4CE MED

Camelina:
a Cash Cover Crop Enhancing
water and soil conservation
in MEDiterranean
dry-farming systems

D 2.4 Preliminary quantification of the environmental performance of the 4CE-MED systems

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Abstract

One of the scopes of WP2 is to quantify the environmental benefits related to the adoption of the 4CE-MED systems. D2.4 aims at first reporting the environmental indicators, agreed among 4CE-MED partners, as the ones suitable for evaluating the new cropping systems. In particular, taking into account the climatic specificities of the participating countries, as well the impact of climate change on the Mediterranean region and the smallholders' needs to reduce the environmental footprint, as well as the cost, of their production a set of "easy to survey" environmental indicators had been chosen. In this preliminary report, derived from the first year of trials in the seven 4CE-MED countries, those environmental indicators are presented and discussed aiming at the basis for the further activities of assessment in WP4 as well as for D2.5 "Final report on environmental benefits related to adoption of 4CE-MED systems" which is due in M42.

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1 Quantification of the environmental performance of the 4CE-MED systems

1.1 Choice of the environmental indicators suitable for the 4CE-MED systems

The choice of the environmental indicators to be analysed in the 4CE-MED systems has been agreed among partners during the 2nd technical meeting, which was held online on September 30, 2020.
The main objective of task 2.4 is to identify some indicators, easy to evaluate/calculate, which each partner could then adopt locally to evaluate camelina as a cash cover crop when compared with typical winter cereals. The indicators should be able to quantify the environmental benefits related to the adoption of the 4CE-MED systems in each country. In particular, they will focus on the following parameters:

- the nutrient use efficiency in camelina, and in the succeeding/preceding crop (where possible);
- the precipitation use efficiency,
- soil coverage,
- and weed, pest and disease pressure

The selected environmental indicators would be presented and discussed in the coming months during the consultation of the Local Multi Stakeholder platforms in order to get feedback from participants on them, for a possible future improvement.

For this first year the evaluation of the environmental performance of the 4CE-MED has been carried out also on the trials established by each partner within Task 2.2.

The selected environmental indicators are the following:

1.1.1 Nutrient use efficiency - Change in Nitrogen fertilizer usage in farming system

Defined by the following equation:

$$N_{reduction} = \frac{\left(\frac{Total\ N\ fertilizer\ applied\ (kg)_{t_0}}{Total\ Area\ of\ application\ (ha)_{t_0}} - \frac{Total\ N\ fertilizer\ applied\ (kg)_{t_{-1}}}{Total\ Area\ of\ application\ (ha)_{t_{-1}}}\right)}{100}$$

Total amount of N fertilizer used in past crop seasons (kg for each year), Total amount of N fertilizer used in this crop season (kg per year).

The inclusion of camelina as a cash cover crop will permit the reduction of the external nitrogen input, thus reducing the environmental footprint of the cropping system, as well as reducing management costs for farmers.

1.1.2 Precipitation use efficiency on total biomass

Precipitation use efficiency (PUE) is the ratio of above-ground biomass (kg DM/ha) at harvest to cumulative precipitation (CAP), from sowing to harvest, and defined by the following equation:

$$\boldsymbol{PUE} = \frac{\boldsymbol{Aboveground\ biomass(AGB)}}{\boldsymbol{Cumulative\ precipitation\ (CAP)}}$$

1.1.3 Precipitation use efficiency on seed yield

Precipitation use efficiency (PUE) is the ratio of seed yield (Kg DM/ha) to cumulative precipitation (CAP), from sowing to harvest, and defined by the following equation:

$$\boldsymbol{PUE} = \frac{\boldsymbol{Seed\ yield\ (SY)}}{\boldsymbol{Cumulative\ precipitation\ (CAP)}}$$

1.1.4 Precipitation efficiency

Precipitation efficiency (PE) is the ratio of the cumulative precipitation (CAP) or the number of rainy days to the number of days with the soil covered (d) from camelina, from emergence to harvest:

$$\boldsymbol{PE1} = \frac{\boldsymbol{Cumulative\ precipitation\ (CP)}}{\boldsymbol{number\ of\ day\ from\ emergence\ to\ harvest\ (d)}}$$

$$\boldsymbol{PE\,2} = \frac{\boldsymbol{number\ of\ rainy\ days\ (d)}}{\boldsymbol{number\ of\ days\ from\ emergence\ to\ harvest\ (d)}}$$

The three above-reported indicators were chosen as the most appropriate to evaluate the resilience of camelina against drought. Besides being widely recognized as an oilseed crop requiring low water input, the precise evaluation of its ability to use available precipitation is fundamental for its future diffusion across the Mediterranean basin, where there is a clear tendency of precipitation reduction in the long term, which will be also more and more unevenly distributed. So, the precise understanding on how not only the total amount but also precipitation distribution will affect camelina will represent an outcome of the 4CE-MED project.

1.1.5 Soil coverage

The capability of camelina to quickly cover the soil to prevent erosion in one of the main features 4CE-MED partners decided to evaluate, since it has a direct impact on the benefits related to camelina cultivation in the whole Mediterranean agro-ecosystem. To survey soil coverage in time the CANOPEO app (https://canopeoapp.com/#/login) was agreed to be adopted by the 4CE-MED partners. This app can be installed in any type of mobile phone and by taking photos with the phone camera it is possible to quantify the soil covered by plant vegetation as a percentage (%). In order to monitor the development of camelina in the different countries the key moments have been defined as the most important for its development to survey. So, CANOPEO measurements were taken by each partner at emergence (2-3 true leaves), rosette and stem elongation phases. At the same moment of the CANOPEO measurement also the total above ground biomass of a small area (<0.5 m^2) of each plot should be sampled in order to possible calibrate CANOPEO not only to provide soil coverage as a % but also as biomass produced in Kg DM/ha.

1.1.6 Weed presence

Weed presence is highly important in particular when adopting Conservation Agriculture systems. This indicator was monitored by surveying the plots at the same three developmental stages as the CANOPEO measurements. In particular the survey will focus on the number of camelina plants, the number of weeds, and the types of weeds (dicot and monocot).

1.1.7 Pest and disease presence/pressure

Being camelina a completely new crop in some 4CE-MED environments (i.e., Morocco, Algeria and Tunisia), this evaluation was defined as important to understand how camelina adapts to special conditions. In some cases the fact that camelina could be tolerant, or non-host of specific plant pathogens will represent an important added value for the inclusion of this oilseed crop in the Mediterranean rotations. This indicator will be assessed by visual inspection of the plot by each partner, aiming at identify if in specific environmental conditions camelina is susceptible to any pests and diseases, and in case also host of wild pollinators, so possibly contributing to increase local biodiversity.

2 Preliminary results for the selected environmental indicators

Since first growing season of trials within Task 2.2 is still on-going (i.e., France) or not available yet (i.e., Greece), the available results are limited to only some growing locations, and the full evaluation of the environmental footprint of camelina will be provided in deliverable 2.5 at M42. The presented data were collected in the following locations/countries.

Italy: Location 1) Bologna; Location 2) Ozzano dell'Emilia

Morocco: Location 1) Sidi El Aidi; Location 2) Marchouch

Algeria: Location 1) Setif

Tunisia: Location 1) Kef

Spain: Location 1) Alcalá Henares; Location 2) Ciudad Real

It is worth noting that the presented environmental indicators are related only to one growing season, so it is impossible to draw any conclusion by now.

2.1 Nutrient use efficiency - Change in Nitrogen fertilizer usage in farming system

The impact of the inclusion of camelina in the existing cropping systems was in general related to a decrease in the usage of N fertilizer. At all locations camelina succeeded to typical winter cereals, either durum or bread wheat or barley. The highest reduction (~ -90%) was surveyed in Italy location 1 followed by Morocco location 1. In all the other locations/countries the reduction on fertilizer usage was about 10%, with a couple of experimental sites, namely Italy location 2 and Spain location 1, where camelina resulted in a 10% higher fertilization usage than the preceding cereal.

2.2 Precipitation use efficiency on total biomass and seed yield

Data for precipitation use efficiency are reported in figures 1 for both total biomass (blue histograms) and seed yield (orange histograms).

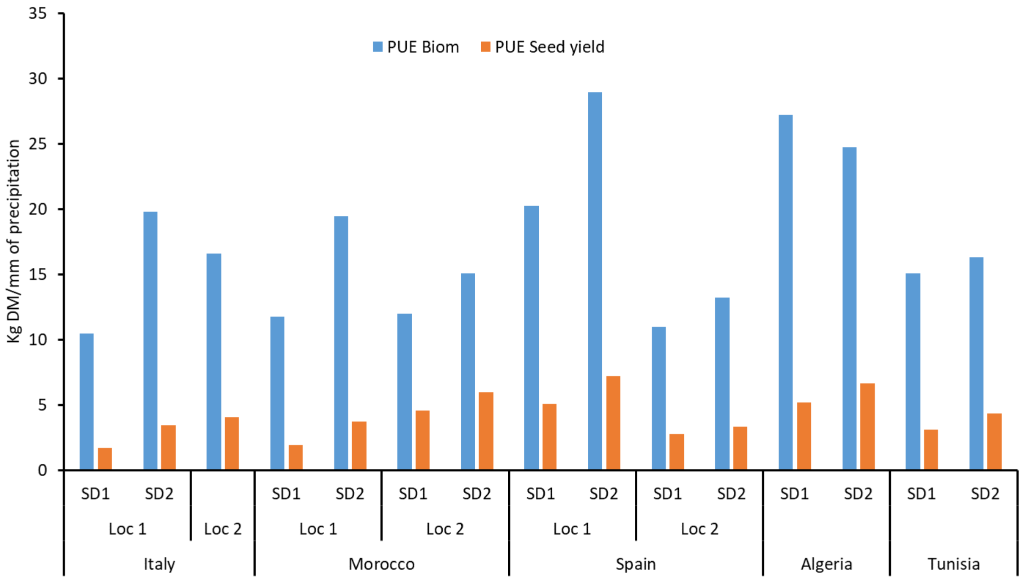

Figure 1. Precipitation use efficiency (PUE: Kg DM/ mm precipitation) for the 4CE-MED countries/locations in the two sowing dates (SD) tested. Blue histograms refer to PUE for total above-ground biomass, while orange histograms refer to PUE for seed yield.

PUE for total above-ground biomass (Fig. 1) was on average 17.45 kg DM/mm of precipitation, and the highest value was surveyed in Spain at location 1 in the later sowing date (SD2), and the lowest was in Italy at location 1 in the earlier sowing date (SD1). When two sowing dates were compared the later one (SD2) achieved a 25% higher PUE for biomass production.

Concerning PUE for seed yield (Fig. 1) a similar trend was highlighted with a mean value of 4.2 kg DM/mm of precipitation, confirming the good capability of camelina to use available precipitation. The highest value was surveyed in Spain at location 1 in the later sowing date (SD2), and the lowest was in Italy at location 1 in the earlier sowing date (SD1). When two sowing dates were compared the later one (SD2) achieved a 40% higher PUE for seed yield.

2.3 Precipitation efficiency

Precipitation efficiency, either PE1 and PE2, as defined by the equations in the previous section, is presented in figure 2.

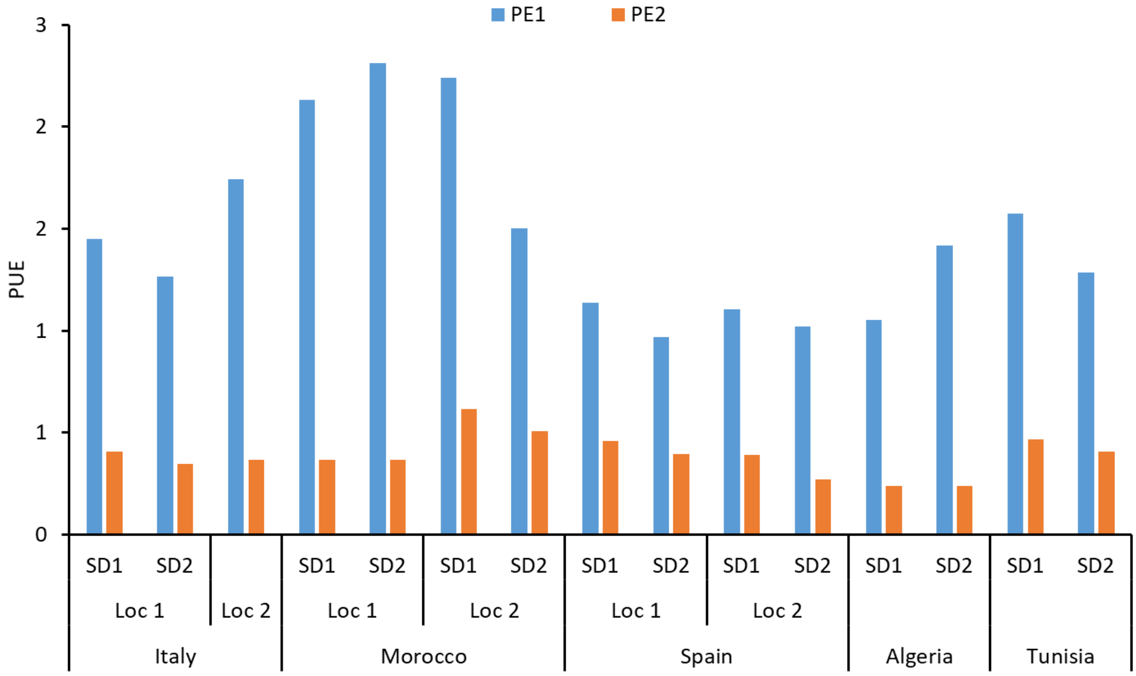

Figure 2. Precipitation efficiency, either PE1 and PE2, for the 4CE-MED countries/locations in the two sowing dates (SD) tested.

The surveyed mean value of PE1, which represents the ratio between the cumulative precipitation and the number of days from emergence to harvest, was 1.48 mm of precipitation/d. The highest value, corresponding to the wettest site, was in Location 1 in Morocco in the later sowing date (SD2), while the lowest value, corresponding to the drier site, was in Location 1 in Spain in the later sowing date (SD2). On average the earlier sowing (SD1) corresponded to a 6% higher availability of precipitation for camelina growing cycle compared with the later sowing (SD2).

The surveyed mean value of PE2, which represents the ration between the number of rainy days and number of days from emergence to harvest, was 0.39. This means that 39% of camelina growing cycle occurred during rainy days. The highest value was surveyed in Location 2 in Morocco in the earlier sowing date (SD1), while the lowest value was in Algeria in the later sowing date (SD2). On average the earlier sowing (SD1) corresponded to a 16% higher occurrence of rainy days during camelina growing cycle compared with the later sowing (SD2).

2.4 Soil coverage

Soil coverage was surveyed by means of the CANOPEO app, the available results are presented in Fig. 3.

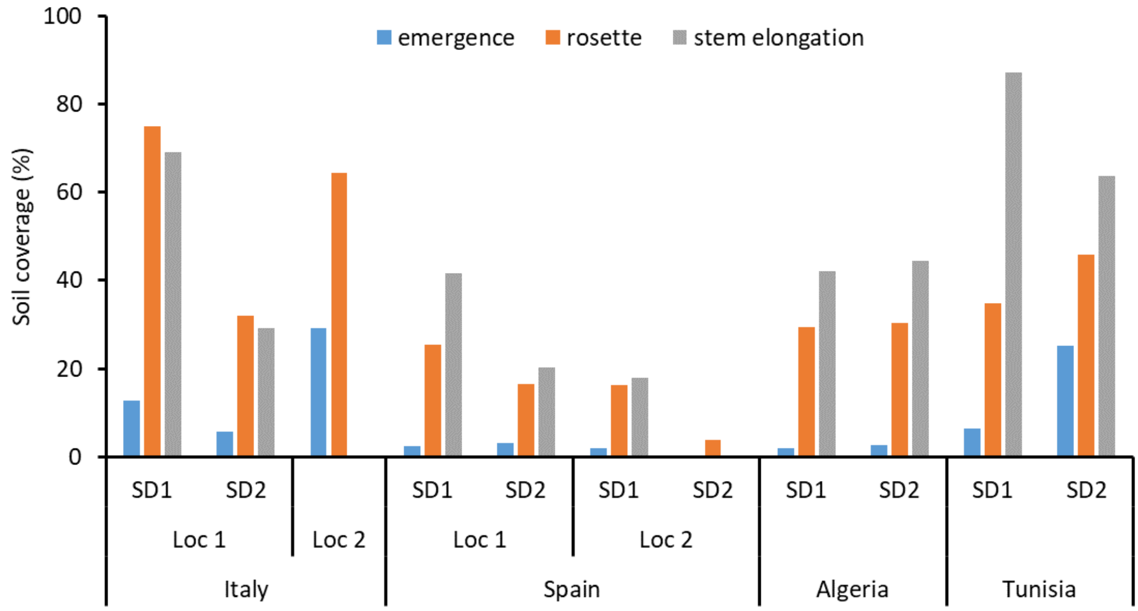

Figure 3. Soil coverage surveyed by means of the CANOPEO app at three developmental stages of camelina (emergence, rosette and stem elongation) in the 4CE-MED trials.

Surveyed data were consistent across countries/locations, only in Italy in the earlier sowing date (SD1) soil coverage reached values about 60% already at stem elongation stage, while at all the other locations this value was about half of it (~30%).

2.5 Weed, pest and disease pressure

While weed pressure was quite seriously affecting camelina development in some countries (i.e., Spain, Italy, Tunisia, and Algeria), the presence of pests and diseases was fortunately quite limited, in particular downy mildew (*Penospora* spp.) was surveyed in Italy and Spain, and it was higher in the later sowing date (SD2) in both countries. Another interesting finding was the survey of *Cuscuta* spp. In Morocco, confirming that camelina could act as a host for such parasitic weed.

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