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# Improving the efficiency of seed production of heterotic cucumber hybrids in protected soil

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**Abstract.** Increasing the efficiency of seed production of heterotic cucumber hybrids is the most important task of protected soil vegetable growing. In recent years, modern heterotic cucumber hybrids have almost completely replaced conventional varieties due to higher economically valuable traits. The article presents experimental data on the study of biological and morphological features of cucumber baselines for the production of heterotic hybrids, as well as new agrotechnological methods of growing seedlings, which reduce the economic costs of obtaining pure cucumber lines. As a result of studying the initial maternal lines, it was found that for the development of the aboveground and underground parts of the plant, it is necessary to use ℓ-80 and ℓ-154 to successfully obtain seeds. To get more male flowers when growing seedlings of maternal lines, it is necessary to sow 2 seeds in each pot at a distance of 2-3 cm. In the course of research, a unique method for obtaining male flowers has been developed by changing the density of the standing of the mother cucumber plants (application for patent of the Russian Federation No. 2023131502 dated 11/28/2023).

## 1 Introduction

Currently, there are different ways to obtain hybrid cucumber seeds. Nevertheless, all of them require a lot of manual labor and funds for chemicals and are not always effective in obtaining seeds.

Over the past 20-25 years, heterotic hybrids of vegetable crops have spread widely around the world, which was facilitated by their high yield and increased resistance to abiotic environmental factors. Heterotic hybrids in greenhouses in Russia, as well as all over the world, have completely replaced conventional varieties-populations, significantly surpassing them in yield, precocity and resistance to adverse environmental conditions. On average, the yield of first-generation hybrids usually exceeds the yield of the parents by 30% [1,6-9].

Due to the organization of seed production in Russia of existing high-yielding heterotic hybrids and the breeding of new even more productive ones with new useful properties, it has become possible to use seeds of domestic breeding in industrial greenhouses, the production of which must be constantly increased. In cucumber culture, the use of

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predominantly female flowering plants as a component contributes to an increase in the percentage of yield of useful heterotic hybrids [2-4].

Increasing the yield of seeds of gerotic hybrids from seeds of female lines and accelerating the process of variety reproduction while reducing the labor intensity of the method without using chemicals to convert female plants into a male type of flowering, while reducing manual labor, is an urgent and important task of breeding and seed production.

In the process of observing and studying the biological and morphological features of cucumber plants, for the first time we have established unique features of the influence of the density of standing female cucumber lines on the manifestation of male sexualization in a single-species community, which significantly reduces the cost of obtaining hybrid cucumber seeds and increases the profitability and efficiency of seed production of this crop as a whole.

The problem is solved by the fact that in seed production of heterotic hybrids, seeds of only female lines are used, and part of the seedlings grown from seeds of female lines of seedlings are physiologically transferred to male-type plants by compacted seeding, 2-3 seeds are thickened in a pot instead of one plant as for female plants, and in the phase 5-6 leaves of the seedling period (age 15-20 days) (stage 5-7 of organogenesis) seedlings with signs of the male type are planted as male plants for crosses as pollinators according to the accepted placement scheme according to the ratio of female and male plants, while the prepared seeds of the female line are sown one at a time in a pot with a volume of 0.4-0.5 liters at an angle of 40-50 degrees down with the sharp end to a depth of 0.8-1.5 cm, and the seeds planned for transfer to male plants are sown thickened in pots at a distance of 2-3 cm between them. At the same time, sowing of seeds converted to the male type of flowering is carried out 7-15 days earlier than seeds for growing female plants, and when growing hybrids from seeds of female lines in plantings on 3-5 female plants, one plant is planted, converted to the male type according to the proposed method [10, 17].

The main parameters and indicators of the proposed method such as sowing 2-3 seeds of female lines at a distance of 2-3 cm with thickened sowing in a pot, the size of the pots, the timing of sowing seeds, the ratio of the number of maternal and paternal plants during cultivation are determined practically empirically and are considered the optimal proposed methods for obtaining seeds.

Sowing seeds of plants transferred to the male type of flowering 7-15 days earlier than seeds for growing female plants is due to the fact that by the time the mother plants bloom, there are enough male flowers on the paternal plants transferred from the female, which is confirmed empirically in experiments.

To substantiate the method, seedlings were grown in an unheated polycarbonate greenhouse. Seedlings were watered with water at a temperature of 25-29°C at the rate of 4-5 liters per 1 $m^2$, gradually impregnating the substrate with moisture [11, 13, 15-16].

## 2 Research methodology and Methods

Before sowing, the seeds were soaked for 12 hours at room temperature in a solution where, based on 10 liters of water, there was 5 g of double superphosphate, 10 g of potassium nitrate and 0.2 g of manganese sulfate. Then they were dried on an open surface, powdered with trichodermine (4g per 1 kg of seeds). The swollen but not sprouted seeds were sown.

The soil for the pots was prepared on the site. 0.5g of ammonium nitrate, 1 g of potassium nitrate, 1.5g of double superphosphate, 0.3g of magnesium sulfate and trace elements: 0.3g of copper sulfate, 0.3g of zinc sulfate, 0.06g of ammonium molybdenum, 11 g of manganese sulfate, were added to 10 liters of water. Pots with a diameter of 10-12 cm and a height of 10 cm are installed in boxes. Before sowing, the soil in pots was watered with warm water (soil moisture should be 85%, and the temperature 25℃ [2, 12].

The sowing period is May 12-13. To start obtaining seeds for the propagation of valuable lines, it is necessary to have their own pollen. To do this, you will have to change the sexual orientation of a part of the plants of each line.

When growing seedlings of female lines in advance (7-15 days in advance), not one seed was sown in some pots, as usual, but two or three. It was noticed where 2-3 seeds were planted, one of the plants had male flowers, which is very important for obtaining pure-grade seeds from female lines.

One, two, three seeds were sown in a pot to a depth of 0.5-1cm and covered with a 1 cm substrate of the same composition as the pot mixture.

## 3 Results

The effect of the density of the female lines of the cucumber plant on the manifestation of male sexualization in a single-species community is presented in Table 1.

Table 1 shows that under the influence of an increase in the density of standing, the ratio of male and female plants in pots changes. On average, studies have shown that to get more male flowers, it is necessary to plant cucumber plants not one at a time in a pot, as is customary, but 2-3 at a time. At the same time, it was noticed that all lines show their ability to transform female flowers into male flowers in different ways in the community. For example, the strongest manifestation of male sexualization in the ℓ-80 community, where, with a community of 2-3 plants in one pot, female flowers turn into male flowers at the fifth stage of morphogenesis by 100%. In ℓ-154, when planting two plants in one pot, the transformation of female flowers into male flowers occurs in 75% of plants. There is a 52% conversion at lines 585(127), and a 38% conversion at lines 585(2). With single placement, frequent female lines of transformations were not noticed.

**Table 1.** The effect of the density of the female lines of the cucumber plant on the manifestation of male sexualization in a single-species community.

| Initial mother lines | Density of standing plants in 1 pot, pieces | Average | |
|---|---|---|---|
| | | ♀, % | ♂, % |
| ℓ-168 | 1 | 100 | 0 |
| | 2 | 75 | 25 |
| ℓ-80 | 1 | 100 | 0 |
| | 2 | 0 | 100 |
| | 3 | 0 | 100 |
| ℓ-72 | 1 | 100 | 0 |
| | 2 | 83 | 17 |
| | 3 | 50 | 0 |
| ℓ-585(127) | 1 | 100 | 0 |
| | 2 | - | - |
| | 3 | 48 | 52 |
| ℓ-585(2) | 1 | 100 | 0 |
| | 2 | 80 | 20 |
| | 3 | 89 | 11 |
| | 4 | 62 | 38 |
| ℓ-154 | 1 | 100 | 0 |
| | 2 | 25 | 75 |
| ℓ-22-49(2) | 1 | 100 | 0 |
| | 2 | 67 | 33 |
| ℓ-22-49(1) | 1 | 100 | 0 |

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| | | | |
|---|---|---|---|
| | 2 | 70 | 30 |
| ℓ-22-49(5) | 1 | 100 | 0 |
| | 2 | 62 | 38 |

At the same time, it was noticed that all lines show their ability to transform female flowers into male flowers in different ways in the community. For example, the strongest manifestation of male sexualization in the ℓ-80 community, where, with a community of 2-3 plants in one pot, female flowers turn into male flowers at the fifth stage of morphogenesis by 100%. In ℓ-154, when planting two plants in one pot, the transformation of female flowers into male flowers occurs in 75% of plants. There is a 52% conversion at lines 585(127), and a 38% conversion at lines 585(2). With single placement, frequent female lines of transformations were not noticed.

Seedlings were planted in 3 pieces per 1 $m^2$ at the age of 30 days.

The search experiment for obtaining seeds of heterotic hybrids according to the proposed method was laid down according to the scheme (Table 2)

The scheme includes the best lines available on the farm.

Total area of the greenhouse - 500 $m^2$.

Accounting (inventory) area of plots in the experiment - 3.6 $m^2$

Plot length - 3 m. Plot width - 120 cm. Bed width - 90 cm.

The repetition is threefold

The location of the plots is systematic, considering the microclimatic zones.

All observations were carried out according to the methods of protected soil. Initially, 600 plants of nine lines participated in the experiment, after selection – 130 plants of five lines.

The size of the accounting plots is 2 $m^2$. Control is a plant without a community.

The following calculations and observations were carried out in the experiment:

Phenological observations of the emergence of seedlings, the unfolding of the 1st, 3rd and 5th leaves, the onset of the planting phase, flowering, beginning and end of fruiting;

Biometric observations of the growth of female lines when planting one seed in a pot and the development of plants in seedlings and during fruiting: the length of the main stem, lateral shoots, the number of leaves on the stem, on lateral shoots, the number of lateral shoots, the length and width of the leaf, the total aboveground mass, the mass of the main stem, lateral shoots, leaves, roots, the total length and volume of the roots;

The mathematical processing was done according to B.A. Dospekhov (1985) [5].

For the care of plants, agrotechnics recommended by UralNIISHKhoz (A.V. Yurina et al., 1989) [14].

**Table 2.** The scheme of the search experiment.

| Initial mother lines | Density of standing plants in 1 pot, pieces | Repetitions | | |
|---|---|---|---|---|
| | | X | X | X |
| ℓ-168 | 1 | X | X | X |
| | 2 | X | X | X |
| ℓ-80 | 1 | X | X | X |
| | 2 | X | X | X |
| | 3 | X | X | X |
| ℓ-72 | 1 | X | X | X |
| | 2 | X | X | X |
| | 3 | X | X | X |
| ℓ-585(127) | 1 | X | X | X |
| | 2 | X | X | X |
| | 3 | X | X | X |
| ℓ-585(2) | 1 | X | X | X |

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| | | | | |
|---|---|---|---|---|
| | 2 | X | X | X |
| | 3 | X | X | X |
| | 4 | X | X | X |
| ℓ-154 | 1 | X | X | X |
| | 2 | X | X | X |
| ℓ-22-49(2) | 1 | X | X | X |
| | 2 | X | X | X |
| ℓ-22-49(1) | 1 | X | X | X |
| | 2 | X | X | X |
| ℓ-22-49(5) | 1 | X | X | X |
| | 2 | X | X | X |

The plants were tied up to a height of 180 cm, the lateral shoots were limited in growth, pinching the tips to prevent overgrowth. Watering during the fruiting period was carried out every day. Root fertilization was not carried out, foliar fertilization – 2 times a week on leaves with urea 15g/10l.

All manifestations of male sexualization are noticed before the appearance of 5-6 leaf axils. Therefore, it is necessary to calculate the sowing time for seedlings to obtain pollen for pollination of seed plants. At the same time, it must be remembered that the last crossing must be done no later than 55-60 days before the end of the culture. It is necessary to sow cucumber plants according to the schedule, considering the timing of the flowering of the female flowers of each line on the mother plant.

It was important to check whether the female lines were kept clean in the offspring, whether male flowers would appear on them when the plants were sitting in a pot alone.

A specially staged experiment showed that this did not happen. Female plants have retained their sexual orientation.

The fruits and seeds of the female lines of the cucumber plant were obtained in the experiment using a newly developed method.

Even more clearly, the transformation of female flowers into male ones is visible in Figures 1 and 2, where the presence of male and female plants planted in the same pot at a distance of 3 cm is clearly visible during the experiment.

**Fig. 1.** The manifestation of male sexualization in cucumber plants.

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**Fig. 2.** Transformation of female flowers into male flowers in cucumber plants.

5 fruits were left on one plant, which were obtained by manual pollination with pollen from the male part. Studies have shown that the formation of seeds in fruits occurred differently in different lines.

The study showed that the studied lines had some differences in the passage of phenophases. This is shown in tables 3 and 4.

**Table 3.** Data from phenological observations of pure maternal lines studied.

| Initial mother lines | Date | | | | | |
|---|---|---|---|---|---|---|
| | sowing | shoots | Leaf emergence | | | planting |
| | | | 1st | 2nd | 3rd | |
| ℓ-168 | 12.05 | 16.05 | 01.06 | 13.06 | 21.06 | 24.06 |
| ℓ-80 | 13.05 | 17.05 | 01.06 | 14.06 | 22.06 | 24.06 |
| ℓ-72 | 13.05 | 17.05 | 30.05 | 13.06 | 22.06 | 24.06 |
| ℓ-585(127) | 12.05 | 14.05 | 29.05 | 10.06 | 20.06 | 24.06 |
| ℓ-154 | 13.05 | 17.05 | 29.05 | 15.06 | 21.06 | 24.06 |

The analysis of the passage of phenophases showed that the period from sowing to germination was the shortest in ℓ-585(127).

**Table 4.** Duration of interphase periods of the studied pure lines.

| Initial mother lines | Duration of phenophase passage, days | | | | |
|---|---|---|---|---|---|
| | From sowing to germination | Leaf emergence | | | planting |
| | | 1st | 2nd | 3rd | |
| ℓ-168 | 5 | 16 | 29 | 37 | 40 |
| ℓ-80 | 5 | 15 | 29 | 37 | 39 |

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| | | | | | |
|---|---|---|---|---|---|
| ℓ-72 | 5 | 14 | 28 | 37 | 39 |
| ℓ-585(127) | 5 | 16 | 28 | 38 | 42 |
| ℓ-154 | 5 | 13 | 30 | 36 | 39 |

The shortest period before the formation of the 1st leaf was in ℓ-154 and lasted only 13 days, whereas in ℓ-168 and ℓ-585(127) it was the longest and lasted 16 days, i.e. 3 days longer. Accordingly, ℓ-154 has a faster development, and later in ℓ-168 and ℓ-585(127). It took from 28 to 30 days for the formation of the 3rd leaf from mass shoots. It took from 36 days for ℓ-154 to 38 days for ℓ-585(127) to form the 5th sheet.

A correlation was observed between the duration of the passage of phenophases from seedlings to the 1st and 5th leaves. The earlier the 1st sheet is formed, the earlier the 5th sheet appears. The correlation coefficient is r=0.813, which indicates a high correlation dependence.

The shoot-forming ability is indicated in Table 5, where it can be noted that the largest length of the main stem was ℓ-80 and ℓ-154, and the smallest ℓ-168. The first differed from the last by 34%. The largest length of all stems was in ℓ-154.

**Table 5.** Characteristics of the shoot-forming ability of the initial forms.

| Initial mother lines | Number of lateral shoots, pcs. | Length, cm | | | Length of the lateral shoots of the total length of the stems, % |
|---|---|---|---|---|---|
| | | Lateral shoots | Main stem | All stems | |
| ℓ-168 | 12 | 810 | 278 | 1088 | 74,4 |
| ℓ-80 | 11 | 967 | 372 | 1339 | 72,2 |
| ℓ-72 | 4 | 550 | 327 | 877 | 62,7 |
| ℓ-585(127) | 0 | 0 | 333 | 333 | 0 |
| ℓ-154 | 13 | 1266 | 336 | 1602 | 79,0 |

The accumulation of raw and dry biomass by plants by the end of the growing season can be judged by Table 6.

The data in table 6 show that the lines differed quite sharply from each other in this indicator. For example, the raw mass of the whole plant was from 180 to 630 g, i.e. 3 times the mass of ℓ-154 was less than the mass of ℓ-168. In the process of mathematical data processing, the correlation dependence of the crude mass of lateral shoots on the crude mass of the entire plant was revealed with a correlation coefficient of r=0.99.

**Table 6.** Biomass of the aboveground part of cucumber plants.

| Initial mother lines | Weight, g | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Whole plant | | including main stem | | Including side shoots | | Including leaves | |
| | raw | dry | raw | dry | raw | dry | raw | dry |
| ℓ-168 | 180 | 52,4 | 86 | 17,8 | 60 | 16,3 | 34 | 18,3 |
| ℓ-80 | 588 | 63,2 | 222 | 24,5 | 280 | 24,2 | 36 | 14,5 |
| ℓ-72 | 344 | 31,8 | 158 | 14,7 | 154 | 11,5 | 32 | 5,6 |
| ℓ-585(127) | 268 | 22 | 208 | 14,1 | 0 | 0 | 60 | 7,9 |
| ℓ-154 | 630 | 40,1 | 197 | 14,2 | 349 | 349 | 98 | 8,9 |

The highest yield of dry biomass is in ℓ-80 and ℓ-168, and the lowest is in ℓ-585(127). A direct correlation was observed between the dry mass of the entire plant and the dry mass of the main stem (r=0.879) and the dry mass of the lateral shoots (r=0.924).

All manifestations of male sexualization are noticed before the appearance of 5-6 leaf axils. Therefore, it is necessary to calculate the sowing time for seedlings to obtain pollen for pollination of seed plants. At the same time, it must be remembered that the last crossing must be done no later than 55-60 days before the end of the culture. It is necessary to sow cucumber plants according to the schedule, considering the timing of the flowering of the female flowers of each line on the mother plant.

It was important to check whether the female lines were kept clean in the offspring, whether male flowers would appear on them when the plants were sitting in a pot alone.

A specially staged experiment showed that this did not happen. Female plants have retained their sexual orientation.

By a newly developed method, seeds of female cucumber plant lines were obtained in the experiment (Table 7) with control of germination of the obtained seeds.

Three seed plants were grown per 1 m$^2$. 5 fruits were left on one plant, which were obtained by manual pollination with pollen from the male part. Studies have shown that the formation of seeds in fruits occurred differently in different lines.

**Table 7.** Seed yield and its structure depending on the line.

| No. of ℓ | Number of seeds, pcs. | | | | | Seed yield, g | | | Germination rate, % |
|---|---|---|---|---|---|---|---|---|---|
| | In 1 fruit | | | | Completed from 1 m$^2$ | In 1 fruit | From 1 m$^2$ | 1000 pcs. | |
| | Total | Including | | | | | | | |
| | | completed | | empty | | | | | |
| | | pcs. | % | | | | | | |
| 5 | 113 | 15 | 13,3 | 98 | 225 | 0,58 | 8,70 | 38,67 | 100 |
| 7 | 158 | 130 | 82,3 | 28 | 1950 | 4,52 | 67,80 | 34,77 | 80 |
| 8 | 131 | 115 | 87,8 | 16 | 1725 | 3,76 | 56,40 | 32,70 | 100 |
| 11 | 103 | 70 | 67,0 | 33 | 1050 | 2,73 | 40,95 | 39,00 | 80 |
| 17 | 17 | 13 | 76,5 | 4 | 195 | 0,47 | 7,05 | 36,15 | 100 |
| 41 | 216 | 203 | 93,0 | 13 | 3045 | 6,95 | 104,25 | 34,24 | 100 |
| 42 | 87 | 87 | 100,0 | 0 | 1305 | 2,41 | 36,15 | 27,70 | 100 |
| 48 | 49 | 36 | 73,5 | 13 | 540 | 1,03 | 15,45 | 28,61 | 80 |
| 50 | 93 | 54 | 58,1 | 39 | 810 | 1,99 | 29,85 | 36,85 | 60 |
| 51 | 247 | 145 | 58,7 | 102 | 2175 | 5,12 | 76,80 | 35,31 | 100 |
| 55 | 49 | 46 | 93,9 | 3 | 690 | 1,52 | 22,80 | 33,04 | 100 |
| 60 | 200 | 180 | 90,0 | 20 | 2700 | 6,17 | 92,55 | 34,28 | 100 |
| 61 | 197 | 182 | 92,4 | 15 | 2730 | 5,73 | 85,95 | 31,48 | 33 |
| 65 | 169 | 65 | 38,5 | 104 | 975 | 1,98 | 29,70 | 30,46 | 100 |
| 72 | 146 | 107 | 73,3 | 39 | 1605 | 3,49 | 52,35 | 32,62 | 100 |
| 75 | 165 | 44 | 26,7 | 121 | 660 | 1,41 | 21,15 | 32,05 | 56 |
| 77 | 147 | 63 | 42,9 | 84 | 945 | 2,21 | 33,15 | 35,08 | 100 |
| 78 | 348 | 92 | 26,4 | 256 | 1380 | 3,06 | 45,90 | 33,26 | 100 |
| 79 | 201 | 66 | 32,8 | 135 | 990 | 2,10 | 31,50 | 31,82 | 100 |
| 86 | 179 | 111 | 62,0 | 68 | 1665 | 3,95 | 59,25 | 35,59 | 92 |

$LSD_{05}$ 1,58. Experimental error is 1.2%. $F_f > F_t$.

Mathematical processing of the experimental data showed that all the differences in the variants are significant, since they are greater than the value of the smallest significant difference ($LSD_{05}$).

The largest number of seeds in the fruit was obtained from line 78, where the seed yield was 348 pieces, 92 of them were completed, which was 26.4%. The second place in terms of fruit content with seeds was taken by line 51, the total number of seeds of which was 247 pieces, 145 were completed, which amounted to 58.7%. Thus, line 51 is more productive than line 78. Line 41 is in third place. The number of seeds in the fruit is 216, of which 203 are completed, which was 93%. The highest yield of seeds from 1 $m^2$ was in the lines: 41 – 3045 pieces, 61 – 2730 pieces, 60 – 270 pieces.

The percentage of the yield of completed seeds was the highest in line 42 – 100%

If we express the yield of seeds in weight units, we get the highest yield from 1 $m^2$ in ℓ-41 – 104.25 g. ℓ-60 – 92.55 g and ℓ-61 – 85.95 g, and the lowest in line 17 – 7.05 g.

When considering the absolute weight of 1000 pieces of seeds, the first place was secured by ℓ-11 – 39 g, the second place ℓ-5 – 38.67 g, the third place - ℓ-50 – 36.85 g.

Thus, the breeder can be recommended to use the following lines in breeding: ℓ-41, ℓ-51 and ℓ-60, since they have 100% germination, the highest yield of pure seeds and their high yield from 1 $m^2$, quite a good indicator of absolute weight.

In the technological map, we find production costs, which consist of wages, labor costs with accruals, depreciation and maintenance costs, planting material, fuel, as well as other costs for organization and management.

The estimated realizable value of the seeds obtained in the experiment, rub. is presented in Table 8.

**Table 8.** The realization value of the completed seeds, rub.

| No. of ℓ | The realization value of the completed seeds, rub. | | |
|---|---|---|---|
| | From 1 fruit | From 1 plant | From 1 $m^2$ |
| 5 | 58 | 290 | 870 |
| 41 | 695 | 3475 | 10425 |
| 60 | 617 | 3085 | 9255 |

1 kg of seeds = 100000 rub. => 1g = 100 rub.

The economic efficiency of obtaining seeds of female pure lines according to the proposed method is presented in Table 9.

According to the calculation results, line 41 has the highest seed yield (104.25 g/$m^2$), which is 92.55 g/$m^2$ higher than the control. This is due to the peculiarities of the line: 100% germination of seeds, the highest yield of completed seeds from 1 $m^2$.

**Table 9.** Economic efficiency of obtaining seeds of female pure lines according to the proposed method.

| No. of ℓ | Yield g/$m^2$ | PZ, rub/$m^2$ | St.VP, rub/$m^2$ | SB, rub/$m^2$ | NP, rub. | Ur, % |
|---|---|---|---|---|---|---|
| 41 | 104,25 | 556,3 | 10425 | 0,68 | 9868,7 | 1774 |
| 60 | 92,55 | 553,3 | 9255 | 0,82 | 8701,7 | 1573 |
| 5 | 8,70 | 542,4 | 870 | 9,59 | 327,6 | 60 |

Consequently, more costs are needed to obtain seeds of this line (556.3 rubles/$m^2$). Thus, line 41 is the most productive, which means it has the highest gross cost of seeds (10425 rubles/$m^2$), their low cost (0.68 rubles/$m^2$), the highest income of 9898.7 rubles and the highest profitability.

## 4 Discussion and Conclusions

The study of the initial maternal lines in the experiment showed that according to the biometric indicators of the aboveground and underground parts of the plant, to obtain seeds, attention should be paid to ℓ-80 and ℓ-154.

In general, studies have shown that to obtain more male flowers, it is necessary to plant cucumber plants not one at a time in a pot, as is customary, but 2 at a distance of 2-3 cm.

Under the influence of an increase in the density of standing, there is a change in the ratio of male and female plants, but all these manifestations of male suxualization are noticed before the appearance of 5-6 leaf axils.

Correlations were found in the experiment: between the duration of the passage of phenophases from seedlings to the 1st and 5th leaves (the earlier the 1st leaf is formed, the earlier the 5th leaf appears (r=813)); between the shoot-forming ability and the number of lateral shoots (r=0.88).

The developed method for obtaining male flowers by changing the density of the mother plants is simple. It does not require expensive reagents, does without injury to plants and without prejudice to the production of testes on the same plants.

The novelty of the method is that, using only cucumber seeds of female lines without the use of chemicals and other mutagens, and considering the physiology of plants as a factor of their interaction with each other and the natural mutation on thickened plant seedlings, considering the proposed parameters of the method, male cucumber seedlings are grown as pollinators to obtain heterotic seeds hybrids.

It is recommended that breeders use the developed method to obtain seeds of clean lines. According to experience, it is possible to use the following lines in breeding: ℓ-41, ℓ-51, ℓ-60, since they have 100% germination, the highest yield of completed seeds and their high yield from 1 m$^2$, a good indicator of absolute weight.

Manifestations of male sexualization are noticed before the appearance of 5-6 leaf axils, therefore it is necessary to calculate the time of sowing for seedlings to obtain pollen for pollination of seed plants.

It is necessary to sow cucumber plants according to the schedule, considering the timing of the flowering of the female flowers of each line on the mother plant. An unobvious effect of the proposed method is the possibility of obtaining seeds of heterotic cucumber hybrids from plants grown from seeds of only pure female lines with a minimum of additional costs for obtaining male lines (forms) when growing cucumbers in the process of accelerating breeding work.

Thus, in the course of research, a unique method for obtaining seeds of heterotic cucumber hybrids has been developed, which allows to increase seed yield, accelerate the process of variety propagation, reduce labor intensity, production costs and increase the efficiency of seed production of this important agricultural crop.

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