with sample T1 being the one with the highest total polyphenol content. All the treatments increased phenolic content in comparison to T0 treatment in La Traversagna Farm. In conclusion, bioestimualnt treatment increased antioxidant olive oil capacity.

The volatile compounds are responsible for the aroma of the extra virgin olive oil, which helps to differentiate it from the rest of the edible oils, since in its preparation a refining process is not required in which all the volatile compounds are lost. In all samples, the compound with the highest concentration was 1-hexanol, a compound that is related to fruity aromas, reminiscent of tomato, whose highest concentration was found in treatments T1 and T4. The next most important compounds were trans-2-hexenal, which did not show significant differences between treatments, and trans-2-hexen-1-ol, being higher in treatment T4. In conclusion volatile compound was increased in bioestimulant treatments T1 and T4.

The sensory analysis established by the COI only includes as key attributes to define the commercial category of the oil the total fruity and the presence or absence of defects, in addition to considering the basic bitter taste and the pungency of the oil. The last two attributes are attributes that depend on factors such as harvest time and variety. In this case, the oils samples have been analyzed in a more descriptive way, expanding the attributes to be studied, such as the maturity character of the oil.

About sensory profile attributes "fruity (olive)" was observed in T2 and T4 and "bitter" attribute, being higher in the T2 sample, while in the pungency of the oil, the T1 sample stands out. In conclusion, sensory profile was improved in T1, T2 and T4 treatments. Respect to bitterness and fruity taste, all the treatments increased oil fruity and bitterness in comparison to T0 treatment in La Traversagna Farm. About almond and grass taste all treatments have similar values.

Pesticides in oil were also analyzed but none of the treatments had pesticide content.

11. Almond quality

Regarding the quality of the almonds obtained in each of the treatments, no twins kernels was detected. Thanks to the implementation of this project, increases in the specific weight of the almonds obtained have been detected, especially in the treatments where biostimulants were applied. Regarding to crude fat, an increase of this parameter was observed in general in all the campaigns in the treatments subjected to deficit irrigation.

Respect to mycotoxins, in most of the treatments they were below the detection limit (<LD). In the cases in which mycotoxins were detected, all were below the limit allowed in Spain for nuts. This was a robust result of this project as none of the years in which it has been

carried out has mycotoxins been detected above the permitted levels in the almond crop. Mycotoxins are a very important quality parameter because they are one of the health hazards that can affect cereals and nuts and their by-products, which is why they were one of the first contaminants to be evaluated and regulated at European level, with the aim of reducing the total intake of consumers to this type of toxins through the diet. The first mycotoxins to be regulated at European level were aflatoxins (B1 and the sum of B1, B2, G1 and G2), establishing maximum levels in cereals and products derived from their processing at the end of the 1990s. Subsequently, the regulation on contaminants in foodstuffs was completed as regards mycotoxins in cereals and derived products with the introduction of maximum levels for ochratoxin (2002) and maximum levels for Fusarium toxins (deoxynivalenol, zearalenone, fumonisins) in 2005.

Table 15. Mycotoxins content per treatment 2018-2021

Treatment	AFLA B1	DON	T2	FUMONISINA	ZEA
T1_Constanti	<LD	<LD	<LD	<LD	<LD
T2_Constanti	<LD	<LD	<LD	<LD	<LD
T4_Vayro	<LD	<LD	4.1	<LD	<LD
T3_Belona	0.55	444	8.9	<LD	<LD

VI. Water use

12. Water use efficiency (WUE)

The WUE is the relation between water consumed (m^3) by the crop and irrigation water applied (m^3). Both values were calculated each year. In Table 13 WUE values are listed. In T2 and T4 treatments deficit irrigation was applied and WUE was increased as expected. On the other hand, in T0 and T1 had the same irrigation and WUE.

El Valenciano WUE per treatment

	T0	T1	T2	T3	T4
WUE	1.94	1.94	2.48	_	2.48

In Table 21 WUE values are listed. In T2 and T4 treatments deficit irrigation was applied and WUE was increased as expected. On the other hand, in T0 and T1 had the same irrigation and WUE.

Charqueirao Farm WUE per treatment

	T0	T1	T2	T3	T4
WUE	1.86	1.86	2.5	1.86	2.5

13. Irrigation water productivity (IWP)

The IWP is the relation between annual yield (kg) and water applied (m^3). Both values were measured each year and IWP was calculated. In Table 14 IWP 2021 are listed. T4 treatment was more productive because IWP was the highest, similar situation was observed in T2 treatment. On the other hand, very similar values were measured in T0 and T1.

El Valenciano IWP per treatment.

	T0	T1	T2	T3	T4
IWP	4.35	4.61	5.92	-	8.66

In Table 22 IWP 2021 are listed. T1 treatment was more productive because IWP was the highest. However, T2 has a less irrigation water application but harvest was very low this year. Almond crop experienced alternate bearing, which means that one year the harvest is high and next one harvest is low. This situation is also observed in avocado and olive trees. In conclusion, the result obtained in T2 treatment is not related with treatments applied.

Charqueirao Farm IWP per treatment.

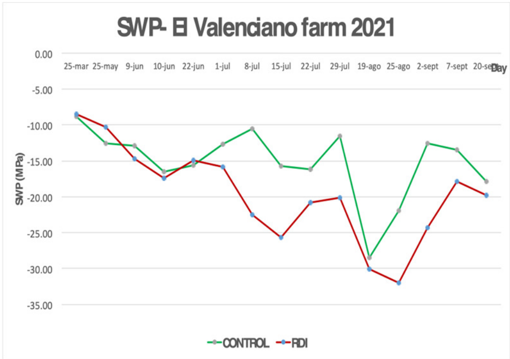
	T1	T2	T3	T4
IWP	1.5	0.18	-	-

14. Stem water potential (SWP)

The SWP was measured by the Scholander pressure chamber on mature leaves every year to determine tree water status in olive crop during the growing season. The measures were taken every week to schedule the irrigation following the Hydrosustainable Protocol (BALAM).

The measurement of SWP allows us to establish the water state of the plant and, in relation to that value, determine the necessary irrigation hours (Hydrosustainbale protocol). When the water requirement demand is satisfied 100%, this value, despite being important, is not critical. However, when we are applying a RDC strategy, the SWP value is crucial to determine the hours of irrigation in a much more precise way, achieving reductions in water consumption but without affecting production.

During the project (3 years), we could applied RDI strategy in El Valenciano Farm, reducing water consumption and without yield reduction.



SWP in Valenciano Farm 2021 season

VII. Carbon footprint

15. CO2 emitted during the agricultural processes

Annual CO_2 emitted in each farm was analyzed at the end of the project. To do that, annual CO_2 emitted in each farm was estimated by Carbon Footprint Assessment ISO/TS 14067:2013. The total carbon reduction associated with the activities of the project that took place at the demonstration sites was: **3.568,7 tons of CO2 eq.**

EMISSIONS				Spain	Portugal	Italy	
Diesel consumption from tractor passes due to weed control and soil preparation activities.	Diesel consumption	20,00	l/ha		Area		
	Passes	7,00		T3, T4	T3, T4	T3, T4	
	ISCC	3,14	kg CO2 /l diesel.				
	CO2 emissions	439,60	kg CO2 eq /ha	12858,30	9666,80	11710,94	kg Co2 eq/ year
Energy consumption from water pumping.	Energy Consumption	100000,00	kWh/ ha	T2, T4	T2, T4	T2, T4	
	Conversion factor	0,36	kg CO2 /kWh				
	CO2 emissions	35700,00	kg CO2 eq / h	784329,00	584766,00	475167,00	kg Co2 eq/ year
Herbicide consumption	ISCC Glyphosate	9,79	kg Co2 eq/ kg a.i.	T3, T4	T3, T4	T3, T4	
	Herbicide (UPL-Cosmic XL-glyphosate 36%)	3,52	kg Co2 eq/ kg a.i.				
	Dosis	3,00	kg/ha				
	Passes	4,00					
	Co2 emissions	42,29	kg CO2 eq/ha	1237,06	930,02	1126,68	kg Co2 eq/ year
Carbon store due to cover crop installation				-	-	-	
	Cover crops CO2 fixing	8000,00	kg Co2 eq/ha	0	0	0	kg Co2 eq/ year

Image 2 *Carbon emissions baselines for the demonstration sites.*

Spain	BE1	12858,30	BE2	784329,00	BE3	1237,06	BE4	0,00	**Total per year**	**Total**
	PE1	3673,80	PE2	627463,20	PE3	0,00	PE4	-234000,00		
	RE1	9184,50	RE2	156865,80	RE3	1237,06	RE4	234000,00	401287,4	1404505,8
Portugal	BE1	9666,80	BE2	584766,00	BE3	930,02	BE4	0,00	**Total per year**	**Total**
	PE1	2761,94	PE2	467812,80	PE3	0,00	PE4	-175920,00		
	RE1	6904,86	RE2	116953,20	RE3	930,02	RE4	175920,00	300708,1	1052478,3
Italy	BE1	11710,94	BE2	475167,00	BE3	1126,68	BE4	0,00	**Total per year**	**Total**
	PE1	3345,98	PE2	380133,60	PE3	0,00	PE4	-213120,00		
	RE1	8364,96	RE2	95033,40	RE3	1126,68	RE4	213120,00	317645,0	1111757,6
									RE (tonCo2 eq)	**3568,7**

Image 3 Project’s reduction at the demonstration sites.

VIII. Biodiversity

16. Auxiliary fauna

Nests hotel and insect boxes were installed on 2020 autumn (September). Occupancy rate of hotels nests and insect boxes was determined by visual counting in 2021 autumn. Of a total of 40 nest boxes and shelters for fauna installed in 2016, plus 23 nest boxes and shelters installed in 2020 in the El Valenciano farm. Respect the percentage of unoccupied boxes has been reduced from 18% in the last revision to 13%. Of the three locations for kestrels, 2 of them have been occupied, twice as many as in the previous review. Moreover, no domestic honeybee swarm has been found, which means less competitive pressure for native wild bees. Concerning the occupation by sparrows, probably Passer montanus in all cases, has increased from 22% to 30% and occupancy by tits, probably Parus major in all cases, has remained stable at 14%. On the other hand, the occupation by bats (Pipistrellus pygmaeus) was detected in 100% of the installed shelters, including those of the last installation in 2020. All the insect hotels installed in 2016 and 2020 have been occupied to a greater or lesser extent by solitary bees and some species of solitary wasps, to a lesser extent. Furthermore, the presence of Dormouse (Eliomys quercinus) hibernating in one of the nest boxes has been detected for the first time. In Portugal nest hotels were installed in September 2020 and evaluation was done in 2021 autumn (September; Image 31). In this farm a problem has occurred, since the local administration cut the trees next to the road a lot of nest boxes were lost. Nest hotel, insect boxes and bat boxes were installed at Villa Filippo Berio on 2020 autumn and occupancy was determined in 2021 autumn. In general, the registered occupancy rate was low, probably due to the availability of natural refuges in the olive grove and in its surroundings. Indeed, the Villa Filippo Berio olive grove is a diverse agroecosystem characterized by the presence of an almost perennial soil coverage (composed by spontaneous plant species), as well as several wild trees and shrubs that can offer suitable sites for the establishment and the development of wild fauna. Several bird species were observed in the olive grove, feeding and or stationing on soil coverage or on olive tree canopy. For example, Parus major, Cyanistes caeruleus, Jynx torquilla, Certhia brachydactyla, Upupa epops, Serinus serinus, Coracias garrulus, Falco tinnunculus, Buteo buteo, Tyto alba were recorded in the olive grove. Since most of these species are insectivorous, their maintenance in the olive agroecosystem could be useful in order enhance the control of some phytophagous insect species, including XF vector. For this reason, in 2021, some herbaceous riparian strips were left at the edges of the experimental plots to offer natural habitats for nidification and feeding of wild bird species. Despite the low occupancy rate registered on nest hotels, some of them (2 out of 10) were colonized by specimens of Parus major. The population of titmouse (29%) in the area of El Valenciano has remained stable compared to the last review, it can be seen that competition with sparrows (60%) is strong. Wryneck clutches have not been detected, but that does not mean that there were not, they are simply difficult to detect if it is not with the remains of eggs since they do not build nests, and the remains of eggs or feces are cleaned by other species that can nest after them, such as sparrows or great tit, eliminating the clues or traces that make it easier for us to know which species nested before, the same thing happens with other species that do not build nests, it is difficult to detect them if it is not at the time of occupation.

In Portugal, large hotels have higher parasitoid activity, so smaller hotels are preferable from the point of view of solitary bee survival. Even so, they can serve as a refuge for geckos and lizards, although for this it would be better to use rock cages or dry-stone walls (or simple piles of rocks on unused margins).

Image 4 Installation of bug hotels and nest boxes in Herdade do Charqueirão Farm

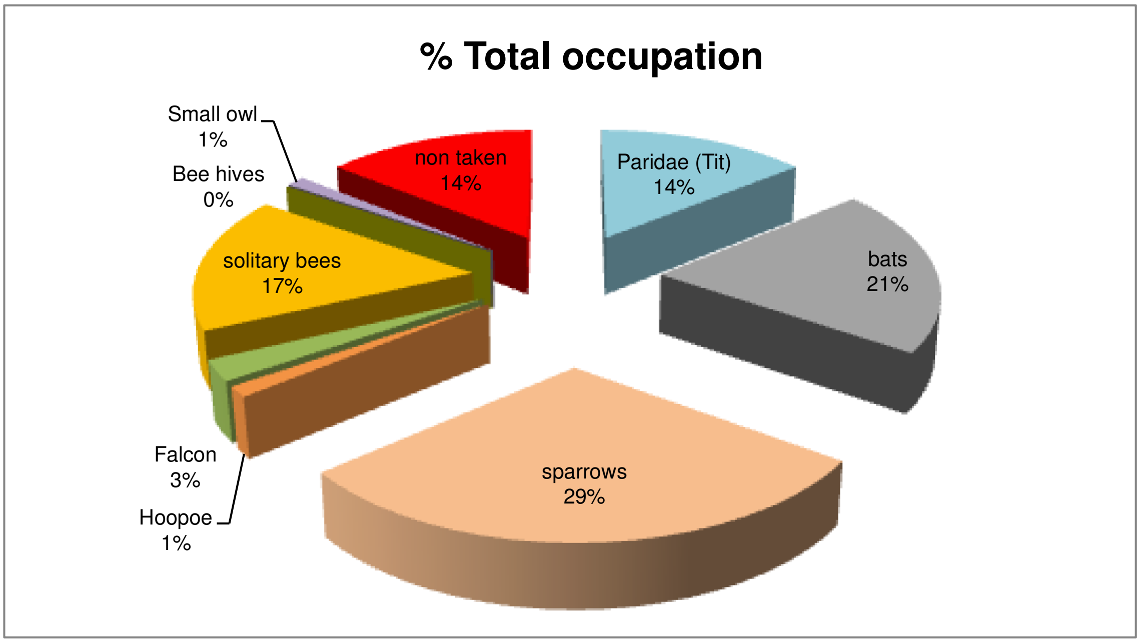
Besides the installation of the above-mentioned devices, a sampling of soil functional biodiversity was carried out in 2020 using pitfall traps. The aims of this sampling were: a) to investigate the composition of soil generalist predator fauna in olive grove agroecosystem; 2) to assess some eventual difference between areas where different soil management are applied. Indeed, plot with natural soil coverage (T0 and T1) were compared with plot where a seed mixture was sown (T3 and T4). Three taxonomic groups of generalist predator have been considered to compare different plots: Carabidae (ground beetles), Staphilinidae (rove beatles) and Spiders.

Image 5 Nest hotel and insect boxes installation in La Tarversagna Farm

Taking into account all of the data, if new nest boxes are installed, they should have a smallest entrance to limit to Passer and favor the titmouse. Most of the boxes were used by Geckos (Tarentola maurtanica) to spend the winter. In fact wintering bats had not been detected in the bird boxes, but were detected in the bat shelters.

Spiders appear to be more abundant in plots characterized by most grasses in the herbaceous soil coverage, while ground beetles seem to be the more abundant group in plots characterized by a greater presence of dicotyledonous species.

We can conclude that the shelters installed on the demo farms such as insect hotels and nest boxes have been a success. Analysis of the data has shown that it has favoured the nesting of birds and beneficial insects, but also other species such as lizards and bats, all of which are beneficial for the control of insects such as XF vectors. In addition, these measures have significantly increased the diversity of agricultural ecosystems.



Graph 1 Total occupation (%)

Image 6 Installation of bug hotels and nest boxes

Nest boxes insectivorous birds:

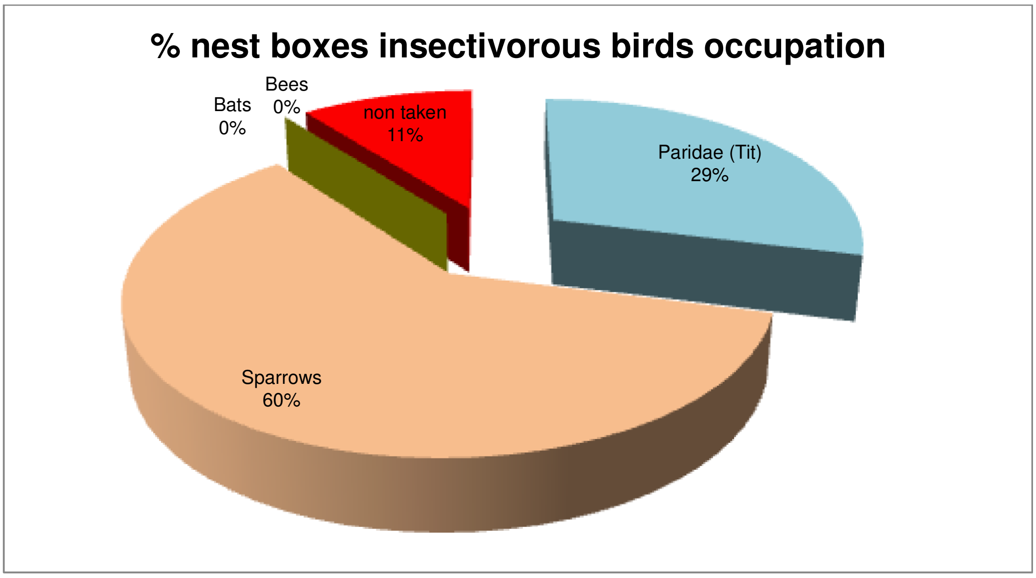
The population of titmouse (29%) in the area has remained stable compared to the last review, it can be seen that competition with sparrows (60%) is strong (Graph 2). Taking into account these data, if new nest boxes are installed they should have the smallest entrance to limit the entrance of Passer and favour the titmouse.

On this occasion there have been no boxes occupied by honey bees, perhaps the drought has influenced, the use of some type of pesticide or the distance from the location of nearby hives by beekeepers, the latter perhaps being the most likely variable (Graph 2).

Wryneck clutches have not been detected, but that does not mean that there were not, they are simply difficult to detect if it is not with the remains of eggs since they do not build nests, and the remains of eggs or feces are cleaned by other species that can nest after them, such as sparrows or great tit, eliminating the clues or traces that make it easier for us to know which species nested before, the same thing happens with other species that do not build nests, it is difficult to detect them if it is not at the time of occupation.

Most of the boxes are used by Geckos (Tarentola maurtanica) to spend the winter. This year we have not detected wintering bats in the bird boxes, but we have detected them in the bat shelters.

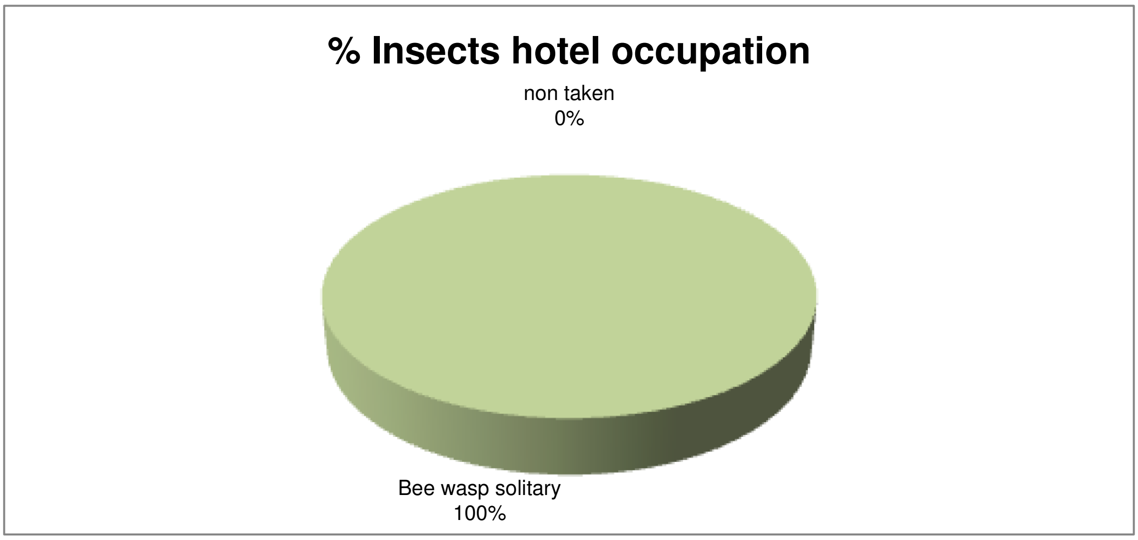
One of the nesting boxes for birds installed in 2016 in the vicinity of the farmhouse was occupied by a pair of hibernating dormouse, this is the first time that the species has been detected in El Valenciano.



Graph 2 Nest boxes insectivorous birds occupation

Insect's hotel occupation

Of the 4 hotels installed in 2017, 3 of them show activity of solitary bees and/or wasps, (*Rhynchium* sp. *Ancistrocerus* sp. *Megachile* sp.), undetermined microbes. The fourth hotel no longer exists, the three hotels have fulfilled their function for 6 years and they are quite old, it would be advisable to remove them to reduce the impact of fungi, mites and kleptoparasites. The technical hotels (holes 15 cm deep) installed in 2020, all of them have activity, mainly from megachylids, but also from other solitary hymenoptera.



Graph 3 Insects hotel occupation

Big nest boxes occupation

Large hotels have higher parasitoid activity, so smaller hotels are preferable from the point of view of solitary bee survival. Even so, they can serve as a refuge for geckos and lizards, although for this it would be better to use rock cages or dry stone walls (or simple piles of rocks on unused margins).

IX. Production Value

17. Money saved

Regarding the money saved 3 different parameters were considered. The first parameter was the application of herbicides which was not carried out thanks to the implementation of the cover crops. The cover crops were carefully selected to provide a greater accumulation of nutrients in the soil and to serve as a reservoir for different insects. This produced a variable saving in each of the farms where it was applied depending on the trial area, being around 1500 €/year of savings in each of the demonstration farms.

The second parameter considered was fertilizer savings. By applying nitrogen fixing microorganisms and phosphorus and potassium solubilizer, NPK fertilization can be reduced by 30%. This resulted in savings of between 4,500 and 6,400 depending on the surface area of the demonstration farm where the treatment was carried out.

The third parameter that was calculated was the reduction of herbicide application with machinery, in this case the tractor used and the fuel savings associated with the reduction of herbicide applied. In this case the cost reduction was between 6,300 and 7,000 €/year depending on the demonstration farm where the treatment was applied.

These three parameters produced a total saving of around €40,500/year. Considering the 4 years of the project, a total saving of 180,000 € was achieved.

	Reduction	€/ha	Reduction €/ha	Valenciano farm	Charqueirao	La Traversagna	Total €
Herbicide	4 application and soil preparation	9,9	9,9	1742	1599	1562	4903
Fertilizer	-30%	1.400	420	5085	6344	4419	15849
Diesel	4 application and soil preparation	32	160	7038	6460	6312	19811
						Total	40563

X. XF Resilience

18. Resilience rate

Due to the long juvenile period of some of the varieties selected as parents in the crosses used in this project, the selection period for future new varieties has been briefly extended. This, together with the long time that an olive plant needs to be propagated and planted again in the field, has meant that the shipment of the plants to the Bari laboratory has been delayed in time.

The plants are currently in the evaluation period through inoculation with the Xylella fastidiosa bacterium under controlled conditions and in Scorrano under field conditions. It is expected that results will begin to be obtained in the coming months. On the other hand, the expected results indicate that a large percentage of the 18 olive preselections of this project are resistant due to the resistant parents used in the crosses

LIFE

RESILIENCE

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