



Deliverable title	D4.4 Recommendations and guidelines on sustainable production of new organic sea fennel crops in the Mediterranean basin
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Author(s)	Dr Branimir Urlic
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Summary of Deliverable D4.4 – Guidelines for Sustainable Sea Fennel Cultivation	Deliverable D4.4 brings together the consortium's field experience and scientific evidence into a practical guide for organic sea fennel cultivation under Mediterranean conditions. These recommendations provide farmers with clear steps to grow sea fennel successfully while respecting the principles of sustainability and the EU's zero-pollution goals. The guidelines cover the entire cultivation cycle. Soil preparation requires only shallow ploughing (about 30 cm), as sea fennel's strong root system thrives in well-drained, light-textured soils. Raised beds and mulching are advised in heavier soils to improve aeration, reduce evaporation, and control weeds. Fertilization should rely on organic inputs—composts or manures—at moderate levels (40–60 kg/ha nitrogen, 30–40 kg/ha phosphorus and potassium), enough to sustain growth without overloading soils. For seedling production, seeds should be sown in January–February in warm greenhouses, transplanted in April when plants have 2–4 true leaves. This timing avoids summer heat stress, particularly in southern regions such as Tunisia and Türkiye. Spacing recommendations vary from the standard 45 × 45 cm layout to denser configurations when mulching is used, offering flexibility depending on site conditions. Weed management is best achieved through mulching, which minimizes the need for manual or mechanical removal, while irrigation should be limited to around 100 mm during critical summer months (June–July) to balance yield with the preservation of aromatic compounds. A second

	irrigation after the first harvest encourages regrowth and enables a second cut later in the season. Harvesting at peak biomass, with immediate cooling and storage at +4°C, ensures that nutritional and bioactive qualities are preserved. The guidelines conclude with a flow chart summarizing the key steps—from soil preparation to harvest—making the process clear and practical for farmers.
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Versioning and Contribution History

Version	Date	Modified by	Modification reason
v1.0	20/04/2024	Branimir Urlić	First version
v2.0	30/04/2024	Branimir Urlić	Comments after peer reviewing process

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1.Recommendations and guidelines on sustainable production of new organic sea fennel crops in the Mediterranean basin

The recommendations and guidelines on production of sea fennel in organic farm in the Mediterranean basin are:

Soil preparation and fertilization

Given the vigorous root system of sea fennel, extensive soil preparation is not necessary. Instead, a shallow ploughing to a depth of around 30 cm is sufficient to loosen the soil adequately for transplanting. This limited soil disturbance not only facilitates proper seedling establishment but also supports in water conservation, which is crucial for sustainable production. Following the ploughing, thorough soil bed formation using a cultivator is recommended to create an optimal seedbed that minimizes transplant shock and supports early root development.

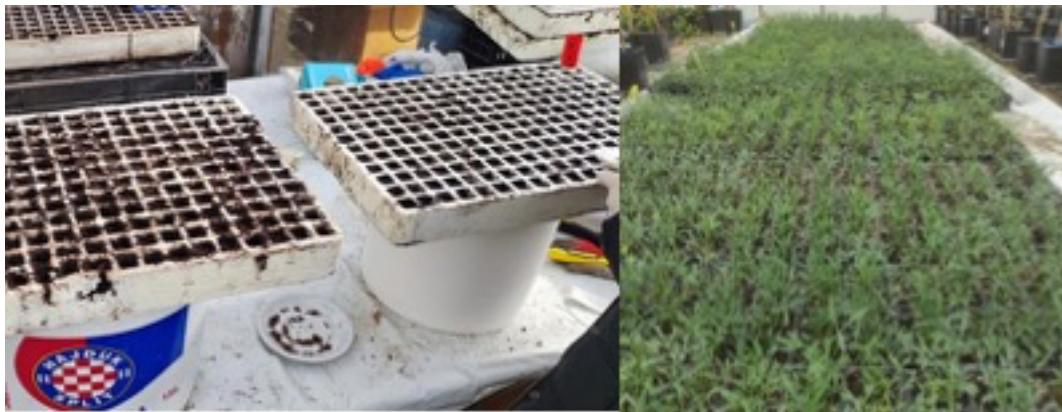
Taking into account some cultivation experiences it can be recommended to plant seafennel seedlings in light textured soils, loamy to sandy soils. Cultivation in clayey soil can result in easier plant degradation over the winter, especially when weed pressure is high what can result in constant humid conditions around the plants. One of the possible solution for heavy textured soils and to increase air movement around plants is to make raised beds with usage of mulch materials to protect and limit evaporation from the surface soil layers and to suppress weed growth.

Studies based on organic agriculture rules showed that use of biostimulants or organic fertilizers (composts or manure) had positive effect on biomass production, both roots and shoots and other physiological indicators (as relative chlorophyll level). Taking that into account, a variety of organic fertilizer options are available. Organic manures, in particular, serve as an excellent alternative to mineral fertilizers as seems that seafennel do not need high amounts of nutrients. Based on field trials and current agronomic practices, it is recommended to apply 40–60 kg/ha of nitrogen, 30-40 kg/ha phosphorus and potassium to meet the nutritional requirements of sea fennel. This rate is sufficient to promote vigorous growth without risking nutrient leaching, soil degradation or decreasing seafennel quality. The combination of minimal soil disturbance

with targeted organic fertilization not only enhances crop performance but also contributes to the long-term sustainability and health of the soil, ensuring that water is conserved and the ecosystem is maintained.

Seedling production and transplanting

For optimal seedling production, it is advisable to sow sea fennel seeds in January or February in low volume containers filled with some kind of commercial peat-based substrate. Containers should be kept in greenhouses or growth chambers in warm conditions (more than 20°C) until emergence and few weeks after it should be transplanted in bigger containers/PE trays (volume of 120-150 ml). During seedling production few application of fertilizers is needed, best results showed addition of manure tea (1% water solution). Mentioned timing of sowing allows seedlings to reach an optimal growth stage by April, which has been identified as the best period for transplanting into the field. Transplanting at this time ensures that the young plants are vigorous enough to establish well in the field environment, while still avoiding the high temperature ranges that occur later in the season. Sowing after April (to seedbeds) is considered risky because the region (especially southern as Turkey or Tunisia) experiences significantly higher temperatures during that period, a risk that is further compounded by ongoing climate change. In cases where sowing is delayed, it is crucial to initiate irrigation early to mitigate the adverse effects of heat stress on the seedlings.



Seedling production and transplanting

Transplanting and field establishment

Timely transplantation is critical to ensuring vigorous plant development and successful establishment in the field. Seedlings should ideally be transplanted once they have developed 2-4 true leaves, as research has identified this developmental stage as optimal for minimizing transplant shock and promoting rapid root establishment. The first recommended field layout involves spacing between rows 45 cm apart and also within each row, yielding approximately 4.8 plants/m². This configuration can be changed depending on weed control or mulch use. When mechanical weed control is used bigger between row distance should be used while in-row distance can be decreased in a way to optimize resource use, such as water and nutrients.

Also, adjustments to different distances may be acceptable based on seed or seedling availability and specific site conditions. In cases where land is covered with different mulches to enhance weed suppression, reduced spacing may be beneficial. Field trials suggest that spacing of 35-40 cm between rows combined with 15-20 cm within rows can offer advantages in terms of better ground cover and improved weed control, especially after the initial establishment period.

These alternative spacings should be tested under local conditions to determine their efficacy in balancing crop competition with resource optimization and weed management.

In summary, while the conventional layout provides a reliable framework for sea fennel establishment, growers are encouraged to consider adaptive spacing strategies that reflect local seedling vigor, weed pressure, and overall management objectives, thereby ensuring the most effective establishment and sustained productivity of the crop.



Irrigation

Crithmum maritimum is a plant that tolerates drought well and does not require much water. However, it is important to provide emergency irrigation to maintain plant growth in prolonged drought periods

Sea fennel is inherently a halophyte, well adapted to saline and water-limited environments, which enables it to succeed in naturally harsh conditions. However, in most or all locations around Mediterranean, supplemental irrigation is necessary to optimize growth and yield, as natural precipitation will not be sufficient in most summer months. It is important to strike a balance, as excessive irrigation can reduce the concentration of aromatic compounds that are key to the plant's value.

Based on field observations and agronomic trials, a total of 100 mm of supplemental irrigation, applied in few equal doses of during the critical growth months of June and July, is recommended to support optimal yield without compromising the

plant's aromatic quality. This irrigation schedule ensures that sea fennel receives adequate moisture during its peak growth phase, while minimizing the risk of over-irrigation, which could otherwise inhibit the synthesis of essential aromatic and bioactive compounds. By carefully managing water input in this manner, growers can achieve a sustainable balance between maximizing biomass production and maintaining the desirable qualitative attributes of the crop.

Additional irrigation should be applied after first harvest and removal of most shoot parts to promote new growth for second harvest in August or September.

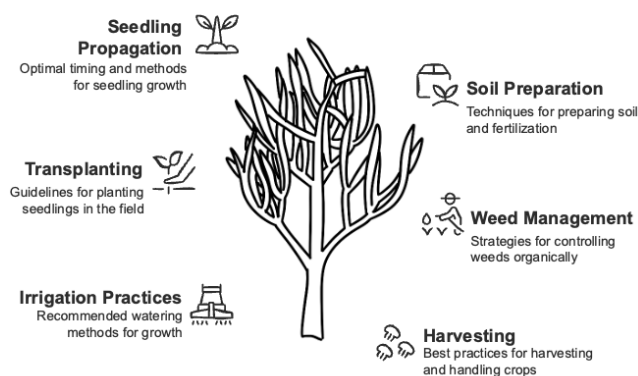
Harvesting

Harvesting should be conducted at peak biomass to maximize both yield and quality of the edible and refuse portions. Immediate post-harvest handling is crucial; harvested materials should be cooled promptly (stored at +4°C) to preserve nutritional and bioactive compounds. These practices are essential to ensure that the quality of the raw material is maintained for further processing or value-added applications.

Additional harvest could be done in August or September if removal of most above-ground parts were done after first harvest what can be used as tool for increasing efficiency of sea fennel cultivation.

In summary, the above recommendations integrate experimental findings and best agronomic practices to provide a comprehensive framework for the sustainable production of organic sea fennel crops.

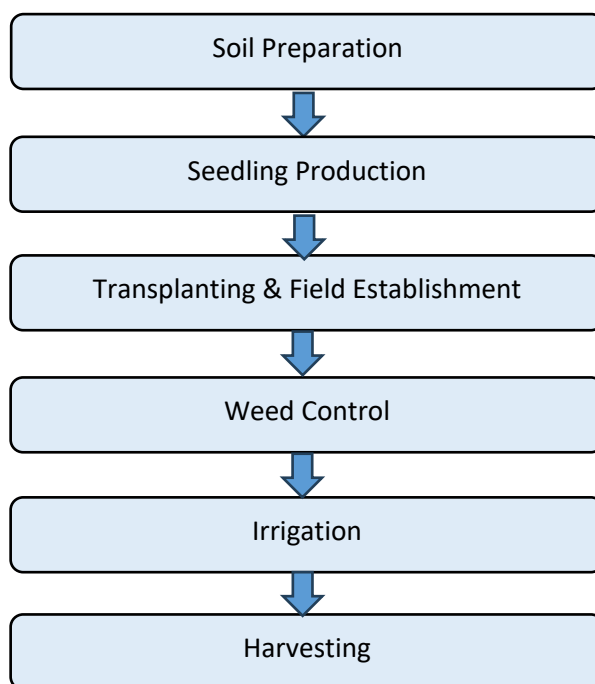
Sustainable Sea Fennel Production Overview



Sustainable sea fennel production overview scheme

2. Cultivation Flow Chart

The following flow chart outlines the key steps for cultivating sea fennel organically in Mediterranean conditions:



3. Summary of Key Recommendations

Key components of successful sea fennel cultivation:

- Soil: Loamy to sandy, well-drained; raised beds for heavy soils
- Fertilization: Organic manure or compost; 40–60 kg/ha N, 30–40 kg/ha P and K
- Sowing: Jan–Feb in greenhouses; transplant in April
- Spacing: Standard 45x45 cm or adaptable spacing with mulch
- Weed Control: Mulch preferred; minimal manual or mechanical intervention
- Irrigation: ~100 mm total in June–July; post-harvest irrigation for regrowth
- Harvest: At biomass peak; additional harvest possible in August/September