DEVELOPMENT OF THE HAZELNUT CHAIN IN TUSCANY: THE INTEGRATED PROJECT "LOACKER, HAZELNUTS OF MAREMMA"

Cristofori Valerio[1] , Pagani Edoardo[1], Bevilacqua Francesco[1], Silvestri Cristian[1], Priori Simone[1], Modica Bianca[2], Bellincontro Andrea[2], Mencarelli Fabio[2], Perugini Marco[3], Felix Niedermayr[3], Furlan Maurizio[3]

[1] Tuscia University, Department of Agriculture and Forest Sciences (DAFNE), Via San Camillo de Lellis snc, 01100 Viterbo, Italy.

[2] Tuscia University, Department for Innovation in Biological, Agro-food and Forest Systems (DIBAF), Via San Camillo de Lellis snc, 01100 Viterbo, Italy.

[3] Loacker Tenuta Corte Migliorina S.a.r.l., Via Gasterer 3 - 39054, Auna di Sotto (Bolzano), Italy.

The recent market impulse affecting the nut sector has led to a new expansion of the Italian hazelnut cultivation, involving both traditional and newly introduced hazelnut areas. Among these, the recent hazelnut introduction in Tuscany shows particular interest with its over 800 ha of new hazelnut orchards recorded in 2022. The most promising regional area for developing a new hazelnut district is in the province of Grosseto, where, under the aegis of Loacker company, a new hazelnut sector is being set up, also supported by the Integrated Supply Chain project funded by the Tuscany Region and titled "Loacker, Hazelnuts of Maremma", sub-project "FIL.CO.T.". Two irrigated farms owned by Loacker, for a total of 360 ha, have been planted with hazelnut since 2014 using cv Tonda di Giffoni for around 60% of the plants, cvs Tonda Gentile Romana and Nocchione each for 15% and cvs Camponica and Tonda Francescana® for the remaining 10%. A portion of the plantations is destined for trials, with plots made with comparative planting layouts and plant shapes, and also planting the cvs Tonda di Giffoni, Tonda Gentile Romana, Camponica, Tonda Francescana® and Barcelona grafted on C. colurna seedlings. Moreover, in November 2020 a collection of the main hazelnut cultivars recently released by the hazelnut breeding programme carried out by Oregon State University, has been established. The sub-project FIL.CO.T., structured in work packages, aims to carry out trials to evaluate the adaptability of European hazelnut in the new cultivation area, to optimize the orchard management techniques and hazelnut conditioning and storage.

VARIETAL SUITABILITY

Particularly interesting has been the introduction of the new hazelnut varieties released by the Oregon State University (USA) and planted in a collection field under proper agreement. During the growing seasons phenological and agronomical traits are under investigation to highlight the more suitable cvs to be introduced in the new growing area.

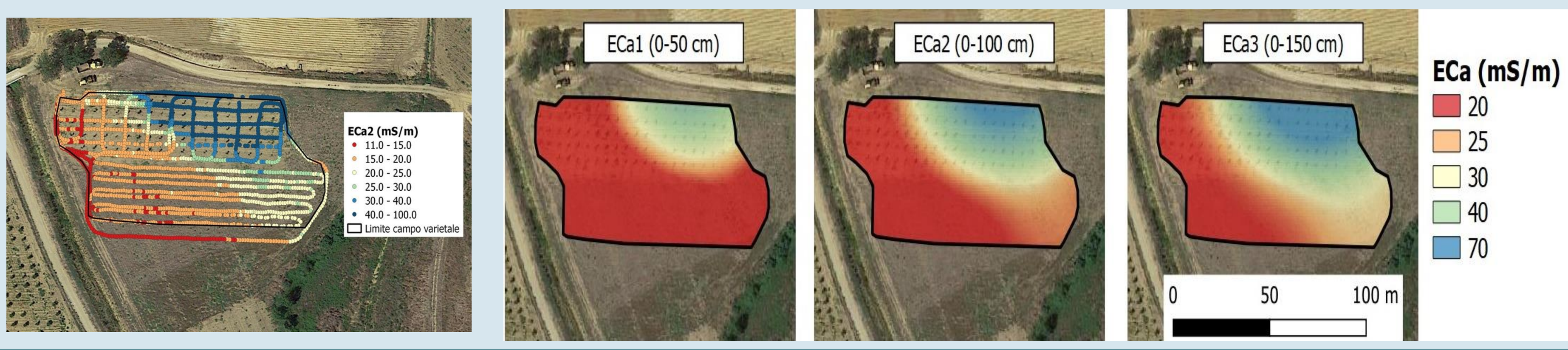
List of OSU hazelnut cvs in the experimental farm. Traits measured in late August 2021 and 2022.

Cultivar	Trunk cross-sectional area (20 cm above the ground) (mm²)		Plant height (cm)	
	2021	2022	2021	2022
Wepster	65.41 ± 8.37	79.31 ± 14.45	82.00 ± 4.35	94.17 ± 13.26
Jefferson	53.60 ± 13.61	83.03 ± 25.09	81.33 ± 4.16	101.23 ± 12.17
Yamhill	44.86 ± 10.87	99.97 ± 31.34	72.00 ± 6.92	101.18 ± 11.78
Tonda Pacifica	40.61 ± 5.32	76.32 ± 18.33	77.66 ± 6.42	98.33 ± 16.27
Dorris	37.54 ± 6.10	75.05 ± 19.67	75.33 ± 6.43	106.34 ± 20.64
Mc Donald	28.39 ± 1.29	66.44 ± 19.29	67.66 ± 5.50	96.25 ± 14.46
York	59.69 ± 21.72	97.15 ± 29.62	78.33 ± 6.50	106.50 ± 12.28
Theta	55.77 ± 3.51	96.41 ± 31.59	85.33 ± 6.02	109.05 ± 19.24
Felix	53.73 ± 1.23	88.22 ± 24.58	80.33 ± 7.23	104.25 ± 14.53
Eta	38.37 ± 9.12	82.41 ± 15.91	82.67 ± 9.86	99.25 ± 16.93

Wepster

Felix

In order to fully understand the agronomic beaviour of the introduced OSU varieties, the soil of collection field has been subjected to an accurate analysis using electromagnetic induction (GF Mini-Explorer) to determine the electrical conductivity (ECa) of soil at three different depths (50, 100, 150 cm). The sensor detected a wide low ECa area mainly due to high sand fraction and a smaller area of high ECa due to a clay-loamy soil, and higher soil moisture in depth. After the data processing and soil clusterization according to its electrical conductivity samples of soils were collected from each cluster to be analysed in lab for soil texture, bulk density, water retention ect.

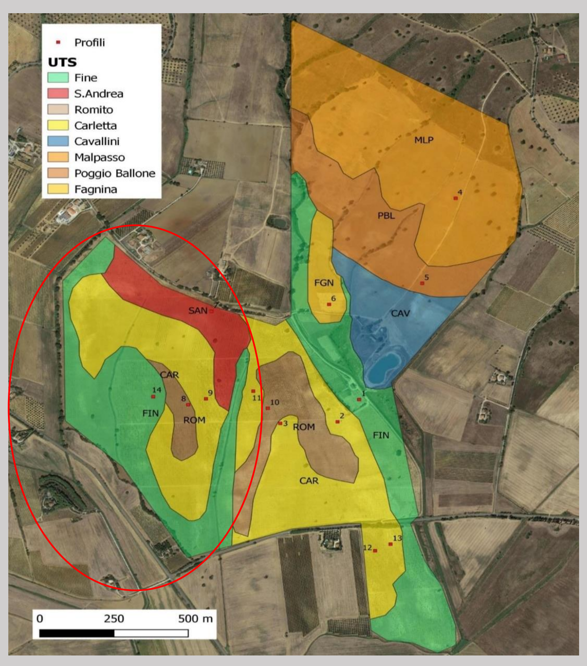


SOIL CHARACTERIZATION AND CLUSTERIZATION

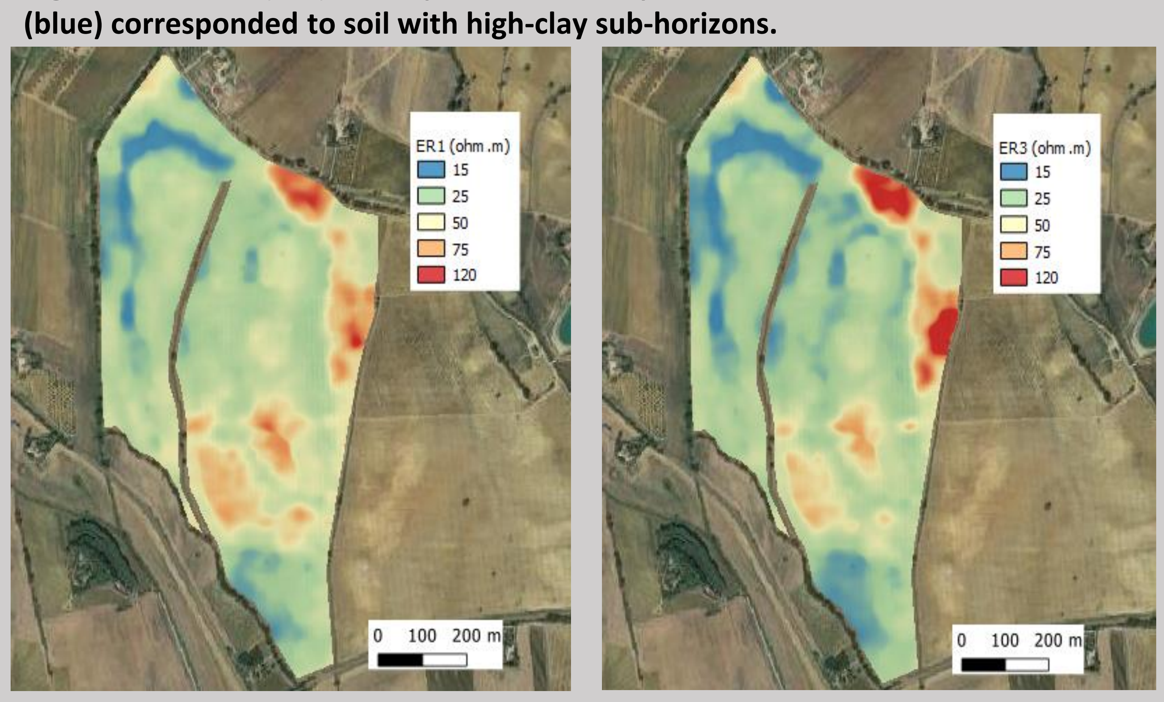
With the aim to develop optimized irrigation and nutrition protocols in the experimental farm, high detail soil mapping and clusterization into homogeneous zones has been carried out. Three growing areas of four hectares each were selected, and the soil profiles were described and analyzed according to the map soil typological units. In the subsurface horizons, undisturbed soil samples were taken for the measurement of bulk density, for the analysis of the stress-volume curve, and for determining the amount of water available to plants that specific kind of soil was able to retain (AWC).

The high-detail mapping soil of the experimental plots (about 50 hectares) was carried out using the GF Mini-Explorer electromagnetic induction sensor, which allows the apparent electrical conductivity (ECa), or the its inverse electrical resistivity (ER) of the soil to be measured at three different depths (approximately 0-50, 0-100 and 0-150 cm). ECa is a parameter related to various soil characteristics such as texture, depth, compaction, stoniness, moisture and salinity. The measurements are continuously geo-referenced via GPS and are recorded in a handheld device.

Map of soil typological units (STUs)



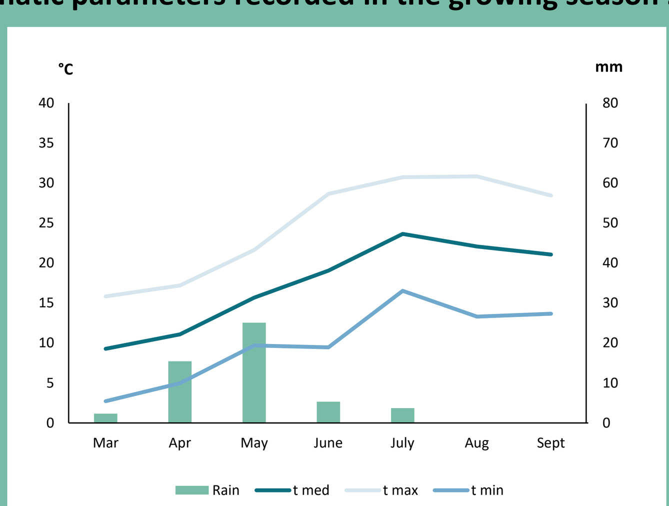
Grid maps obtained by the geostatistical interpolation of ER, in particular the shallowest (0-50 cm) on the left, and the deepest (0-150 cm) on the right. The highest ER areas (red) corresponded to stony soils, whereas the lowest ER areas (blue) corresponded to soil with high-clay sub-horizons.



ORCHARD SUB-IRRIGATION: MONITORING OF WATER DISTRIBUTION

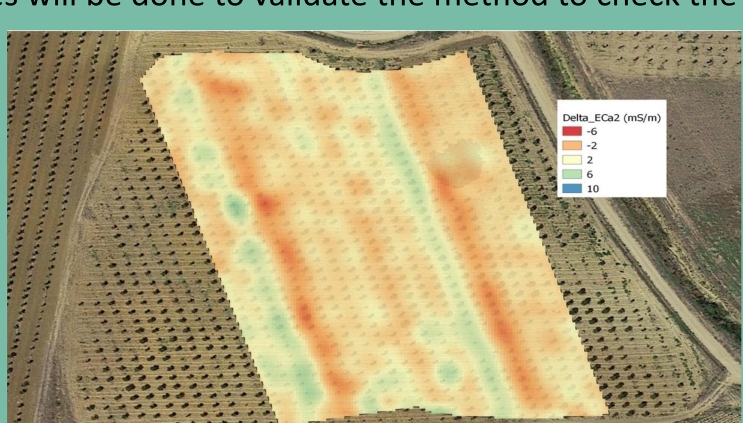
Optimization of water supply is a need in hazelnut orchards characterized by limited water availability and uneven distribution of rainfall. To this end, a trial has been established in early summer 2022 to monitor the efficency in irrigation water distribution trough sub-irrigation system. The protocol provided an initial soil mapping using the EMI sensor described above (GF Mini-Explorer), before the irrigation system was seasonally activated. The same sensor acquisition was then conducted after about 5 hours of irrigation (the first seasonal). Two macro-areas were revealed, where two profile soil profiles emerged. The area 1 was characterized by loamy texture, rich in gravel; the area 2 was a clay texture, poorly draining soil, and with high waterlogging aptitude.

Climatic parameters recorded in the growing season 2022

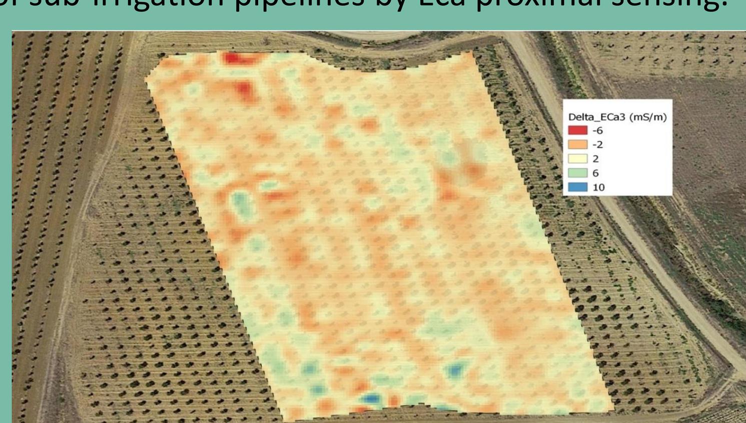


Maps of ΔEca = ECa after irrigation – ECa before irrigation

The variation of ECa after 5 hours or sub-irrigation respect to ECa before irrigation, showed two lines with positive delta (about +6-10 mS/m) for ECa2 (left figure), not confirmed in the shallower ECa1 (0-50 cm) and in the deeper ECa3 (0-150 cm, right figure). The direction of these two lines corresponds to the sub-irrigation pipelines (depth about 40-50 cm). Further studies will be done to validate the method to check the efficiency of sub-irrigation pipelines by Eca proximal sensing.



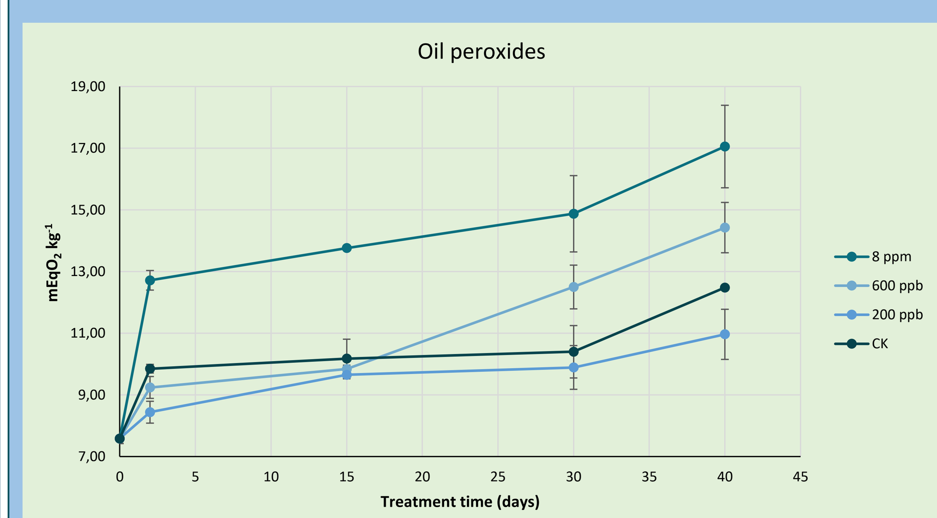
ΔECa2 (0-100 cm)

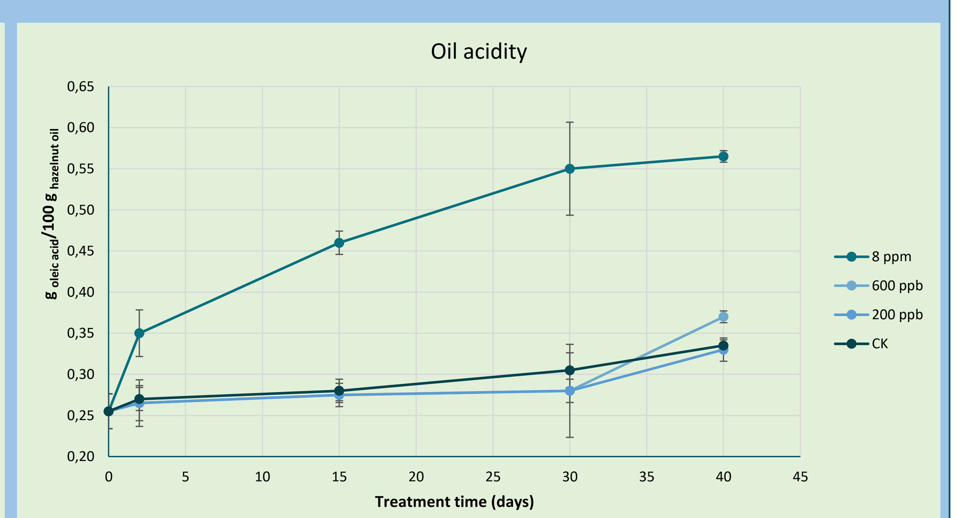


ΔECa3 (0-150 cm)

NIR TECHNOLOGY AND HAZELNUT QUALITY

In this trial, an objective method for quality determination of fresh shelled hazelnuts and their storability have been tested. Ozone application is a technique for food preservation that improves the food safety, not compromising quality and without endangering the environment (Carletti et al., 2013). The ozone effect on pathogens manifests in degrading cell walls, membranes and DNA structure. As a strong oxidising agent, ozone can lead to oxidation of amino acids, proteins and nucleic acids (Brodowska et al., 2017), but a modulated stress is also able to trigger secondary metabolites synthesis. Three hazelnut kernel sample sets were overnight-treated at different ozone concentrations (8ppm, 600ppb, 200ppb), while one was used as untreated control. Every ten days, for five different times, kernels were sampled for destructive and non-destructive analyses.





The highest concentrated ozone treatment has, from the outset and as expected, a much higher amount of peroxides than the other treatments and the control which was evident just after two days. The milder treatments and the control (CK), on the other hand, show no significant differences between them at the initial stages of the storage, with an increase from 30 days onwards. CK and 200 ppb have a very similar trends throughout all the storage and up to 40 days.

During the cold storage, the acidity values of the kernels ozone-treated at 8 ppm were twice as high as in the other treated theses. This evidence can be explained because the high ozone treatment resulted in a higher fatty acid oxidation phenomenon already observed in peroxides results. Absolutely equivalent trends were detected for CK, 200 and 600 ppb treated samples, from 0 up to 40 days of storage.

REFERENCES

- Brodowska A.J., Nowak A. and Śmigielski K. 2018. Ozone in the food industry: Principles of ozone treatment, mechanisms of action, and applications: An overview. Food Science and Nutrition, 58: 2176–2201.
- Carletti L., Botondi R., Moscetti R., Stella E., Monarca D., Cecchini M. and Massantini R. 2013. Use of Ozone in Sanitation and Storage of Fresh Fruits and Vegetables. J. Food Agric. Environ., 11: 585-589.

Conclusions

The work packages developed in the FIL.CO.T. project, both for in field and post-harvest hazelnut chains, will contribute to consolidate the new hazelnut district in southern Tuscany, as new introducing area of the Italian hazelnut cultivation. Particularly interesting is: 1) the introduction in the selected environment of the new hazelnut cultivars released by Oregon State University; 2) the new protocol proposed for monitoring the irrigation water distribution in the orchard trough sub-irrigation; 3) increase the protocols for highly efficiency kernels storage using proper ozone concentrations.

The outputs of the research project will be properly disseminated in the selected district to support farmers wishing to invest in hazelnut cultivation.