

Investigating the Effects of Plant Density, Seed Inoculation with Bacteria and Different Nitrogen Fertilizing Methods on Yield, Yield Components and Essential Oil of Fennel (*Foeniculum vulgare* Mill.)

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Abstract

Background and Objectives

Fennel is one the most important medicinal and aromatic plants which is widely used in food, medicine and cosmetic industries worldwide. This study was carried out in order to investigate the effects of different nitrogen nutritional systems including chemical, organic and biologic ones at different plant densities on yield, yield components and seed essential oil content and yield of fennel in south western Iran climatic conditions.

Materials and Methods

To do this research, a field experiment was carried out in 2013-2014 agricultural season at Islamic Azad University of Shoushtar agricultural college in split plot design with 18 treatments in 4 replications based on completely randomized blocks design. Different nitrogen system treatments consisting of N₁: Uniformly spreading urea fertilizer in the plot, half at planting time and other at stem elongation, N₂: Uniformly spreading half of urea fertilizer in the plot at planting time and spraying the other half at stem elongation on fennel foliage, N₃: cow manure, N₄: Inoculation of fennel seeds with *Azotobacter* and *Azospirillum*, N₅: Applying half of required nitrogen fertilizer from cow manure and other half from urea, N₆: Applying half of required nitrogen fertilizer from cow manure + inoculation of fennel seeds with *Azotobacter* and *Azospirillum* were applied to the main plots. Three fennel densities consisting of FD₁: 60 plant/m², FD₂: 80 plant/m² and FD₃: 100 plant/m² were applied to subplots.

Results

Based on the results, utilization of the first integrated treatment which consisted of cow manure and urea as chemical fertilizer at 50:50 percent, along with using 100 plant per m² as a proper crop density achieved production of 94.575 g/m² seed yield containing 3.375 percent of essential oil. Other findings showed that *Azotobacter*+ *Azospirillum* had no positive effect on plant seed yield and essential oil.

Discussions

The findings of our study showed that replacing 50 percent of required nitrogen with cow manure in fennel could lead to a favorable quantitative and qualitative seed production as well as the treatments which use 100 percent of nitrogen as chemical fertilizers. It seems that nitrogen application with manure probably through increasing organic matter mineralization and mineral absorption, improved the effectiveness of manure. Therefore application of such a combination not only could lead to a desirable fennel quantity and quality, but also is more consistent with environment. Other findings of the present study showed that seed inoculation with bio-fertilizers (*Azotobacter* + *Azospirillum*) had no positive effects on plant seed yield and essential oil. For such a result, it could be said that climate and soil conditions and also plant species and varieties are important in bio-fertilizers usefulness and also in determining suitable bacteria species for application.

Keywords: Bio-fertilizer, Chemical fertilizer, Density, Nutritional system, Organic fertilizer.