Perennial cereal (*Thinopyrum intermedium*) to promote soil carbon sequestration in Mediterranean soils

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INTRODUCTION

Moving toward resilient agricultural systems in the Mediterranean region can be crucial to cope with the effects of climate change. Perennial cereals as Kernza® (*Thinopyrum intermedium*) can increase the long-term capacity of agricultural land to capture and store carbon in the soil through the addition of continuous plant debris and deep root systems. In the frame of TRANSITION project, plant roots biomass, soil properties and carbon changes were evaluated in the Kernza® crop under dryland Mediterranean conditions.

Keywords: *dryland Mediterranean; perennial cereal; soil organic matter*

METHODOLOGY

Location

- **Kernza® crop was established in a commercial farm (0.33 ha) in northeast Catalonia, Spain (41°57'N 2°15'E)**
- **Mediterranean dryland conditions**
- **Average annual precipitation: 661.3 mm**
- **Previous crop: winter wheat**

Fig.1. Kernza® plot location (red colour)

Crop Establishment

- **Kernza® seeds were provided by the Land Institute (USA) in December 2020**
- **Seeds were sown in mid-February 2021 (22 kg ha^{-1})**
- **Crop management was performed according to the Land Institute assessment**
- **Soil and roots analyses were performed yearly at the first and third harvest periods.**

Fig.2. Kernza® plant after two months of sowing

Soil and roots sampling

Sampling	Dates	Depth† (cm)	Points / depth / sampling	Roots depth (cm)
Before sowing	February 2021	00 – 30	6	n.a.
First yield	July 2021	30 – 60	3	00-30
Third yield	July 2023	60 – 90	3	00-30

†Three sampling depths were performed at each sampling date

Samples and data processing

Root samples were gently cleaned, oven dried, and weighted

Soil samples were carried into the laboratory, air-dried, sieved, and analysed for the following:

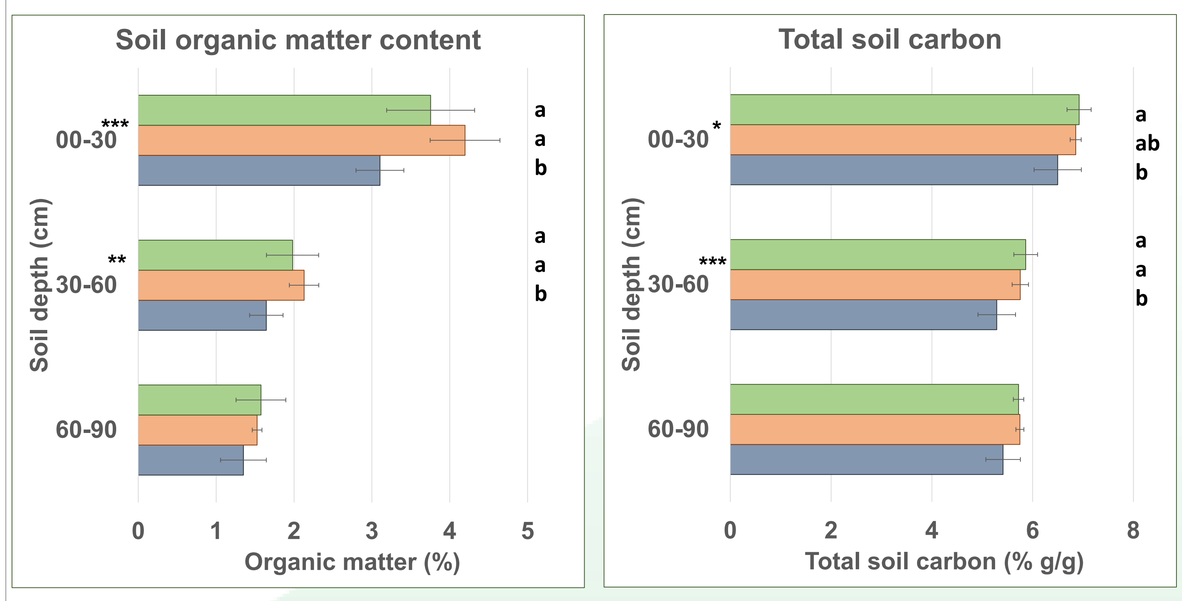
- **pH**
- **Electrical conductivity**
- **Soil organic matter**
- **Total carbon**
- **Total nitrogen**
- **Nitrogen nitrates**
- **Nitrogen ammonia**
- **C:N ratio**

R-studio was used to perform the statistical analyses (normality test, ANOVA, and Tuckey α=0.05)

Fig.3. Kernza® previous harvest (lef) and winter wheat (right)

RESULTS

Soil analysis



Mean values per sampling and depth (bars) and standard deviation (lines).

Letters indicate differences among sampling dates for the same soil depth. Levels of statistical significance appear at: $^{*}P < 0.05$, $^{**}P < 0.01$ and $^{***}P < 0.001$.

Summary table of of soil parameters (average values) at each sampling date and depth: pH, Electrical conductivity (EC), nitrogen nitrates (N-NO_3^-), ammonia nitrogen (N-NH_4^+), total elemental nitrogen (N), and carbon: nitrogen ratio. Standard deviation in crochets.

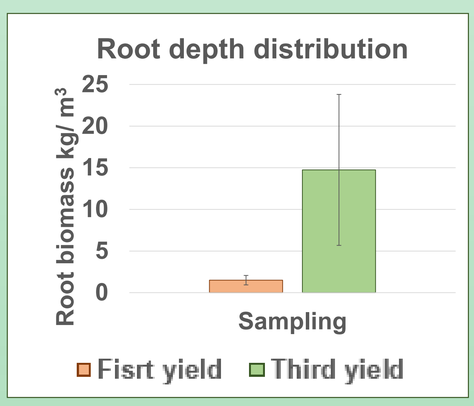
Sampling depth (cm)	Date (YYYY/MM)	pH	EC (µS cm^{-1})	N-NO_3^- (mg kg^{-1})	N-NH_4^+ (mg kg^{-1})	N [% (g g^{-1})]	C:N ratio
00-30	2021/ 02	7.5 [0.8]	139.2 [21.5]	31.9 [03.3]	4.4 [0.9]	0.28 [0.02]	23.6 [2.7]
	2021/ 07	8.2 [0.1]	200.2 [18.5]	21.4 [01.4]	5.4 [2.4]	0.23 [0.03]	30.6 [3.8]
	2023/ 07	8.1 [0.2]	291.4 [13.4]	47.8 [12.2]	4.7 [2.0]	0.22 [0.04]	32.5 [4.9]
30-60	2021/ 02	7.6 [0.7]	136.6 [28.5]	44.4 [17.9]	2.4 [1.0]	0.17 [0.02]	31.9 [2.7]
	2021/ 07	8.3 [0.1]	277.4 [20.2]	67.5 [10.9]	1.7 [1.0]	0.11 [0.00]	50.9 [2.7]
	2023/ 07	8.2 [0.2]	357.6 [206.5]	43.6 [00.4]	1.4 [0.4]	0.13 [0.02]	47.1 [5.8]
60-90	2021/ 02	7.2 [0.9]	147.8 [22.9]	65.9 [14.4]	1.9 [0.9]	0.14 [0.01]	38.6 [4.9]
	2021/ 07	8.3 [0.1]	295.4 [03.2]	77.6 [02.3]	0.9 [0.4]	0.09 [0.02]	64.2 [12.7]
	2023/ 07	8.4 [0.2]	267.1 [72.6]	55.0 [12.3]	0.8 [0.1]	0.09 [0.00]	66.7 [5.4]

RESULTS

Roots biomass

The graph indicates the root biomass per cubic meter of soil at the first and the third sampling year of establishment.

After three years of growth, average root biomass increased up to 7 times, compared with the first year of establishment, despite the variability.



CONCLUSIONS

- **Perennial cereal increased significantly the Soil Organic Matter and Soil Carbon in the dept of 0-30 and 30-60 cm depth.**
- **At 60-90 cm depth, there were no significant differences probably because of the lack of root influence.**
- **The increase in root biomass would be related to the increase of soil organic matter and soil carbon.**
- **Kernza® can increase soil carbon up to 60 cm depth three years after its establishment.**

REFERENCES

- **Climatic data: https://www.meteo.cat/wpweb/climatologia/el-clima/climatologia-xema/**
- **https://landinstitute.org/**

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To Land Institute for providing the Kernza® seeds

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