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Influence of oil content and yield of *Foeniculum vulgare* Mill. cv. Soroksary seeds by adapting different plant densities

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In this experiment, the effect of different plant densities on the oil content and yield of *Foeniculum vulgare* Mill. Cv. Soroksary seeds was studied at the Faculty of Agricultural Sciences and Engineering, Karaj, Iran (Latitude 35° 47´ N and Longitude 50° 59´ E) in 2008. Different spacing studied were 10, 15, 20, 25, and 30 cm and the distance between rows in all treatments was 40 cm using a complete randomized block design with three replicates. According to the results, the effect of plant density on oil content and yield was significant (P<0.01). The highest oil content (3.33%) and yield per hectare (116.73 L) was obtained with the lowest plant density.

Key words: *Foeniculum vulgare* cv. Soroksary, plant density, oil content, oil yield.

INTRODUCTION

Fennel (*Foeniculum vulgare* Mill.) is one of the most important medicinal plants, native of Mediterranean regions and belongs to the Apiaceae family (Omidbaigi, 2007). The plant has abundant applications in various industries; for instance, the essential oil obtained from seeds is added to perfumes, soaps, pharmaceuticals and cosmetics. Fennel oil, seeds or extracts are also used for flavoring food preparations including meats, ice cream, candy, baked goods and condiments. Recent studies have shown that essential oil of this plant can be used as a valuable antioxidant, antibacterial and antifungal agent (Lucinewton et al., 2005). One of the major restraints in crop production is improper crop spacing in the field (Dupriez and Deleener, 1989). The effect of spacing on growth and secondary metabolites is largely due to change in the interception of radiant energy (Yao and Shaw, 1964). When crops are over crowded, there will be competition for water, sunlight and nutrient uptake. In the wider spacing, there will be no competition for water, sunlight and nutrient uptake between the plants (Ozar, 2003). Plant density is one of the most important factors affecting yield, yield components, oil and essential oil in medicinal plants. Masood et al. (2004) investigated the effect of row spacing (40, 50, 60, and 70 cm) on morphological characters and seed yield of fennel and reported that the highest plant height, seed yield per bed, and seed yield per hectare were obtained with the lowest row spacing. Arabaci and Bayram (2004) reported that

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Table 1. Physico-chemical properties of soil.

Soil sample	Property
pH (in 2:1 water)	8.1
Sand (%)	30
Clay (%)	32
Silt (%)	38
Ca (g/kg)	293
Fe (mg/kg)	12.1
Organic matter (g/kg)	0.78
N (g/kg)	0.092
P (cmol/kg)	12.83
K (cmol/kg)	305

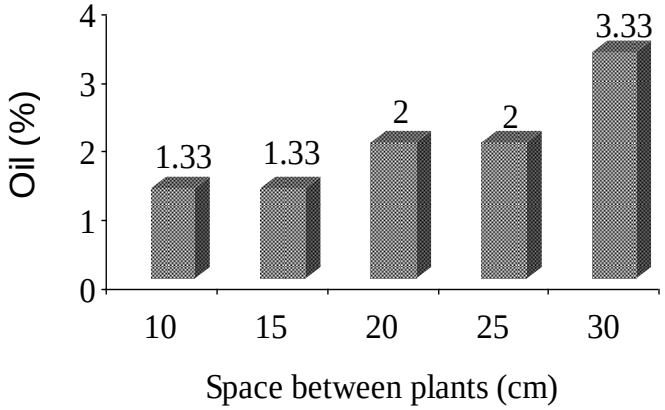

Figure 1. Relationship between plant density and oil percentage.

Table 2. Oil content and yield of seeds in different plant cultivation densities.

Space between plants (cm)	Oil content (%)	Oil yield (L/ha)
10	1.33[a]	86.19[c]
15	1.33[a]	65.27[a]
20	2[b]	85.89[c]
25	2[b]	72.94[b]
30	3.33[c]	116.73[d]

Different letters in each column indicating significant difference at P<0.01.

the highest yield in the Basil (*Ocimum basilicum* L.) was obtained in lower plant density. The maximum oil percentage and oil yield in Coriander (*Coriandrum sativum* L.) were obtained in density 30 plant per m^2 (Masood et al., 2004). Based on the aforementioned facts in view, the study was conducted, to evaluate the percentage variation and oil yield of *F. vulgare* cv. soroksary in different plant densities.

MATERIALS AND METHODS

A field study was conducted at the Faculty of Agricultural Sciences and Engineering, Karaj, Iran (Latitude 35° 47´ N and Longitude 50° 59´ E) to determine the effect of different plant densities on the oil content and yield of *F. vulgare* cv. Soroksary seeds, in 2008. A result of soil analysis is shown in Table 1. Experiment was conducted in a completely randomized block design with three replicates and different plant densities. The plot size was 2.5×1.5 m. The distance between blocks and plots were 1 m. Different plant spacing studied were 10, 15, 20, 25, and 30 cm. The distance between rows in all treatments was 40 cm. Each plot consisted of five rows. The bitter fennel seeds were sown on the 7th of March 2008. The following irrigation regime is as follows: (1) Irrigation interval of 2 to 3 days until germination stage, (2) Irrigation interval of 4 to 5 days from germination to appearance of first flowers stage, (3) Irrigation interval of 7 days from appearance of first flower to harvest stage. Thinning was done when plants had 4 to 5 leaves.

General agronomic practices were done for all the treatments. The seeds were harvested twice after ripening (20th August and 30th August) and dried in a shade for 72 h. After drying, 15 g of seeds were powdered and their oil content was extracted using a soxhlet apparatus with hexane solvent method (Harwood et al., 1999). After isolation, the oil was purified in a rotary vacuum evaporator apparatus (Buchi, Switzerland). Data collected were analyzed using Duncan Multiple Range Test (Duncan, 1955) and statistical software (SPSS).

RESULTS AND DISCUSSION

Different plant densities influenced the oil content and seed yield of bitter fennel. With increasing the spacing between plants, the oil content of seeds was increased but the pattern of changes in oil yield was irregular. Generally with increase in spaces between plants, the oil percentage increased significantly (P<0.01). The maximum oil percentage (3.33%) and yield (116.73 L/ha) were obtained in the lowest plant density. While the minimum oil percentage (1.33%) was obtained in the highest plant density and the minimum oil yield (65.27 L/ha) was obtained in 15 cm space between plants (Figures 1 and 2). Comparison of treatments indicated that there was no significantly difference in the oil percentage between 10 and 15 cm of plant densities. Similarly, there was no significant difference in the oil percentage between 20 and 30 cm of plant densities (Table 2). These results are in concomitant with the findings of Akbarinia et al. (2006) and Ozer (2003). The studies in most of the plants have shown that plant density is an important factor affecting yield. In the lower plant density, the competition between the plants for nutrients, sunlight, water and air is very less and therefore the plants grow better and finally produce the higher oil content and yield. But in the higher plant densities, they have restricted conditions for development and thus produce the lower yield. In conclusion, to reach the maximum oil content and yield of *F. vulgare* cv. Soroksary seeds, the minimum plant density is suggested.

In this study, increases observed in the yield of seeds

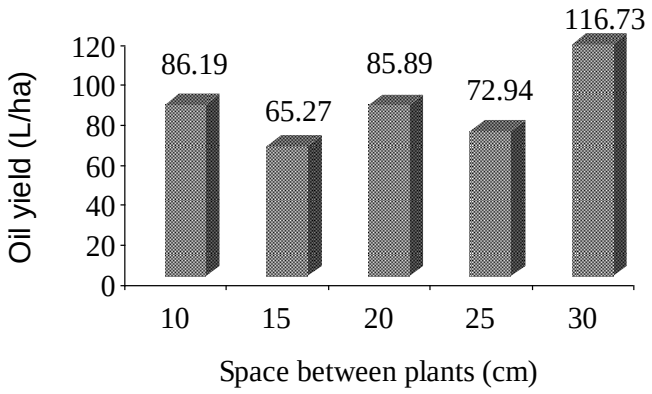

Figure 2. Relationship between plant density and oil yield.

can be attributed to the better growth of plants and subsequently the better canopy development which led ultimately to the better use of solar irradiance and higher photosynthesis. Considering the significant effect of different plant densities, it can be argued that seed yield increases in suitable plant densities are due mainly to production of more seeds in each umbel.

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