



OPTIMIZATION OF COMPLEX TECHNOLOGICAL MEASURES IN GROWING OF FENNEL IN THE TERMS OF FOREST STEPPES OF UKRAINE

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KEYWORDS

*fennel, row spacing,
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ABSTRACT

In the article the research results of the influence of technological factors (sowing time, seeding rate, row spacing) on the yield and quality of fennel fruits in the western Forest-Steppe are highlighted. the component composition of the fennel essential oil is given depending on the time of sowing.

1. INTRODUCTION

Fennel is commonly used in medicine for a long time. Ancient Saxons included fennel in the number of nine sacred herbs. in the history of British medicine, Stefenson's medicines are mentioned (for the treatment of kidney diseases), the main component of which was fennel.

Fennel fruits are traditionally used for the treatment of renal stone disease, chronic cholecystitis, with gastrointestinal cramps, to improve digestion. Fennel fruits are included in many medical collections that have a weakening, choleric and calming action. From the essential oil of fennel anetol is extracted (the main component of essential oil of fennel), which is used for the treatment of heart disease. in addition to the therapeutic value, fennel is also commonly used in perfumery, cosmetics, alcoholic beverages, textiles, confectionery and other sectors of the national economy. Fennel is the raw material for a number of odorous substances that form the basis of modern perfumery and cosmetics, and also used as a flavoring or spice in the preparation of various dishes.

Today there is a tendency to change the weather conditions, therefore, it was possible to cultivate those heat-loving crops that were previously considered typical southern in almost all zones of Ukraine. Thus, the study of the complex of agrotechnical measures

in the cultivation of common fennel in the conditions of the forest-steppe zone of Ukraine is currently relevant and timely.

In Ukraine, conventional fennel is still a small area, among the reasons - imperfect growing technology and lack of information on the feasibility of cultivating this plant. Interesting data on the cultivation of fennel of the usual are given in the late 60's by A.MSmolyanov. According to the results of his research, high yields of fennel seeds 1,44 t / ha can be obtained by introducing 10 hundredweight of phosphate slag, 2 hundredweight of cainite, and in the spring under cultivation - 1 hundredweight of ammonium nitrate and 0,4 hundredweight of superphosphate. Stotska S.V. in her research conducted in conditions of the botanical garden of Zhytomyr National Agroecological University, she studied the ways of fennel sowing (with inter-row width: 15, 45 and 60 cm). According to the author, in the conditions of Polissya, fennel needs to be sown in a wide-ranging way with a width of 60 cm spacing, in these agrotechnical parameters the soil-climatic conditions of the zone allow obtaining a stable yield of seeds at the level of 0,82 t / ha. Fedorchuk M.I., Makukha O.V. studied in the conditions of southern Ukraine the peculiarities of growth and development of fennel plants, taking into account the complex of such agrotechnical factors: sowing period, row width and fertilizer system. According to scientists on dark chestnut soils of southern Ukraine, it is advisable to add nitrogen fertilizers in a dose of 60 kg of active substance per hectare, to carry out the early spring laying in a wide-ranging way with spaced rows of 45 cm. in the forest-steppe zone there are insignificant areas in private farms occupied by this crop, but we do not know the study of growing fennel technology.

2. MATERIAL AND METODS

Among the tasks set out in the research plan was: to determine the duration of the interphase and vegetative periods of fennel, to carry out a biometric analysis of the plants, to determine the yield and quality of the seeds, depending on the time of sowing, row spacing, the norm of seeding. the investigations were carried out in the production conditions of the agricultural enterprise Prudyvus S.M. Khmelnytsky region of Kamyanyets-Podilsky district. the research work was carried out with Mertsyshor variety. the experiment involved factors: a - the seeding period (April 1, RTR soil 6-8°C), (II decade of April, for RTR soil 10-12°C); factor B - width of row: 15, 30, 45 and 60 centimeters; factor C - seeding rate: 1, 1.5 and 2 million similar seed per hectare. the area of the registration area is 50 m².

Repetition is fourfold. Observations, records and analyzes were performed in accordance with generally accepted methods.

After harvesting, the predecessor was harvested with stubble and deep plowing of plowing - 27 cm. the seed was harvested with a beet seed drill. in the autumn, the culture was fed with full mineral fertilizer at the rate of N45P60K60 under the plowing, while during sowing - P10. During the period of stem formation, vegetative feeding was carried out (N30P30). Organic fertilizers were not added to the culture, so as not to reduce the yield of seeds due to the growth of the earth's weight.

Field studies were accompanied by observations, records, and laboratory tests that were carried out in accordance with generally accepted techniques. Phenological observations, determination of biometric indices were carried out according to Yoshchenko V.O. (2005). the content of essential oil in the seeds is by the method of Ginsberg (DSTU 7109: 2009). These studies were processed by the method of dispersion analysis using the software and information complex "Agroctat" (Ushkarenko V.O., 2008).

RESULTS

The availability of western Forest-Steppe to thermal resources makes it possible to obtain the seeds of fennel during one growing season. the sum of active temperatures above 100C for the formation of fennel seeds was an average of 2665°C, effective – 2174°C.

In general, the growing season lasted for 117-137 days. the least prolonged it was during sowing in the second decade of April in a continuous row way (width of rows of 15 cm), the norm of seeding 1 million sprouted seeds per hectare. the most prolonged 137 days was the growing season of fennel plants for sowing in the first row with a width of rows of 60 cm, the seeding rate of 2 million sprouted seedi per hectare (Table 1).

Tab. 1. Duration of interphase and vegetation periods of fennel depending on the period of sowing, row spacing and sowing rate, days.

| Sowing term (A) | Row spacing, cm (B) | Seeding rate, mln.sp.s./ha (C) | Interphase periods | | | Vegetative period |
|-----------------------------|---------------------------|-----------------------------------|----------------------|-------------------------|-------------------------|----------------------|
| | | | sprout s-stemming | stemming - flowering | flowerin g- ripening | |
| I-st (RTR of soil 6-8°C) | 15 | 1 | 50 | 17 | 53 | 120 |
| | | 1,5 | 50 | 18 | 55 | 123 |
| | | 2 | 51 | 18 | 56 | 125 |
| | 30 | 1 | 49 | 17 | 54 | 120 |
| | | 1,5 | 50 | 18 | 56 | 124 |
| | | 2 | 51 | 18 | 56 | 125 |
| | 45 | 1 | 51 | 19 | 58 | 128 |
| | | 1,5 | 51 | 20 | 60 | 131 |
| | | 32 | 52 | 21 | 62 | 135 |
| | 60 | 1 | 51 | 20 | 59 | 130 |
| | | 1,5 | 52 | 21 | 60 | 133 |
| | | 2 | 52 | 22 | 63 | 137 |
| II-nd (RTR of soil 10-12°C) | 15 | 1 | 48 | 15 | 54 | 117 |
| | | 1,5 | 49 | 16 | 54 | 119 |
| | | 2 | 49 | 16 | 57 | 122 |
| | 30 | 1 | 48 | 16 | 54 | 118 |
| | | 1,5 | 48 | 17 | 54 | 119 |
| | | 2 | 49 | 17 | 57 | 123 |
| | 45 | 1 | 49 | 18 | 58 | 125 |
| | | 1,5 | 49 | 18 | 60 | 127 |
| | | 32 | 50 | 19 | 62 | 131 |
| | 60 | 1 | 50 | 18 | 59 | 127 |
| | | 1,5 | 50 | 19 | 60 | 129 |
| | | 2 | 51 | 20 | 61 | 132 |
| V, % | | | 2,5 | 9,7 | 5,2 | 4,4 |

The duration of each phase and interphase period depends mainly on the temperature regime. Therefore, considering the duration of the periods of growth and development of plants of fennel, depending on the time of sowing, we observe the natural changes

in the reduction of the interphase periods and the vegetation period as a whole for the later sowing.

Variation analysis allowed to reveal slight fluctuations in the coefficient of variation regarding the duration of the staggering period ($V = 2,5\%$). Then, as the course of the interphase period of stem-blossoming was characterized by a more significant variability ($V = 9,7\%$). with larger areas of food, plants form a large number of umbrellas and, accordingly, require a longer period for flowering plants.

Regarding the plant density of the fennel plants in the beginning and at the end of the vegetation, field similarity was observed within the range of 87,5-91,0% and the survival of plants from 83,6 to 88,8% (Table 2).

Tab.2. Standing density of fennel plants depending on the period of sowing and placement of plants per unit area,%

| Row spacing, cm (B) | Seeding rate, mln.sp.s./ha (C) | I-st sowing term (RTR of soil 6-8°C) (A) | | II -nd sowing term (RTR of soil 10–12°C) (A) | |
|------------------------|-----------------------------------|---|----------|---|----------|
| | | sprouting | survival | sprouting | survival |
| 15 | 1 | 91,0 | 88,8 | 90,1 | 87,7 |
| | 1,5 | 90,9 | 88,6 | 89,9 | 87,5 |
| | 2 | 91,0 | 88,7 | 89,8 | 87,2 |
| 30 | 1 | 91,0 | 88,8 | 90,0 | 87,3 |
| | 1,5 | 90,8 | 88,5 | 89,9 | 87,2 |
| | 2 | 90,9 | 88,3 | 88,8 | 85,8 |
| 45 | 1 | 90,8 | 88,2 | 89,9 | 87,0 |
| | 1,5 | 90,7 | 87,9 | 89,7 | 86,5 |
| | 2 | 90,0 | 87,0 | 89,1 | 85,6 |
| 60 | 1 | 89,9 | 87,0 | 89,5 | 86,2 |
| | 1,5 | 90,0 | 86,8 | 89,2 | 85,5 |
| | 2 | 88,3 | 84,8 | 87,5 | 83,6 |

The investigated factors practically did not effect on the sprouting, except for the variant with the width of intermediate rows of 60 cm and the sowing rate of 2 million sprouted seeds per hectare, that is, at a sowing with a seeding density of 125 pieces per running meter of the row. Regarding the survival of plants, the smallest – 83,6% it was on variants of the second period of sowing with a width of rows of 60 cm and the norm of sowing 2 million similar seeds per hectare, that is, with a given plant density of 125 pieces per running meter of the row, which caused competition of plants for moisture, lighting and batteries. in this variant, the percentage of dead plants was 4.4.

With the increase of row spacing and sowing rates for normal fennel sowing, there was a tendency towards an increase in the percentage of dead plants, the index for the first sowing period fluctuated within the range of 2,3-3,9, while the second one was 2,6-4,4. That is, at a later stage of sowing, the worst conditions for the passage of phases of growth and development of plants have developed. It should be noted that mainly plants died in the initial periods of growth - from sprouts to the beginning of stalking of plants, which could be influenced by environmental factors.

Biometric analysis of the usual fennel showed that, according to the height of plants, variants of our studies differed significantly. The height of the fennel plants varied from 89 to 150 cm. At the first time of planting, the plants were formed taller, compared with the second time, the difference was 3-12 cm (in variants) (Table 3).

Tab.3. Biometric indices of fennel plants depending on sowing terms, row spacing and sowing rate.

| Row spacing, cm (B) | Seeding rate, mln.sp.s./ha (C) | Height of plants, cm. | | Number of sprouts of the 1st order, pcs. | | Weight of seed from a plant, g. | |
|---------------------|--------------------------------|-----------------------|------------------------|--|------------------------|---------------------------------|------------------------|
| | | I-st sowing term (A) | II -nd sowing term (A) | I-st sowing term (A) | II -nd sowing term (A) | I-st sowing term (A) | II -nd sowing term (A) |
| 15 | 1 | 118 | 114 | 8,0 | 7,0 | 0,73 | 0,71 |
| | 1,5 | 122 | 116 | 8,3 | 7,2 | 0,75 | 0,73 |
| | 2 | 121 | 117 | 8,5 | 7,3 | 0,79 | 0,75 |
| 30 | 1 | 147 | 136 | 11,7 | 10,9 | 1,74 | 1,70 |
| | 1,5 | 145 | 134 | 10,0 | 9,1 | 1,18 | 1,16 |
| | 2 | 139 | 129 | 8,7 | 7,9 | 0,80 | 0,76 |
| 45 | 1 | 150 | 139 | 12,1 | 11,3 | 1,81 | 1,75 |
| | 1,5 | 137 | 129 | 9,7 | 9,0 | 1,10 | 1,01 |
| | 2 | 118 | 115 | 8,2 | 8,0 | 0,75 | 0,69 |
| 60 | 1 | 120 | 116 | 11,2 | 10,7 | 1,70 | 1,65 |
| | 1,5 | 119 | 117 | 9,1 | 8,4 | 0,93 | 0,90 |
| | 2 | 98 | 89 | 7,2 | 6,9 | 0,61 | 0,57 |
| V, % | | 11,8 | | 17,6 | | 40,5 | |

Higher plants were formed on variants of sowing with an intermediate row spacing of 30 cm with all seed rates and with an intermediate row width of 45 cm with seed rates of

1-1,5 cm, that is, in variants, where the amount of plants retained at the end of vegetation was within the range of 23,8-54,2 pieces per linear meter. Consequently, the height of plants in these variants at the 1st term sowing was 137-150 cm, while in the 2nd line sowing - 129-139 cm.

The least tall plants - 89 cm were formed at a width of rows of 60 cm seeding rate of 2 million per hectare, where the thickening of crops at the end of vegetation of plants was 91,4 pc. per running meter of (1 million 463 thousand plants per hectare).

An important biometric indicator is the number of sprouts of the 1st order, on which the productivity of plants depends to a large extent. Significant difference in this indicator was depending on the term of sowing. So, at the first term of sowing, the number of sprouts was within 7,2-12,1 pc., while the second – 6,9-11,3 pcs, but the trend was similar for both rows. the maximum number of sprouts of the 1st order is 12,1 pcs. on the fennel plant, variants with a width of rows of 45 cm were formed with the seeding rate of 1 million per hectare for the first seeding period.

The weight of the seed from the plant varied in a fairly wide range - from 0,57 to 1,74grams. There was a tendency to increase the productivity of plants in a larger area of food. When sowed in a continuous row way (15 cm), even with insignificant thickening of plants at the end of the vegetation - within 11,9-24,3 pcs. the least productive plants were observed, while in the sowing with the width of row spacing of 30 and 45 cm with seed rates of 1 and 1,5 million sprouted seeds per hectare, and at the end of the vegetation, the survival of plants in these variants was from 23,8 to 54,2 pcs. the most productive plants - with a mass of seeds of 1,81 grams were formed on variants with row spacing of 45 cm and seeding rate of 1 million per hectare for sowing in the first decade of April.

Variation analysis allowed detecting certain variations in the coefficient of variation regarding plant height and number of sprouts, respectively: $V = 11,8$ and $17,6\%$. Then, as an indicator of the weight of seed from the plant was characterized by high variability ($V = 40,5\%$).

The main resultant indicator, which determines the success of the technological factors being studied, is yield. Crop yields showed that it varied within a fairly wide range from 0,56 to 1,45 t / ha (Table 4).

Tab.4. Productivity of fennel fruits depending on the period of sowing, row spacing and seeding rate t / ha.

| Row spacing, cm (B) | Seeding rate, mln.sp.s./ha (C) | Sowing term (A) | | | |
|--|--------------------------------|--------------------------|--------------|-----------------------------|--------------|
| | | I-st (RTR of soil 6-8°C) | | II-nd (RTR of soil 10-12°C) | |
| | | fact. | ± to control | fact. | ± to control |
| 15 | 1 | 0,58 | -0,51 | 0,56 | -0,53 |
| | 1,5 | 0,9 | -0,19 | 0,86 | -0,23 |
| | 2 | 1,16 | 0,07 | 1,11 | 0,02 |
| 30 | 1 | 1,4 | 0,31 | 1,33 | 0,24 |
| | 1,5 | 1,42 | 0,33 | 1,36 | 0,27 |
| | 2 | 1,28 | 0,19 | 1,15 | 0,06 |
| 45 | 1 | 1,45 | 0,36 | 1,36 | 0,27 |
| | 1,5 | 1,31 | 0,22 | 1,17 | 0,08 |
| | 2 | 1,17 | 0,08 | 1,05 | 0,04 |
| 60 | 1 | 1,32 | 0,23 | 1,27 | 0,18 |
| | 1,5 | 1,09 (K) | - | 1,02 | -0,07 |
| | 2 | 0,91 | -0,18 | 0,83 | -0,26 |
| LSD ₀₅ : A – 0,05, B – 0,06, C – 0,06, AB – 0,09, AC – 0,08, BC – 0,11 ABC – 0,16 | | | | | |

The best variant in our research is sowing in the 1-st term (for RTR 6-8°C) with row spacing of 45 cm, a seeding rate of 1 million sprouted seeds per hectare. the yield of seeds of the 2-nd sowing period was lower by 0,02-0,14 t / ha compared to the 1-st year.

The variance analysis showed that the difference between the variants was reliable, as evidenced by the values of LSD₀₅ (A – 0,05, B – 0,06, C – 0,06, AB – 0,09, AC – 0,08, BC - 0,11, ABC – 0,16 t / ha).

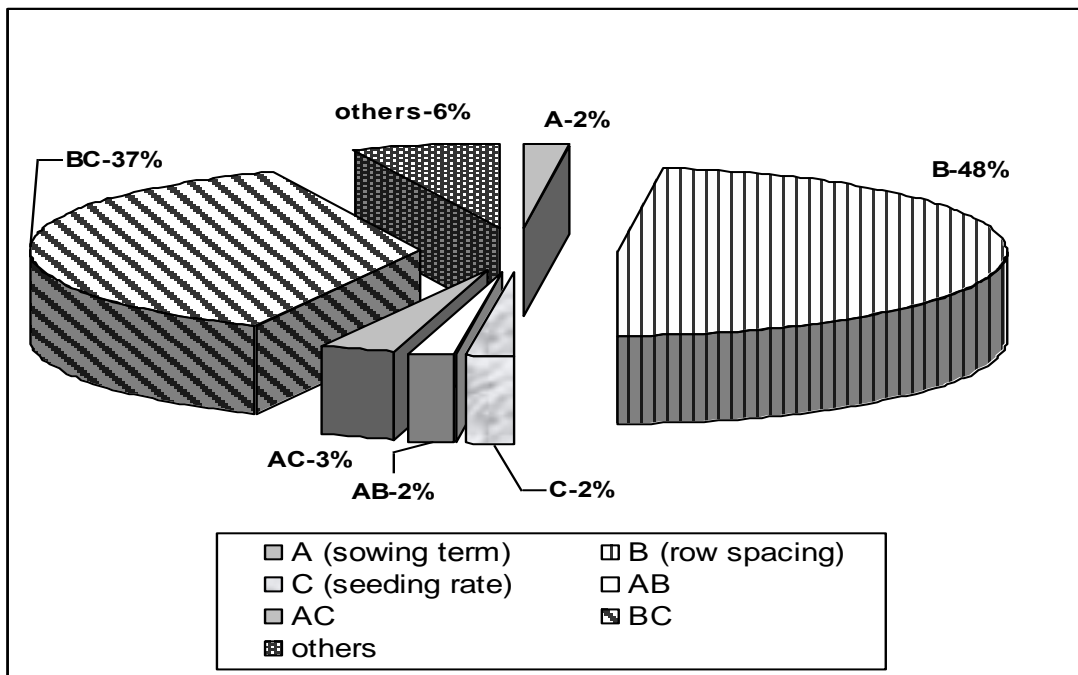


Fig.1. Particle of factors effect on the yield of fennel, %

In Figure 1, the proportion of the influence of the investigated factors on the yield of fennel, which indicates that the most influential was the factor B (row spacing), as well as the interaction of factors B (row spacing) and C (seeding rate), the percentage of their influence was 48 and 37.

The main active ingredient of fennel is an essential oil. the content of essential oils in terms of absolutely dry matter varied from 5,35 to 6,23%. the most favorable conditions for the accumulation of essential oils were observed in the variant for sowing in the first row with row spacing of 45 and 60 cm, seeding rate of 1 million sprouted seeds per hectare (Table 5).

It should be noted that the accumulation of essential oils in the seeds of coriander was primarily affected by the time of sowing. Consequently, the early sowing was in more favorable conditions, the difference in this indicator between the dates of sowing varied within 0,45-0,87%. with regard to the width of row spacings, for broad-row crops, the content of essential oil in the seed was larger, compared with continuous sowing and sowing of 30 cm. with the increase of seeding rate the content of essential oils decreased.

Tab.5. the content of essential oil in the seeds of fennel depending on the period of sowing and placement of plants per unit area, %

| Row spacing, cm (B) | Seeding rate, mln.sp.s./ha (C) | I-st sowing term (RTR of soil 6-8°C) (A) | | II -nd sowing term (RTR of soil 10–12°C) (A) | |
|---------------------|--------------------------------|---|-------------|---|-------------|
| | | факт. | ± до контр. | факт. | ± до контр. |
| 15 | 1 | 6,07 | - 0,08 | 5,42 | - 0,73 |
| | 1,5 | 6,10 | - 0,05 | 5,37 | - 0,78 |
| | 2 | 6,11 | - 0,06 | 5,35 | - 0,8 |
| 30 | 1 | 6,11 | - 0,06 | 5,46 | - 0,69 |
| | 1,5 | 6,13 | - 0,02 | 5,42 | - 0,73 |
| | 2 | 6,17 | 0,2 | 5,44 | - 0,71 |
| 45 | 1 | 6,22 | 0,7 | 5,79 | - 0,36 |
| | 1,5 | 6,18 | 0,3 | 5,69 | - 0,46 |
| | 2 | 6,14 | - 0,1 | 5,65 | - 0,46 |
| 60 | 1 | 6,23 | 0,8 | 5,78 | - 0,37 |
| | 1,5 (K) | 6,15 | - | 5,68 | - 0,47 |
| | 2 | 6,17 | 0,2 | 5,65 | - 0,5 |

In the essential oil of fennel there are anetol, fenchon, methylhavikol, a-pinen, a-felandren, anisive aldehyde, anisolic acid and other substances. the anethole contained in the fennel stimulates the intestinal contraction, the secretion of mucus in the respiratory tract, and expektoration. the content of anetol in the essential oil of fennel is the largest - usually about 60%.

The content of essential oil and its component composition depends on many factors, both biological and technological.

We determined the component composition of the essential oil of fennel in the phase of full fruiting of the fruits on the central umbrella at different sowing terms (Table 6).

Tab.6. Component composition of essential oil of fennel depending on the terms of sowing,%
(row spacing of 45 cm, seeding rate of 1 million sp. s / ha)

| Component | I-st (RTR of soil 6-8C) | II-nd (RTR of soil 10-12C) |
|--------------------|-------------------------|----------------------------|
| Anetol | 69,50 | 64,93 |
| Metilhavikol | 2,79 | 2,72 |
| Linalool | 1,41 | 1,30 |
| Fenghon | 10,02 | 9,54 |
| a-pinen | 6,32 | 6,27 |
| Camfen | 0,11 | 0,10 |
| β -pinene | 0,15 | 0,13 |
| β -felandrin | 0,93 | 0,89 |
| 1,8-cineol | 1,29 | 1,25 |

It should be noted that during sowing in the second term there was a decrease in the generative period of development of fennel plants and, accordingly, the growing season as a whole, which somewhat influenced the accumulation and composition of essential oils in fennel fruit. the difference in the component composition of essential oil at different times of sowing is negligible, with the exception of the anetol content, which for the first term was 69,50, while for the other it was 64,93%. in total, the percentage content of the essential oils, determined during the first period of sowing fennel, is 92,52%, and for the second – 87,13%, that is, the difference lies with other, undefined substances, possibly less valuable.

Fennel is common in highly profitable crops due to the relatively low cost of production of production costs. the amount of contingent net profit and the level of profitability per hectare of fennel crops is an order of magnitude higher than in the cultivation of traditional crops, which in turn allows more efficient use of production areas, significantly increase the return on investment cash and material resources.

The technology of fennel growing and hence the production costs may undergo certain changes, but in any case, the production of seeds due to high prices for the sale remains profitable. it is expedient to grow fennel on small plots - in private or farms, which seek to improve the productivity of their productive activities.

The main reserve for improving the economic efficiency of fennel seed production is, first of all, the regulation of crop productivity by optimizing the complex of technological measures, as well as the development of a modern marketing strategy for product sales.

The market for fennel in Ukraine is on the stage of formation. Thanks to the rapid development of domestic industry (medicines, cosmetics, seasonings, spices, teas, etc.)

for fennel today is stable high demand. in addition, there is the possibility of attracting additional sales channels by exporting products to countries in Europe and Asia.

In our studies, culture has shown a significant potential for profitability. the performed calculations confirm the high economic efficiency of growing fennel in the conditions of the forest-steppe of Ukraine. the production costs for all technological operations are 6450-7130 UAH / ha, depending on the experimental variants, the difference between which is the weight standards of the sown seeds and conducting additional pre-sowing cultivation for the later sowing of culture. However, production costs are fully compensated by the proceeds from the sale of products, the size of which in terms of options varied within the range of 4700-22400 UAH / ha (Table 7).

Tab.7. Economic efficiency of fennel cultivating depending on the investigated factors

| Row spacing, cm (B) | Seeding rate, mln.sp.s./ha (C) | Producti-vity, t/ha | Cost of gross product, UAH / ha | Costs for yield growing, UAH / ha | Conditio-nally net profit, UAH / ha | Profitabi-lity level,% |
|-----------------------------|--------------------------------|---------------------|---------------------------------|-----------------------------------|-------------------------------------|------------------------|
| I-st (RTR of soil 6-8°C) | | | | | | |
| 15 | 1 | 0,58 | 11600 | 6900 | 4700 | 68 |
| | 1,5 | 0,9 | 18000 | 6900 | 11100 | 160 |
| | 2 | 1,16 | 23000 | 6900 | 16100 | 233 |
| 30 | 1 | 1,4 | 28000 | 6750 | 21250 | 314 |
| | 1,5 | 1,42 | 28400 | 6750 | 21650 | 320 |
| | 2 | 1,28 | 25600 | 6750 | 18850 | 279 |
| 45 | 1 | 1,45 | 29000 | 6600 | 22400 | 339 |
| | 1,5 | 1,31 | 26200 | 6600 | 19600 | 296 |
| | 2 | 1,17 | 23400 | 6600 | 16800 | 254 |
| 60 | 1 | 1,32 | 26400 | 6450 | 19950 | 309 |
| | 1,5 | 1,09 | 21800 | 6450 | 15350 | 237 |
| | 2 | 0,91 | 18200 | 6450 | 11750 | 182 |
| II-nd (RTR of soil 10-12°C) | | | | | | |
| 15 | 1 | 0,56 | 11200 | 7130 | 4070 | 57 |
| | 1,5 | 0,86 | 17200 | 7130 | 10070 | 141 |
| | 2 | 1,11 | 22200 | 7130 | 15070 | 211 |
| 30 | 1 | 1,33 | 26600 | 6980 | 19620 | 281 |
| | 1,5 | 1,36 | 27200 | 6980 | 20220 | 289 |
| | 2 | 1,15 | 23000 | 6980 | 16020 | 229 |
| 45 | 1 | 1,36 | 27200 | 6830 | 20370 | 298 |
| | 1,5 | 1,17 | 23400 | 6830 | 16570 | 242 |
| | 2 | 1,05 | 21000 | 6830 | 14170 | 207 |
| 60 | 1 | 1,27 | 25400 | 6680 | 18720 | 280 |
| | 1,5 | 1,02 | 20400 | 6680 | 13720 | 205 |
| | 2 | 0,83 | 16600 | 6680 | 9920 | 148 |

The conditional net profit was maximum at the variant of sowing in the early term (for RTR soil 6-8°C) with a width of rows of 45 cm seeding rate of 1 million sprouted seeds per hectare, the level of profitability in this variant 339%, slightly less - 320% the level of profitability of the early term of sowing with row spacing of 30 cm, seeding rate 1,5 million sprouted seeds per hectare.

3. CONCLUSION

The results of researches show that with the increase of row spacing and sowing rates there was a tendency to extend the periods of growth and development of plants of fennel. The most prolonged vegetation period of fennel was 137 days with the sowing in the first term (1st decade of April) with row spacing of 60 cm, the seeding rate of 2 million sprouted seeds per hectare.

The least survival of plants was 83,6% at variants of the second sowing period (II decade of April) with a width of 60 cm intervals and a seeding rate of 2 million sprouted seeds per hectare, that is, with a given plant density of 125 pcs per running meter of a row survival within 88, 2-88,8% was observed at sowing with row spacing of 15 and 30 cm with all surveyed seeding standards and in the variant with row spacing of 45 cm with seeding rate of 1 million sp. s. / ha

The yield of fennel fluctuated within the range of 0,56-1,45 t / ha. The maximum index was obtained at the sowing in the 1-st term (according to RTR 6-8°C) with row spacing of 45cm, seeding rate 1mln. sp. s. / ha

The content of essential oil in terms of absolutely dry matter was optimal (6,22-6,23%) in the variant for sowing in the first term with row spacing of 45 and 60 cm, seeding rate 1 million sprouted seeds per hectare.

The difference in the component composition of essential oil at different times of sowing is negligible, with the exception of the anetol content, which for the first term was 69,50, while for the other it was 64,93%.

The calculations of economic efficiency showed that the share of net profit was maximum at the variant of sowing in the early term (for RTR soil 6-8°C) with row spacing of 45 cm, seeding rate of 1 million sprouted seeds per hectare, the level of profitability in this variant was 339%

REFERENCES

1. Ethereal plants: Textbook / [Bakhmat M.I., Kvaschuk O.V., Khomina V.Ya., Zagorodniy M.V., Suchek M.M.]. - Kamyans-Podilsky: Medobory-2006, 2012.
2. Ethioarticle cultures / Ed. Smolyanova A.M., Ksenza A.T. - M.: Kolos, 1976.
3. Fedorchuk M.I. Biological peculiarities of growth and development of fennel in arid conditions of Kherson region / M.I. Fedorchuk, O.V. Makukha // Tavriysky Scientific Bulletin. - Kherson, 2012.
4. Ivanyshyn, V., Hutsol, T.: The Ukrainian agricultural groups state and agromachinery revision. Scientific achievements in agricultural engineering agronomy and veterinary medicine: Polish-Ukrainian

cooperation : monograph. State Agrarian and Engineering University in Podilya, Agriculture University in Krakyw. Vol. I. Krakyw: Traicon 1 (1), 5-18 (2017).

5. Makukha O.V. Features of generative development of *Foeniculum vulgare* Mill. When introducing in dry conditions of southern Ukraine / Makukha O.V., Fedorchuk M.I. // Tavriysky Scientific Bulletin. - Kherson, Ed.83, 2013.
6. Stotska S.V. Formation of seed yield of fennel of depending on the methods of sowing / S.V. Stotska // Collection.sc.-prakt. conf. "Theoretical and practical aspects of scientific research in the field of agrotechnology and land management". - Zhytomyr: Publishing House "Zhytomyr National Agroecological University", 2011
7. Wrobel M., Frączek J., Francik S., Slipek Z., Mudryk K.: Influence of degree of fragmentation on chosen quality parameters of briquette made from biomass of cup plant *Silphium perfoliatum* L., Engineering for Rural Development Jelgava, 2013 Available at:
http://tf.llu.lv/conference/proceedings2013/Papers/121_Wrobel_M.pdf