Silvoarable systems with hybrid poplar in Po valley

Trials on agroforestry systems at the pilot and demonstrative agricultural farm Sasse Rami at Ceregnano (Rovigo)

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800 ANNI 1222-2022 UNIVERSITÀ DEGLI STUDI DI PADOVA

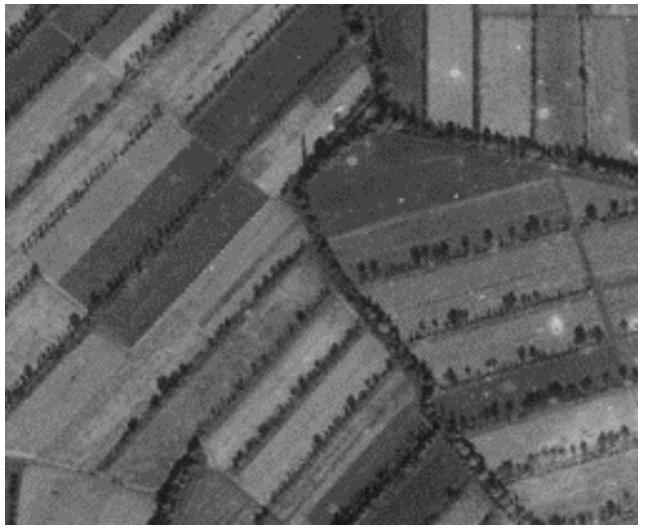
DAFNAE Dipartimento di Agronomia Animali Alimenti Risorse naturali e Ambiente

TESAF Dipartimento Territorio e Sistemi Agro-Forestali Università di Padova

Introduction – Silvoarable systems and practices in the North of Italy

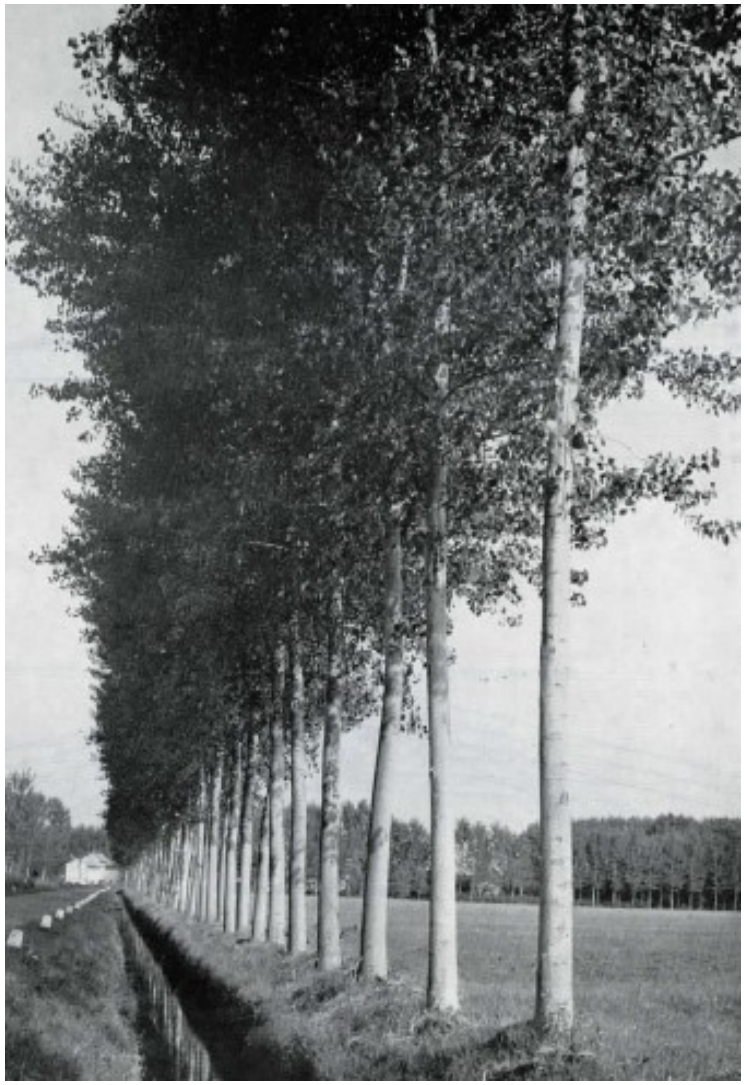
J. R. Cozens, Veduta da Mirabella, view of the Veneto plane from the Euganei hills, 1782 (Londra, Victoria and Albert Museum)

Oil on copperplate by anonymous Flemish painter that represents the Ghisileri's estate, outside Porta Lame in the province of Bologna (half of the XVIII century. Collection of Carisbo, bank foundation in Bologna).



Countrysides near, Padua province (Italian national geographic institute, 1929).

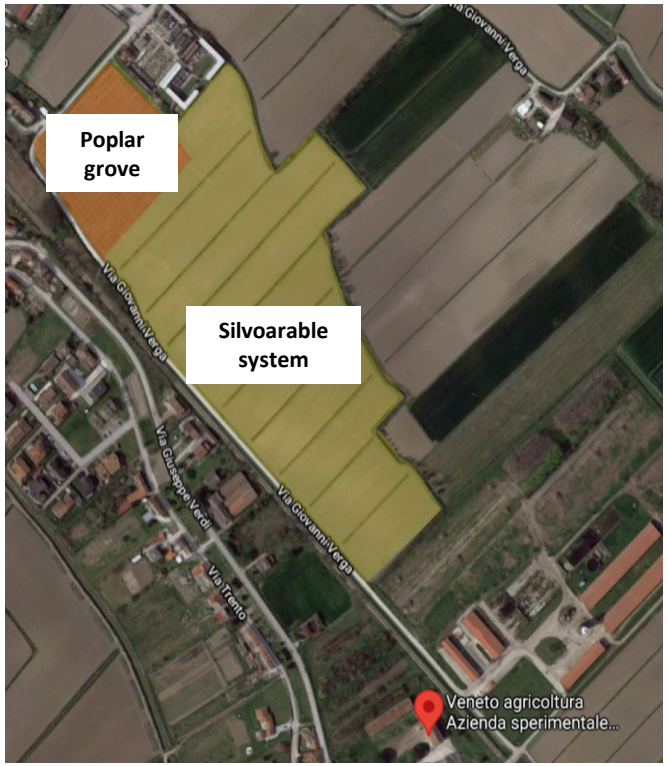
Agroforestry systems are agricultural systems were trees are associated with crops and/or livestock in the same land. They were largely widespread in Europe and in the North of Italy until before 1950s and silvoarable practices were present in the North of Italy until the end of 70s.



Poplar cultivation along drainage ditches in Po Valley (Prevosto, 1971)

Introduction – Silvoarable systems and practices in the North of Italy

With the aim of returning to more sustainable agricultural systems, **at the beginning of 2018**, Veneto Agricoltura in its "Sasse Rami" demonstrative Farm (Ceregnano, Rovigo) built up a **7.5 hectare silvoarable system with poplar** and a poplar grove adjacent, both with the same high environmentally sustainability clones, to evaluate in these mixed systems **i)** how to manage poplars, **ii)** their growth, **iii)** which are the most suitable clones and **iv)** how poplar rows affect quantitative and qualitative parameters of associated crops.



Experimental plan 2018-2021

Before 2021, Veneto agricoltura at the end of every growing seasons **measure DBH and height** of each clone in each system and **my team** (Dott.ssa Anna Panozzo and Prof. Teofilo Vamerali) evaluated quantitative and qualitative parameters of the **intercropped crops**.In 2021 started a collaboration with TESAF department (Dr. Gaia Pasqualotto, Vinicio Carraro and Professor Tommaso Anfodillo) to study **poplar growth in silvoarable systems**.

Activities from 2021

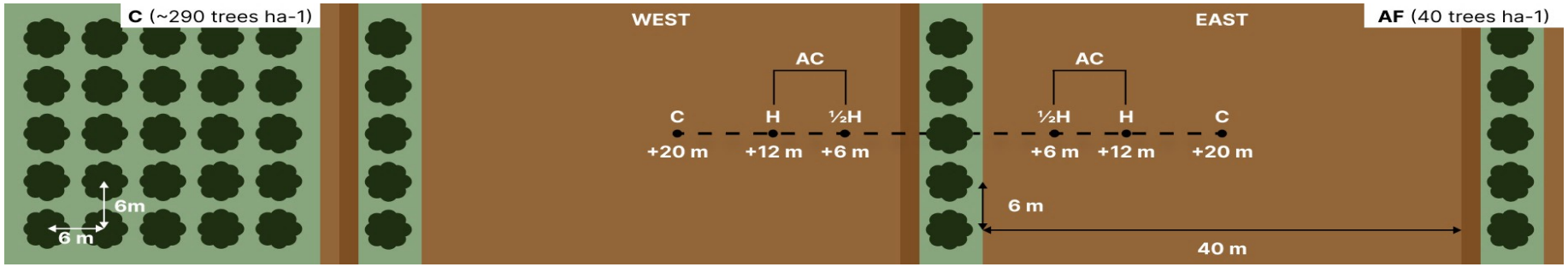
In 2021 at Sasse Rami Farm we have monitored the **radial growth** and the **phenology** of an early budding clone (Moncalvo) in two systems:

- Alley-cropping system with 40 m of inter-row (**SA**)
- Poplar grove 6 x 6 block design (**C**)

In each system we have monitored three clones each and also **VPD**, soil temperature (**°C**), electrical conductivity (**CE**) and moisture content (**%**).

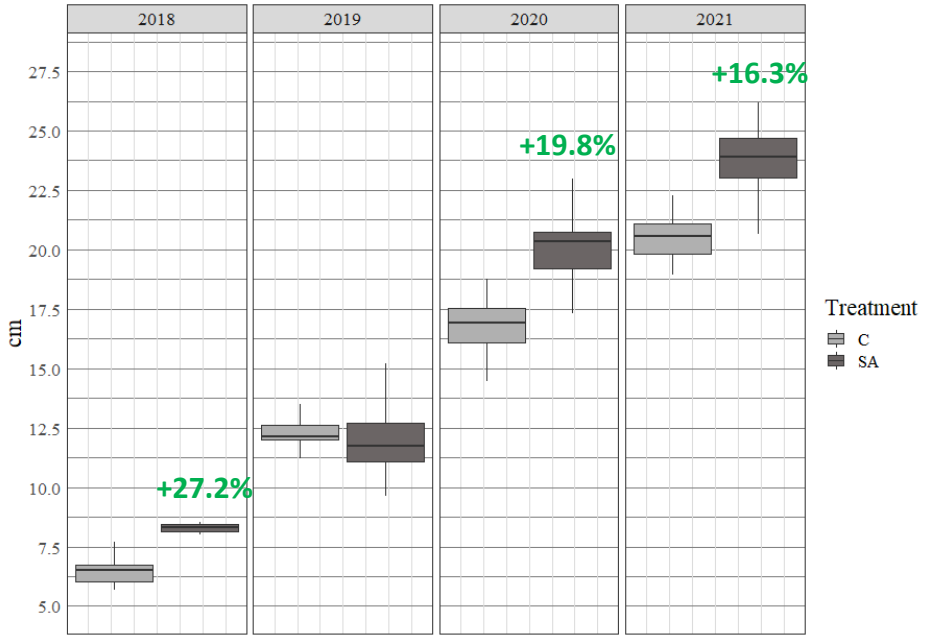
Obejctives in 2021

I. Evaluating the radial growth of Moncalvo clone in each system and when the grow **starts**, reach the **maximum daily** and **ends**
II. Assessing how **phenology changes** in SA compared with C
III. Evaluate wheat **yield** and **protein content** at different increasing distance from poplar rows



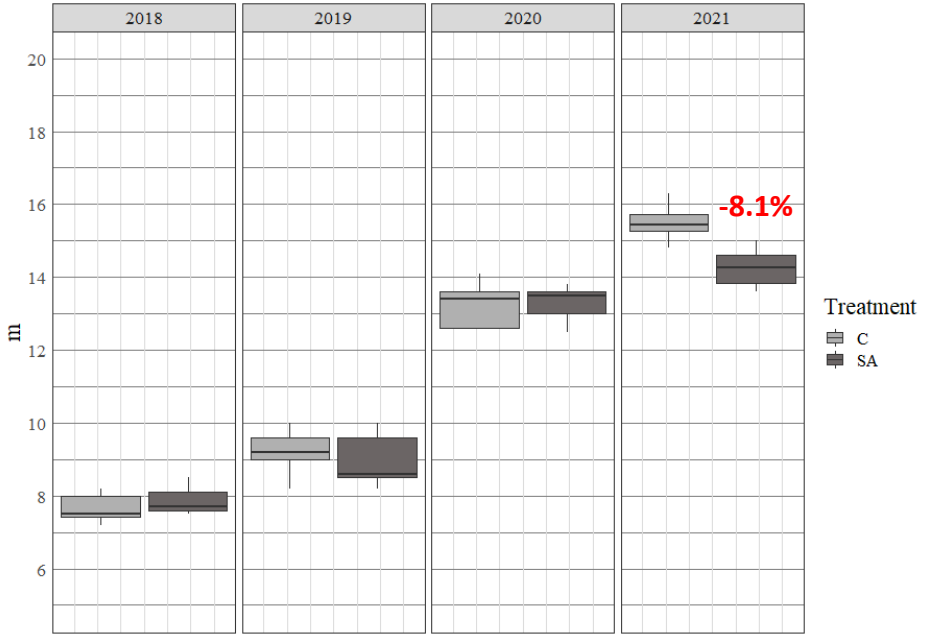
Our results – Poplar

DBH



Poplar DBH comparation in poplar grove (C) and silvoarable system (SA) from 2018 to 2021 growing season. In 2019 there were few data in SA (n=3 compared to n=14 in other years). Statistic performed by Welch two sample t-test ($p < 0.05$).

Height

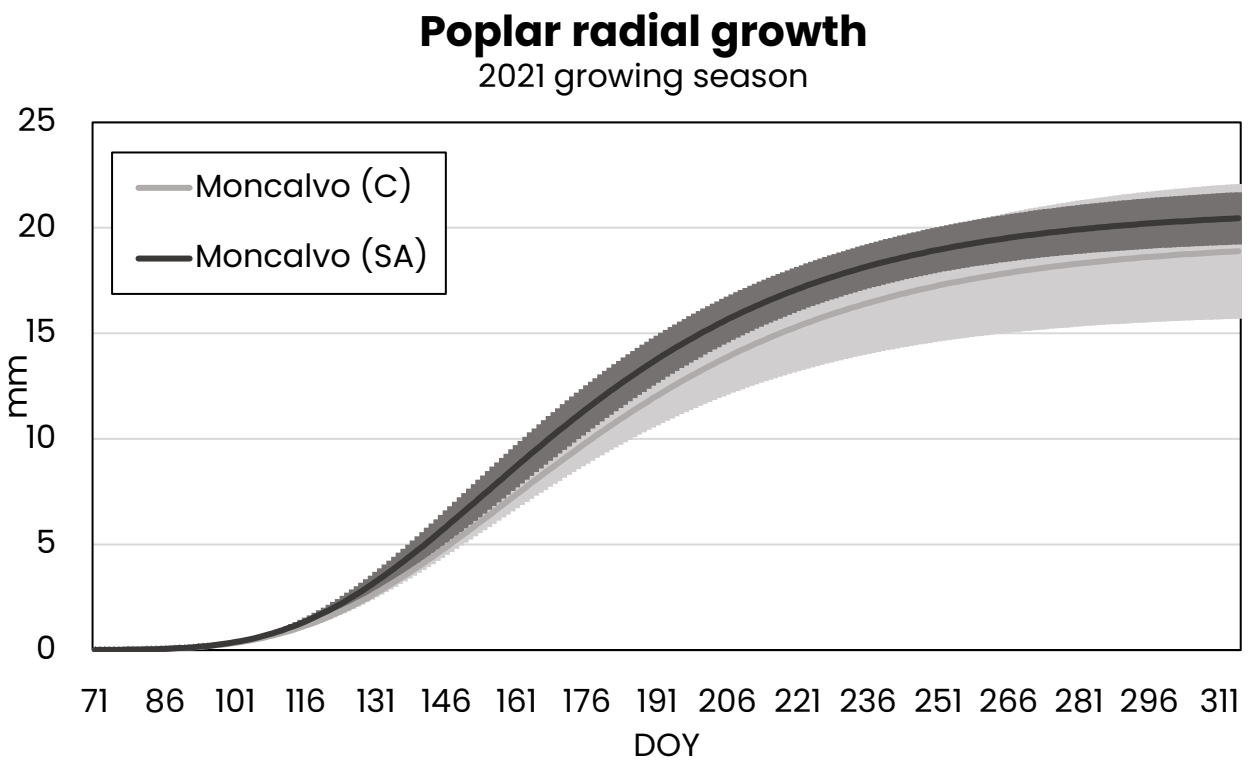


Poplar height comparation in poplar grove (C) and silvoarable system (SA) from 2018 to 2021 growing season. Statistic performed by Welch two sample t-test ($p < 0.05$).

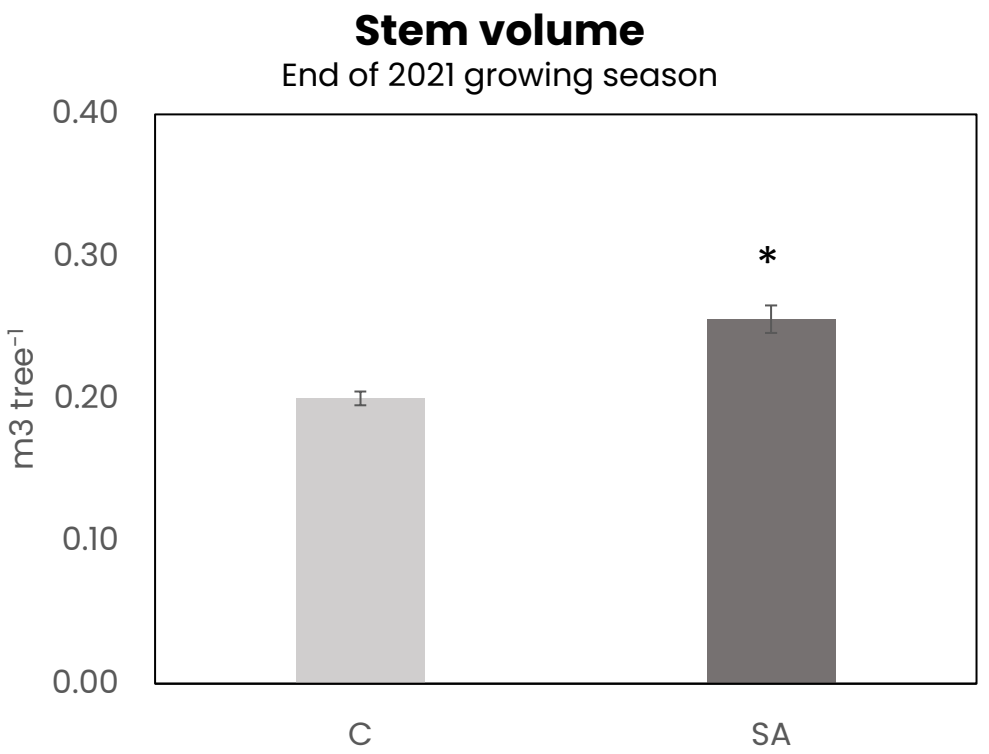
The **DBH of poplars in SA**, except in 2019, **were significantly higher if compared with C** (8.28 cm in Sa vs. 6.51 cm in C and 23.80 cm in SA vs. 20.47 in C at the end of 2018 and 2021 growing season)

The **height of poplars in C were significantly higher than SA at the end of 2021 growing season** (14.3 m in SA vs. 15.4 m in C)

Our results – Poplar



Poplar radial growth in poplar grove (C) and in silvoarable system (SA) in 2021 growing season. Statistic performed by Welch two sample t-test ($p < 0.05$).

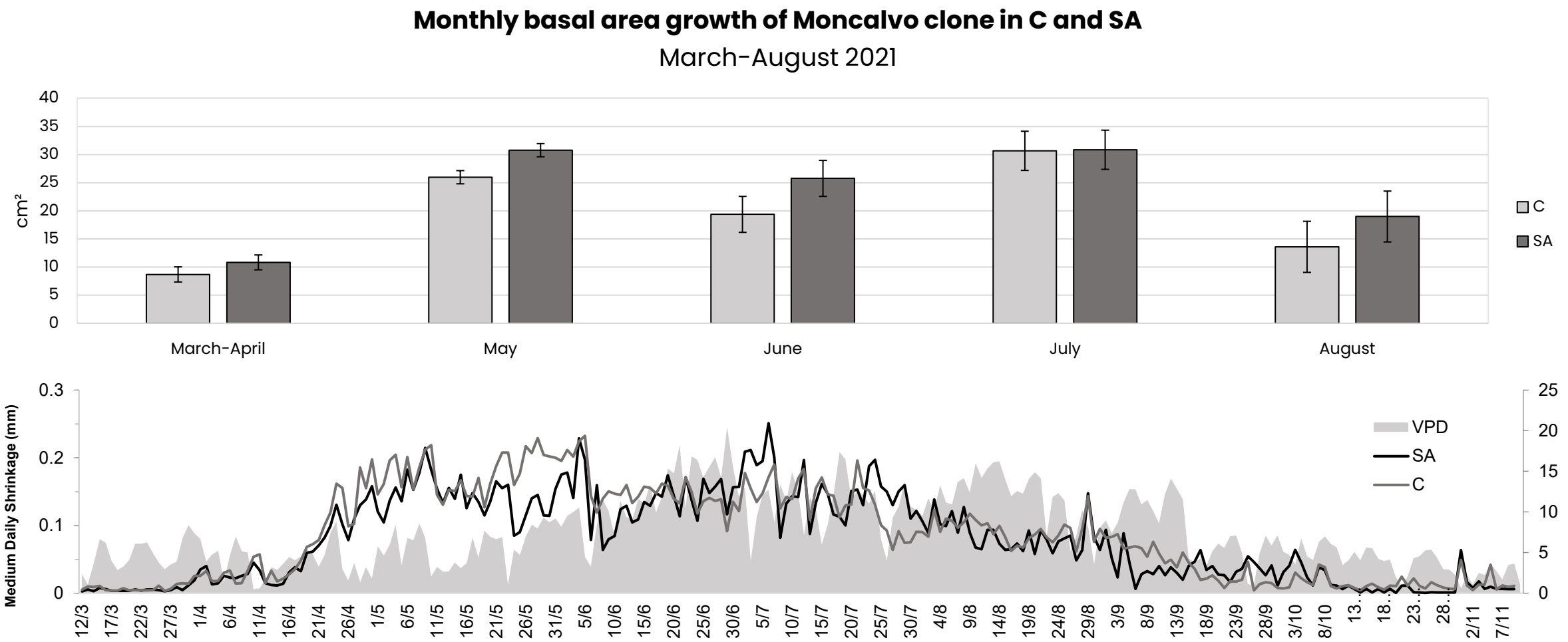


Stem volume per tree in a poplar grove (C) and in silvoarable system (SA) at the end the 4th vegetative growth. Statistic performed by Welch two sample t-test ($p < 0.01$).

At the end of 2021 growing season, 20.45 mm of radial growth were reached in SA treatment, while 18.89 mm in C (**+8.2% in SA**).

Stem volume per tree at the end of 2021 growing season was significantly higher in SA as compared with controls, with 0.20 and 0.26 m^3 $tree^{-1}$ respectively in C and SA ($p \leq 0.05$).

Our results - Poplar

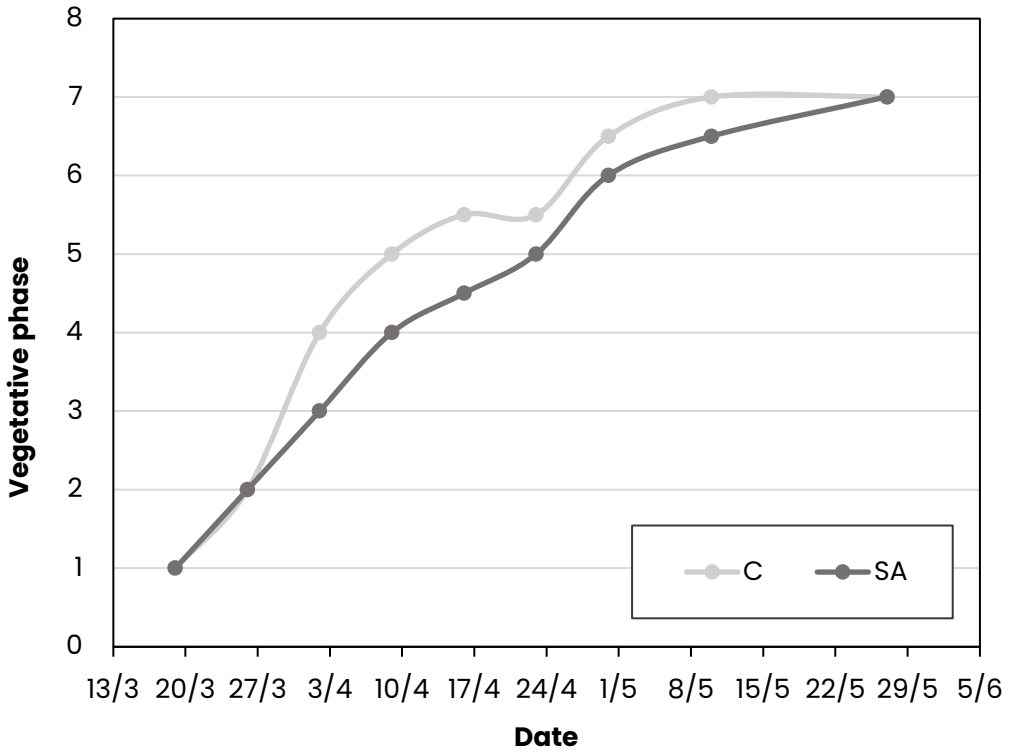


Monthly basal area growth were **higher** and **in SA** if compared with C.

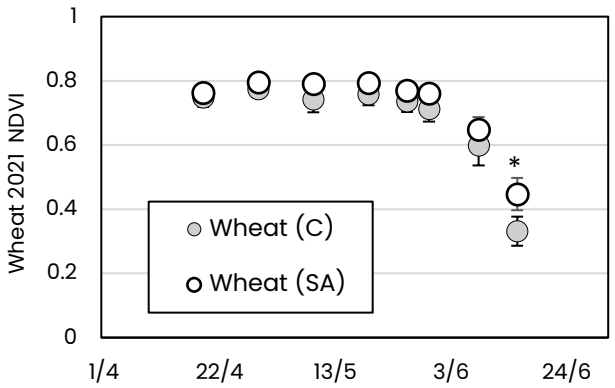
In C it can be noticed that **in June** the **growth was lower** and this could be due to **high VPD values** (to determine).

Our results - Poplar

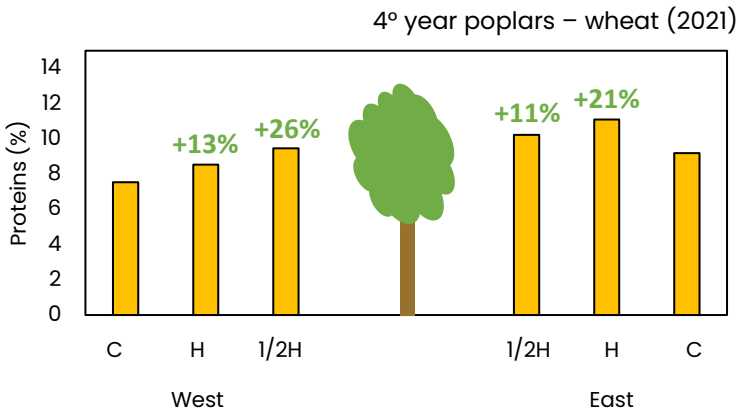
Starting from end of May, a **delay** in the **phenological development** of poplar trees in the **silvoarable system** was noticeable as compared to the trees in the specialized poplar grove, ranging **from less than one week to two weeks**.



Our results – Crops



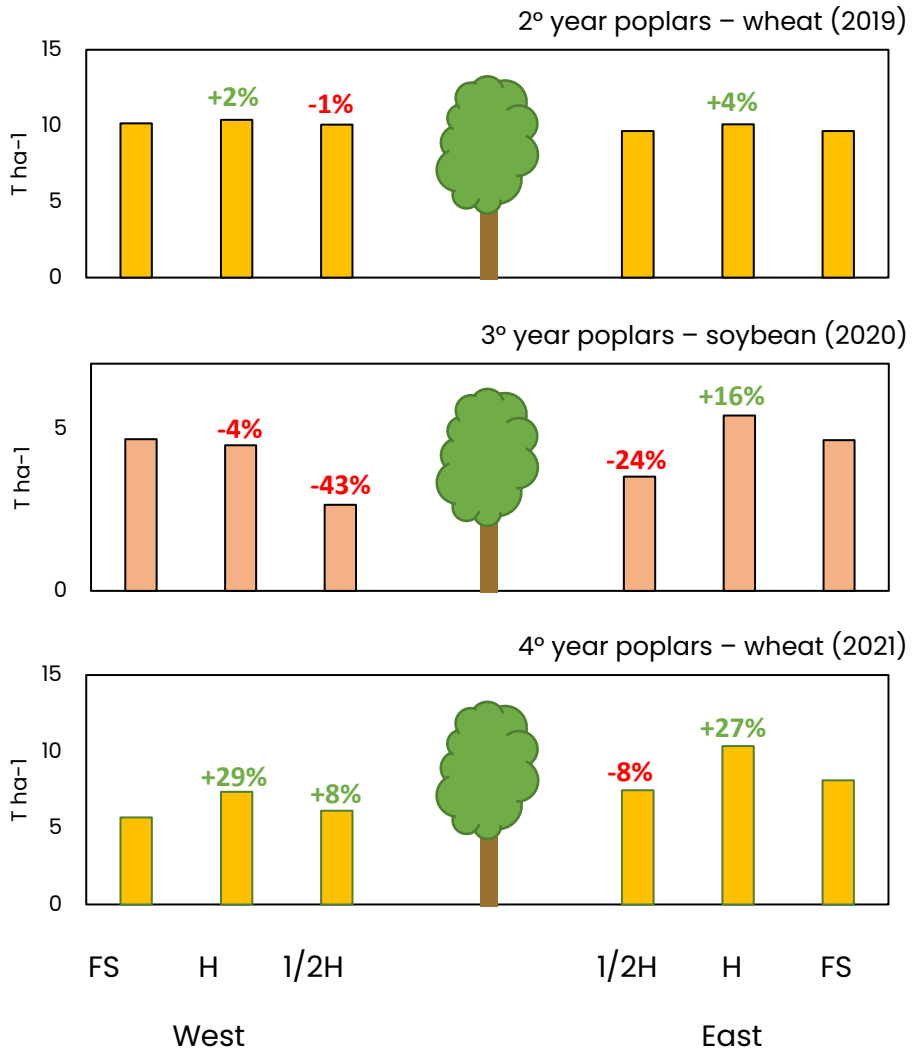
Wheat Vegetational index NDVI in the middle of the field (C) and at 1/2H and H from tree rows (AF) .



Grain protein content of wheat in the middle of the field (C) and at 1/2H and H from tree rows (AF).

Yield of consociated crops were affected by poplar rows and by their **distance** and **side**, especially in soybean. **Wheat yield** in proximity of tree rows were **equal with C values in 2019**, while **in 2021** it was **significantly higher** ($p<0.01$). **Soybean yield** instead, has been very **negatively influenced** by poplar rows proximity.

In 2021, a **longer** maintenance of **leaf greenness** was revealed in the wheat growing in the proximity of poplar rows (**SA**), as compared to full sun conditions (C), with NDVI values being significantly higher in SA during the last stages of the crop cycle. This could explain **higher protein values** observed in wheat grown near poplar rows.



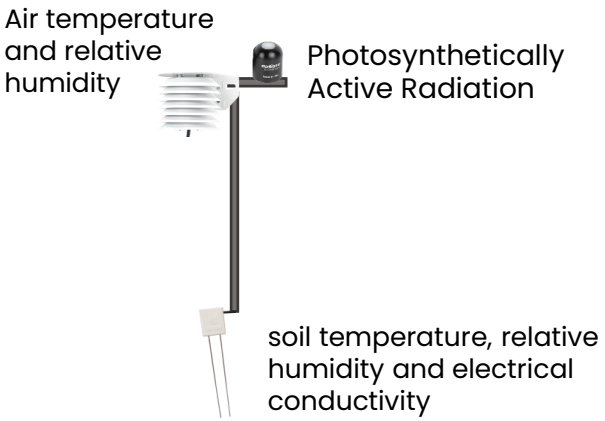
Yield of wheat and soybean grown in the middle of the fields (C) and at different distances from poplar rows (1/2H and H).

New experimental plan 2022 – Poplars

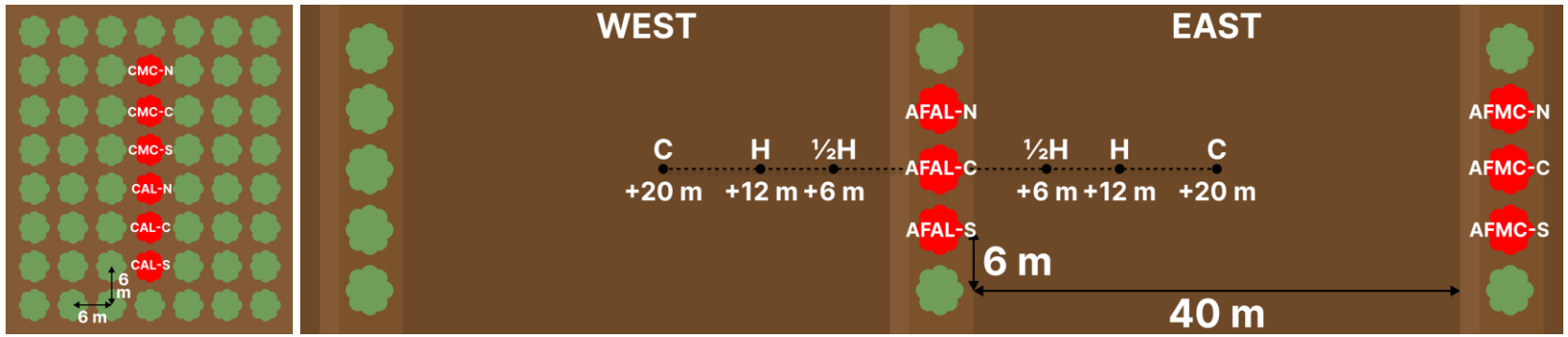
Activities

In 2022 at Sasse Rami Farm we are monitoring **radial growth** and **phenology** of two clones with different time of leaf sprouting (**Aleramo** - very early leaf sprouting time and **Moncalvo** – medium-early leaf sprouting time). We are monitoring three replicas for each clone in two systems: **Alley-cropping system** with 40 m of inter-row (SA) and **Poplar grove** 6 x 6 block design (C). Radial growth is monitored through **dendrometers**, while phenology is monitored through **field surveys**. In poplar grove we are also monitoring **environmental parameters**.

The Obejctives are evaluating **i)** the radial growth of each clone in each system and when the grow starts, reach the maximum daily and ends, **ii)** how phenology change in SA compared with C and **iii)** environmental parameters inside a poplar grove.



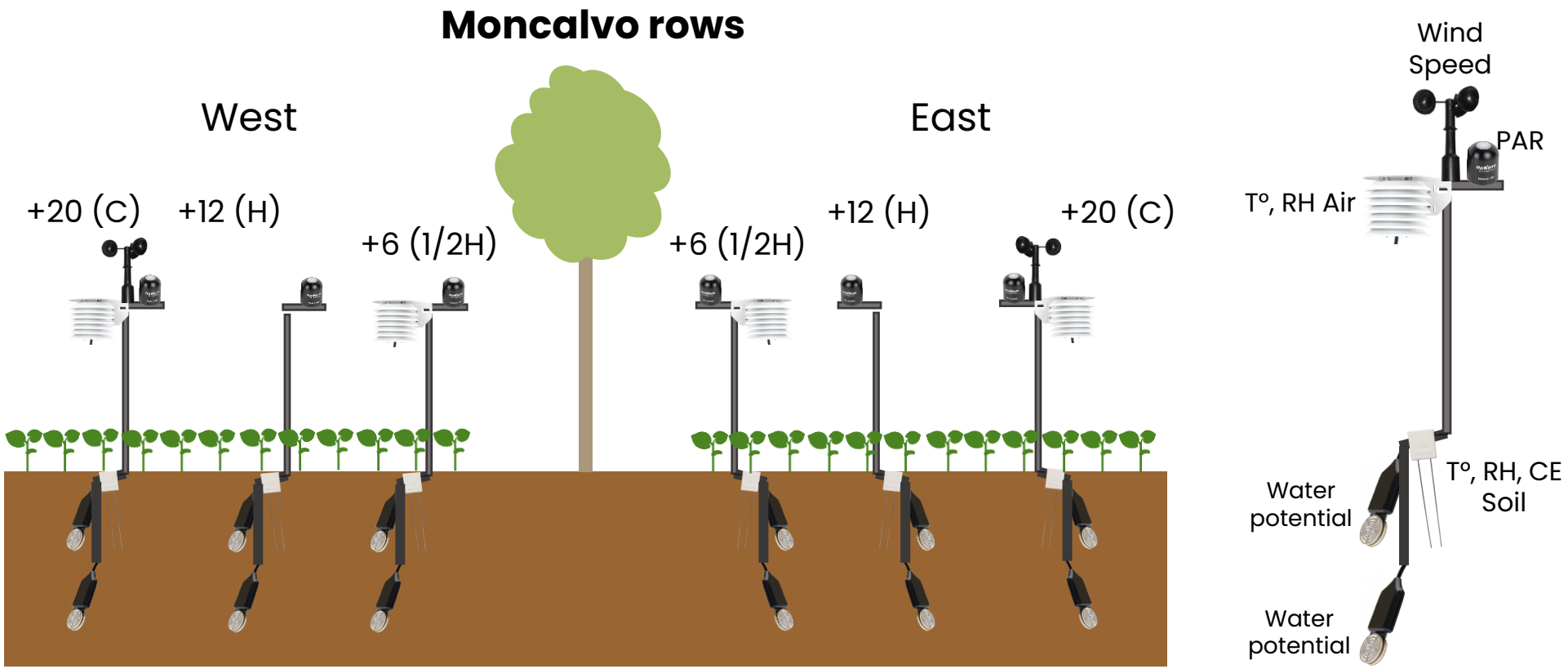
Environmental Sensors located inside poplar grove.



Poplar grove plantation (left) and silvoarable systems (right) with trees with dendrometers applied marked in red.

Experimental plan 2022 – Crops

In 2022 in the silvoarable system poplars are intercropped with soybean and we are monitoring **environmental variables** at **different distances** from Moncalvo **poplar row** (1/2H – 6 m; H – 12 m; C – 20 m), both at **east** and **west** side (water potential, soil T°, RH and C and PAR in each point, air T° and RH in H and C and wind speed only in C). Near the silvoarable system there is also a **weather station**, necessary to assess how trees affect environmental parameters.

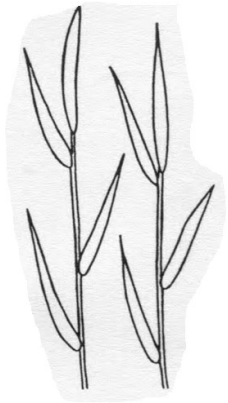


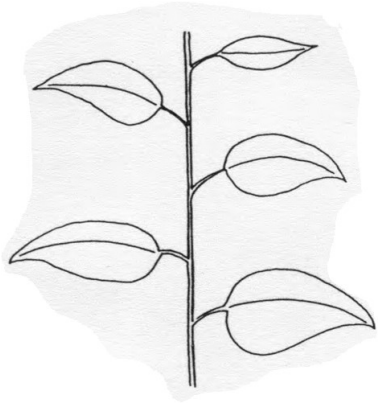
On the left, a graphic illustration of the experiment with different environmental sensors at different distances from poplar row and on the right the weather station in a monocultural system nearby.

Experimental plan for 2023 – Maize

2 maize hybrids with **different leaf orientation angle**

Erect leaves vs. **Planophile leaves**





2 maize hybrids with **different precocity**

FAO 400 vs. **FAO 700**