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## INFLUENCE OF AGROTECHNICAL METHODS ON THE QUALITATIVE INDICATORS OF ESSENTIAL OIL OF FENNEL IN THE ZONE OF SOUTHERN STEPPE OF UKRAINE

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**Abstract:** The article highlights the important aspect of introduction of the valuable aromatic plant, fennel, in the steppe area of southern Ukraine. It describes the effect of cultivation technology elements (the dates of sowing, the spaces between rows, mineral nutrition background) on the content of essential oil in fennel seeds.

**Key words:** *Foeniculum vulgare*, essential oil, fennel seeds, the dates of sowing, row spacing, mineral nutrition background, fertilization rates.

## ВЛИЯНИЕ АГРОТЕХНИЧЕСКИХ ПРИЕМОМ НА КАЧЕСТВЕННЫЕ ПОКАЗАТЕЛИ ЭФИРНОГО МАСЛА ФЕНХЕЛЯ В ЮЖНЫХ СТЕПНЫХ ЗОНАХ УКРАИНЫ

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**Резюме:** В статье освещается важный аспект внедрения ценного ароматического растения, фенхеля, в степной зоне Юга Украины. Описываются эффекты элементов технологии выращивания (даты сева, промежутки между рядами, минерального питания фоне) на содержание эфирного масла в семена укропа.

**Ключевые слова:** *Foeniculum vulgare*, эфирное масло, семена укропа, даты посева, расстояние между рядами, минеральное питание фон, темпы оплодотворения.

Fennel (*Foeniculum vulgare* Mill.) – valuable essential-oil, officinal, spicy, vegetable, aroma, melliferous and ornamental plant. Fennel seeds and products of its processing are used in medicine, cooking, in a variety of industries, veterinary medicine, animal husbandry [1, 2]. The beneficial properties of plants are caused by the

essential oil and its major components – anethole (anis camphor) and fenchone [1, 2]. The demand for fennel oil is growing every year and requires searching for new ways to improve its yield and collection [3].

In Ukraine the traditional zones of cultivation of the crop are Western regions and the Crimea region [1]. In recent years, due to the rapid development of various branches of industry and increase of production capacity, there was a necessity of expansion of areas under *Foeniculum vulgare* and its introduction into rotation in new regions, in particular in the southern Steppe of Ukraine.

In 2011-2013 field experiments were established and conducted in the Kherson Regional State Centre for Expertise of Plants Varieties on dark chestnut soils, typical for the southern Steppe of Ukraine. The plan of the experience included such factors and their variants: Factor A – nutrition background: without fertilizers;  $N_{30}$ ;  $N_{60}$ ;  $N_{90}$ ; Factor B – the sowing date: early (the 3<sup>rd</sup> ten-day period of March); middle (1<sup>st</sup> ten-day period of April); late (2<sup>nd</sup> ten-day period of April); Factor C – row spacing width, cm: 15; 30; 45; 60. The experiment is laid with the help of the method of split sections, replication – fourfold. The agrotechnics of fennel cultivation during the experiment was usual, except for the factors and options that have been studied. The essential oil content in seeds was determined using the method of Ginsburgh [4].

The results of the studies testify to the fact that the content of essential oil in the seeds of fennel depends on the effect of hydrothermal conditions and of the factors studied.

In 2011 the mass fraction of essential oil in the seeds of fennel, on average over the experiment, constituted 5.74, in 2012 and 2013 – 5.52 and 5.69%, respectively. The decrease of this indicator in 2012 in comparison with other years of research may be associated with the losses of essential oil under the influence of considerable amount of precipitation in the interphase period of fructification - ripeness.

The content of essential oil in the seeds of fennel, averagely for the years of research, changed according to the variants of experiment from 5.14 to 6.27% of absolutely dry matter. The most favourable conditions for accumulation of essential oil were observed in  $N_{60}$ , when sown in the early period with the width of the row spacing of 45 cm, the least favourable – without fertilizers control, sown in a later date with usual rows.

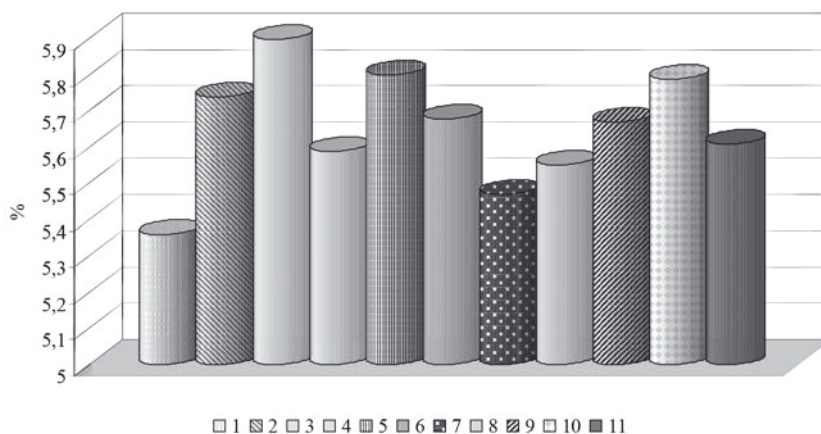
In average by factors of value of indicator in the variant without fertilizers was 5.36%, nitrogen fertilizers have increased it 1.04-1.10 times. The mass fraction of essential oil in the seeds of fennel under the background of  $N_{30}$ ,  $N_{60}$  and  $N_{90}$  increased relative to the control test 0.38; 0.54 and 0.23%, respectively (Fig. 1). Under the background of the  $N_{90}$  there was a decrease of this characteristic in comparison with the variants of application of  $N_{30}$  and  $N_{60}$  on 0.15 and 0.31%, respectively.

The positive influence of fertilizers on the content of essential oil in the fennel seeds depended on the interaction with the other surveyed factors. Under the back-

ground of  $N_{60}$ , there was an increase of this characteristic relatively to the control test of 1.08 times on the sites of late term sowing with a row spacing of 15 and 60 cm; 1.13 times when sown in the third decade of March with row spacing of 45 cm.

The mass fraction of essential oil in the fennel seeds sown in the early period, in the third ten-day period of March constituted 5.80%. When seeds are sown 10 – 20 days later, the analyzed characteristic fell by 0.12 - 0.33 %, or 1.02-1.06 times.

Average factor, the highest concentration of essential oil in seeds of 5.79% was observed at sowing with aisle 45 cm. Changing the width of the aisle relatively 45 cm resulted in the decrease of this indicator by 0.12-0.24 %, or 1,02-1,04 times.

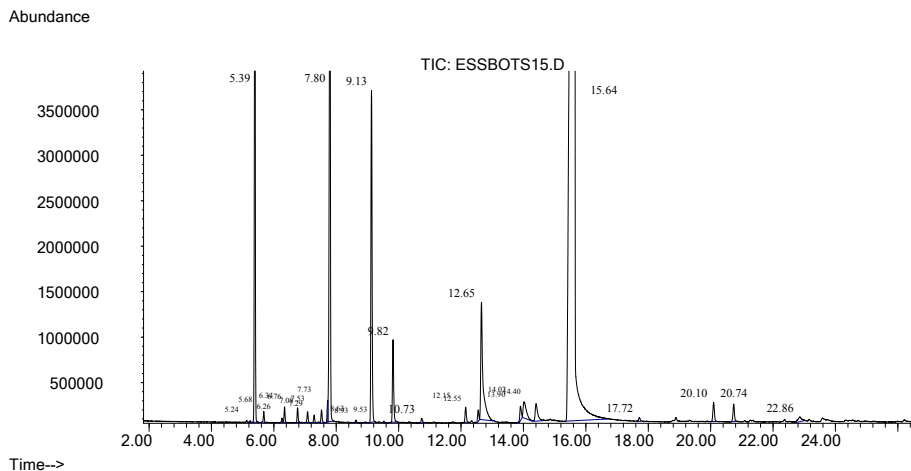


Factor A - background supply: 1 - without fertilizers; 2 -  $N_{30}$ ; 3 -  $N_{60}$ ; 4 -  $N_{90}$ .  
 Factor B - sowing date: 5 - early; 6 - medium; 7 - late  
 Factor C - row spacing: 8 - 15 cm; 9 - 30 cm; 10 - 45 cm; 11 - 60 cm

**Fig. 1.** The content of essential oil in the fennel seeds, on averagely due to the studied factors, % of absolutely dry matter

The chromatographic analysis of the composition of the fennel seeds essential oil revealed 28 chemical compounds, the main of which are trans-anethole, limonene,  $\alpha$ -pinene, fenchone, estragole, linalool (Fig. 2).

In addition, the essential oil of fennel contains such components as:  $\alpha$ -tuyen, camphene, sabinene, beta-pinene, beta-myrcene, beta-phellandrene, Delta-Karen, p-cymene, 1,8-cineole, gamma terpinene, trans-linalool oxide,  $\alpha$ -terpinolene, camphor, terpinene-4-ol, p-COP-1-ene-8-ol, carvone, 4-methoxybenzaldehyde, 1-methoxy-4(prop-1-enyl)benzene, patience acetate, trans-caryophyllene, beta-bergamot,  $\alpha$ - bis-abolen.



**1** - 5,246 (0,023%  $\alpha$ - tuyen); **2** - 5,395 (7,691%  $\alpha$ -pinene); **3** - 5,679 (0,151% camphene); **4** - 6,261 (to 0,055% sabinene); **5** - 6,346 (0,215%  $\beta$ -pinene); **6** - 6,761 (0,216%  $\beta$ -mircen); **7** - 7,086 (0,169%  $\beta$ -phellandrene); **8** - 7,289 (0,115% Delta-Karen); **9** - 7,524 (0,219% p-cymene); **10** - 7,727 (0,282% 1,8-cineole); **11** - 7,799 (8,770% limonene); **12** - 8,629 (0,040%  $\gamma$ -terpinene); **13** - 8,926 (0,015% trans linalool oxide); **14** - 9,129 (5,726% fenchone); **15** - 9,531 (0,027%  $\alpha$ -terpinolene); **16** - 9,819 (1,435% linalool); **17** - 10,735 (0,090% camphor); **18** - 12,147 (0,279% terpinene-4-ol); **19** - 12,548 (0,203% p-COP-1-ene-8-ol); **20** - 12,652 (3,817% estragole); **21** - 13,901 (0,322% carvone); **22** - 14,014 (0,767% 4-methoxybenzaldehyde); **23** - 14,402 (0,654% 1-methoxy-4(prop-1-enyl)benzene); **24** - 15,647 (67,581% trans-anethole); **25** - 17,721 (0,084% patience acetate); **26** - 20,098 (0,422% trans-caryophyllene); **27** - 20,743 (0,369%  $\beta$ -bergamot); **28** - 22,858 (0,262%  $\alpha$ -bisabolen).

**Fig.2.** Component composition of fennel seeds essential oil

Therefore, the most favourable conditions for the accumulation of essential oil in the seeds of fennel were observed under  $N_{60}$ , when carrying out the sowing in the early period (in the third ten-day period of March) with the width of the row-spacing of 45 cm.

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