Effect of biological and organic fertilizers on growth processes, productivity and quality of melon fruits under Southeastern Kazakhstan

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Abstract. In Kazakhstan, melon growing is cultivated using chemical fertilizers. Organic production is not practiced where there being no research. Our country, possessing a great high-quality variety, can be the focus of world community attention as a producer and supplier of ecological melon. Besides economic interests, changeover from traditional methods of cultivation to biological one is of great importance in ecological aspect. Unregulated and too high agrochemicals application causes a number of negative consequences, upwards from soil pollution with severe salts to poisoning caused using low-quality products. The most popular and regulated elements of biological melon cultivation in production include organic fertilizers instead of chemical ones. Therefore, our research is aimed to study bioorganic fertilizers on melon culture under Southeastern Kazakhstan. Scientific experiments were held at the experimental sites of the «Fruit and Vegetable Research Institute» LLP. We experimented using classical research methods generally adopted in melon cultivation. The findings showed that bioorganic fertilizers improve the growth parameters and quality of melon culture, and increase fruit productivity. The yield growth on the studied options for control ranged from 31.23% to 41.71%, depending on the nutritional conditions.

1. Introduction
Kazakhstan watermelons and melons are famous for a great high-quality varieties, fine taste and market quality.

Our country has a great export potential for cucurbits. Edaphoclimatic conditions and significant volumes of agricultural areas of Kazakhstan allow to produce high volumes of gourd fields, thereby providing the domestic market in full [1].

As to statistics from 2021, the cucurbits were cultivated in Kazakhstan on an area of more than 103.5 thousand hectares, and the gross harvest was 2581.3 thousand tons. [2]. Domestic country supply with melon products amounted to 472%.

Melon cultivation is one of the main agricultural sectors of Kazakhstan, which is more to be changed to organic production. It should be noted that if we have a rather high traditional production, there is no organic melon cultivation in the country at all. So, to have a huge potential of productivity, Kazakhstan may well become a supplier of ecological (organic) melon products in the world community.
To changeover from the traditional method of cucurbit cultivation to the organic one grows with the negative chemical effects among consumers caused by the poor quality of the grown products. As we know, 95% of melon products are consumed fresh without being heat-treated. That is why the ecological fruit purity is of great importance. So, the production of natural, high-quality cucurbits is of special importance to guarantee a good, high-quality nutrition, gaining in nation health.

The representatives of domestic and foreign science minding about the chemicalization in traditional melon cultivation find disturbing with the violation of the ecological environmental integrity.

It is known that gourd fields, making high yields of the main and by-products, remove a large amount of nutrients from the soil, thereby depleting soil reserves. Soil nutrition re-entry as mineral fertilizers in high rates is associated with the soil toxic re-entry along with fertilizers. Toxic trace elements found in fertilizers include mercury, cadmium, arsenic and lead [3-4].

Organic melon cultivation is a production system that avoids or significantly excludes the use of chemical (mineral) fertilizers, pesticides and growth regulators, provides for the conservation of the natural ecological balance, minimizing the negative affect of agrochemicals on the environment [5-6].

It is necessary to biologize the main agrotechnologies used in melon cultivation in order to changeover from chemical methods of cultivation to organic ones. The use of organic fertilizers is one of the most popular and regulated elements of biological melon cultivation in production environment.

The value of organic fertilizers is increased by its natural origin. And as scientists note, to renew chemical fertilizers with organic ones, contributes to a natural boosting soil fertility [7-8].

A number of studies show that organic content of soils can be increased through the organic waste addition [9-12].

Besides soil fertility, organic waste contributes to the active plant growth, thus increasing agricultural productivity.

If we add organic waste as a topdressing, it will improve the physical, chemical and biological soil feature, which provides the plants with all the necessary nutrients to stimulate growth and yield [13-16].

Research results in foreign countries show [17] that bio-fertilizers have a significant effect on crop productivity due to microorganisms that contribute to macro- and microelements being more available for plant nutrition. Also, if we use biofertilizers, it will improve the morphological characteristics of plant growth, increase the content of chlorophyll and N, P, K elements, food organs (weight and quantity of fruits/plants) and quality indicators.

Today, there is no scientific information to use organic waste for melon production in Kazakhstan, which makes it more difficult to changeover the melon industry of the country to purely organic production. Therefore, these research results are new, latest and have a high practical value.

Now therefore, scientific studies have been conducted in order to assess the impact of various organic fertilizers (cow manure, poultry manure and biohumus (vermicompost)) and recommended chemical fertilizers (NPK) on melon fruit characteristics (growth parameters, yield and quality) under Southeastern Kazakhstan.

2. Materials and Methods

Edaphoclimatic conditions of experimental areas. Scientific studies were conducted at the experimental laboratory station “Selection of vegetable and berry crops” and in the laboratory “Biosafety and biocontrol of vegetable and berry crops” of the Regional Branch of the Fruit and Vegetable Research Institute LLP “Kainar”, located at the piedmont area of the Southeastern Kazakhstan, at the north face of Zailiyskiy Alatau mountains (1000-1050 m above sea level) during the growing season 2020-2021.

The climate in the piedmont area of the Southeastern Kazakhstan is sharply continental, characterized from high daily and annual fluctuations in air temperature, and by cold winters and long hot summers. The air temperature reaches minimum values in January (-32.35°C), and maximum ones in July (+37.43°C). The warm period lasts 240-275 days, the frost-free is 140-170 days. The total heat (above 0°C) is 3450-3750°C. Relative air humidity reaches a maximum in winter (85-90%), a minimum in summer
The hydrothermal coefficient is 0.7-1.0. The annual quantity of precipitation is 350-600 mm, 120-200 mm falls during the warm period.

The soil cover in the piedmont area of the Southeastern Kazakhstan is characterized from a wide variety of soil types (black soil, chestnut soil, and gray soil).

The experimental station soil of the Kainar Regional Branch is dark chestnut, medium loamy. The higher slice contains 2.9-3.0% of humus; 0.18-0.20% of total nitrogen; 0.19-0.20% of total phosphorus, 30-40 mg/kg of soil P2O5, 350-390 mg/kg of K2O. The capacity of cation exchange is 20-21 mg-equiv. for 100 g. The reaction of the soil solution is slightly alkaline (pH 7.3-7.4). The volume soil mass is 1.1-1.2 kg/cm³, the lowest moisture capacity is 26.6%.

3. Methodology and research objects

The following classical methodologies were used in the research: Methodology of Field Experience (B.I.Dospekhov, 1985) [18]; Methodology of Experimental Work in Vegetable Growing and Melon Cultivation (V.F.Belik, 1992) [19]; Methodology of Watermelon and Melon Breeding (Moscow, 1998) [20].

The biochemical composition of melon fruits was defined according to the following methods: dry substance - weight method (drying); total sugar - according to Bertrand; vitamin C – according to Murri, nitrates - potentiometrically with ion-selective electrodes.

Research objects: dark chestnut soil, melon, phenological phases of development, biometric indicators, organic fertilizers, biological fertilizers, biochemical composition, productivity.

Melon production practices in experiments generally recognized for piedmont area of the Southeastern Kazakhstan, is realized in accordance with the scientific recommendations of the Regional Branch of the Fruit and Vegetable Research Institute LLP “Kainar”.

The melon variety - Prima, released in Almaty region, was cultivated on the experimental areas.

The area of the experimental plot was 28 m² (2.8 m x 10 m). The experiment tiers are 4-fold.

Phenological observations were conducted according to the following phenological phases: seedlings (single, mass), 3-4 true leaves, the shatrik phase, main shoot formation, lateral formation, staminate (male) flowers blooming, pistillate (female) flowers blooming, fruit formation, fruit ripening, and industrial ripeness.

Biometric studies were conducted on the following parameters: the length of the main shoot, stem quantity, internode length, leaflet length, leaf width and length, number of inflorescences and fruits, average fruit weight.

Yield accounting was done during industrial ripeness period of melon fruits using a running method to determine its structure divided at each tier.

As to chemical fertilizer sources at control No. 2 (fertilized control), we used the following: ammonium nitrate (34.5% rate of application N), from phosphoric - double superphosphate (46% rate of application P2O5), potassium chloride (60% rate of application K2O). As to organic fertilizers, we used biohumus (vermicompost), manure, poultry manure, grain straw, biohumus, the content of organic substances, nitrogen, phosphorus and potassium which are presented in Table 1.

### Table 1. Ratio of nutrients in organic fertilizers.

| Organic fertilizers         | Organic substance, % | C:N | N, % | P2O5, % | K2O, % |
|-----------------------------|----------------------|-----|------|---------|--------|
| Rotted manure               | 21                   | 24.4| 0.5  | 0.25    | 0.60   |
| Poultry manure              | 40                   | 14.5| 1.6  | 1.50    | 0.80   |
| Grain straw                 | 35                   | 40.6| 0.5  | 0.25    | 0.80   |
| Biohumus (vermicompost)     | 40                   | 10.5| 2.2  | 1.80    | 1.60   |
The diagram of experimental fields included 8 variants of the experiment:

- **В1**: Control without fertilization (N₀P₀K₀);
- **В2**: Control with mineral fertilizers (N₁₂₀P₁₂₀K₁₅₀);
- **В3**: Biohumus (10 t/ha);
- **В4**: Biohumus (15 t/ha);
- **В5**: Rotted manure (40 t/ha);
- **В6**: Poultry manure (5 t/ha);
- **В7**: Poultry manure (10 t/ha);
- **В8**: Grain straw (3 t/ha) + minimum norms of mineral fertilizers (N₉₀P₆₀K₆₀).

### 4. Results and Discussion

Cucurbit further yield is defined using sophistication of the vegetative plant biomass. As a result, the assimilation surface decline of melon leaves at the competitive enhancement and formation of vegetative organs may have a negative affect on the level of productivity. Low volume of the leaf area leads to a decrease in photosynthesis, in the process of which the plants are suppressed and the size of the fruit is lost. The cucurbit leaves are the main extension shoot of nutrients to the fruits [21]. Therefore, the longer and greener the leaves, the grosser and tastier the fruits.

Take all these points together, we have studied the effect of organic and biological fertilization methods on the main phenological growth phases and biometric indicators of melon plants. The results of phenological observations at experimental areas showed the main phases of plant growth occurred a few days earlier in the experiments, where different types of bioorganic fertilizers were applied under the melon, than in control No. 1, where fertilizers were not used at all.

![Figure 1. The effect of various types and combinations of biological and organic fertilizers on the phenological indicators of melon culture, 2020-2021.](image)

We can explain process acceleration of plant growth by the positive effect of bioorganic fertilizers on root growth dynamics and thus, the underground plant mass. Periods of beginning and end of a certain phenological phase on melon were faster on variants where manure was applied usually 40 t/ha (В5),
biohumus - 15 t/ha (B4) and poultry manure - 10 t/ha (B7). There was also an increase in growth processes during the second control variant, where the plants were fertilized with the full rate of mineral fertilizers (N120P120K150). As to non-fertilized control (B1), all the processes of melon plant growth were late and occurred on average from 2 to 6 days later than the subjects (Figure 1).

We conducted biometric studies in the phases to qualify the growth and development intensity of melon plants, their formation of green mass and nutritive organs at all experimental areas: flagelliform - early bloom and mass bloom - fruit formation. As to research results, we found biometric plant indicators were higher than the first control (B1) in all parameters using variants with different combinations of organic and biological fertilizers. The highest rates were recorded in variants (B5), (B4) and (B7) during the period of intensive growth of the biological melon mass (Tables 2, 3-4).

The smallest indicators of melon growth, such as the length of the main shoot, the quantity of stems, root thickness, internode length, leaf width, leaf length, quantity of inflorescences, quantity of fruits, fruit diameter and average weight of the 1st fruit according to the results of 2-year studies were recorded on the control without fertilizers (B1). The recommended fertilizer rate (T2) had a great effect on the parameters of melon growth, followed by manure (T5).

**Table 2. Effect of various types and combinations of biological and organic fertilizers on the formation of melon plant biomass (flagelliform - early bloom), 2020-2021.**

| Prototype options | Years | Length of the main shoot, cm | Literal quantity, pcs. | Base thickness, cm | Internode length, cm | Staminate (male) flowers, pcs. | Pistillate (female) flowers, pcs. | Button quantity, pcs. | Average plant weight, g |
|-------------------|-------|-----------------------------|------------------------|-------------------|---------------------|-----------------------------|-----------------------------|----------------------|----------------------|
| B1                | 2020  | 56.30                       | 5.60                   | 1.40              | 5.40                | 5.35                        | 0.82                        | 0.42                 | 193.3                |
|                   | 2021  | 57.02                       | 4.00                   | 0.89              | 4.83                | 2.95                        | 0.92                        | 0.47                 | 197.7                |
| Average           |       | 56.66                       | 4.80                   | 1.14              | 5.11                | 4.15                        | 0.87                        | 0.45                 | 195.5                |
| B2                | 2020  | 69.80                       | 6.92                   | 1.76              | 6.31                | 7.77                        | 1.35                        | 0.95                 | 235.4                |
|                   | 2021  | 68.05                       | 4.65                   | 1.06              | 5.49                | 4.90                        | 1.47                        | 1.10                 | 301.9                |
| Average           |       | 68.92                       | 5.78                   | 1.41              | 5.90                | 6.33                        | 1.41                        | 1.02                 | 268.6                |
| B3                | 2020  | 61.92                       | 5.82                   | 1.49              | 5.82                | 6.67                        | 1.00                        | 0.70                 | 224.2                |
|                   | 2021  | 65.47                       | 4.37                   | 0.97              | 5.13                | 4.62                        | 1.10                        | 0.85                 | 264.1                |
| Average           |       | 63.70                       | 5.10                   | 1.23              | 5.48                | 5.65                        | 1.05                        | 0.77                 | 244.1                |
| B4                | 2020  | 66.32                       | 5.95                   | 1.59              | 5.94                | 6.97                        | 1.25                        | 0.80                 | 229.4                |
|                   | 2021  | 64.25                       | 4.12                   | 0.88              | 4.90                | 4.67                        | 1.05                        | 0.55                 | 253.6                |
| Average           |       | 65.28                       | 5.04                   | 1.23              | 5.42                | 5.82                        | 1.15                        | 0.67                 | 241.5                |
| B5                | 2020  | 70.65                       | 6.25                   | 1.69              | 6.28                | 6.95                        | 1.22                        | 0.85                 | 238.6                |
|                   | 2021  | 67.75                       | 4.70                   | 1.05              | 5.35                | 4.77                        | 1.22                        | 0.92                 | 292.7                |
| Average           |       | 69.20                       | 5.47                   | 1.37              | 5.81                | 5.86                        | 1.22                        | 0.89                 | 265.6                |
| B6                | 2020  | 60.50                       | 5.67                   | 1.48              | 5.43                | 6.47                        | 0.90                        | 0.62                 | 230.8                |
|                   | 2021  | 62.40                       | 4.35                   | 0.93              | 5.08                | 4.50                        | 1.05                        | 0.67                 | 262.2                |
| Average           |       | 61.40                       | 5.01                   | 1.20              | 5.25                | 5.48                        | 0.97                        | 0.65                 | 246.5                |
| B7                | 2020  | 66.30                       | 5.90                   | 1.59              | 5.91                | 6.85                        | 1.05                        | 0.75                 | 238.5                |
|                   | 2021  | 64.90                       | 4.42                   | 0.94              | 5.18                | 4.62                        | 1.17                        | 0.97                 | 280.7                |
| Average           |       | 65.60                       | 5.16                   | 1.27              | 5.55                | 5.74                        | 1.11                        | 0.86                 | 259.6                |
| B8                | 2020  | 60.40                       | 5.42                   | 1.40              | 5.74                | 5.97                        | 0.85                        | 0.50                 | 210.5                |
### Table 3. Effect of various types and combinations of biological and organic fertilizers on the formation of melon plant biomass (mass bloom - fruit formation), 2020-2021.

| Prototype options | Years | Length of the main shoot, cm | Literal quantity, pcs. | Base thickness, cm | Internode length, cm | Leaflet length, cm |
|-------------------|-------|------------------------------|------------------------|-------------------|---------------------|-------------------|
| B1                | 2020  | 84.10                        | 5.65                   | 2.44              | 6.30                | 5.81              |
|                   | 2021  | 84.45                        | 5.20                   | 1.85              | 6.30                | 5.75              |
| Average           |       | **84.27**                    | **5.42**               | **2.14**          | **6.30**            | **5.78**          |
| B2                | 2020  | 110.78                       | 6.25                   | 3.14              | 8.81                | 7.75              |
|                   | 2021  | 108.60                       | 5.90                   | 2.25              | 8.39                | 7.06              |
| Average           |       | **109.69**                   | **6.07**               | **2.69**          | **8.60**            | **7.40**          |
| B3                | 2020  | 89.15                        | 5.80                   | 2.71              | 6.53                | 6.05              |
|                   | 2021  | 93.45                        | 5.55                   | 1.91              | 6.60                | 5.79              |
| Average           |       | **91.30**                    | **5.67**               | **2.31**          | **6.56**            | **5.92**          |
| B4                | 2020  | 95.90                        | 5.90                   | 2.88              | 6.67                | 6.36              |
|                   | 2021  | 97.40                        | 5.60                   | 2.03              | 6.65                | 5.82              |
| Average           |       | **96.65**                    | **5.75**               | **2.45**          | **6.66**            | **6.09**          |
| B5                | 2020  | 110.51                       | 6.05                   | 2.96              | 8.60                | 7.66              |
|                   | 2021  | 104.60                       | 5.60                   | 2.04              | 6.93                | 6.02              |
| Average           |       | **107.55**                   | **5.82**               | **2.50**          | **7.76**            | **6.84**          |
| B6                | 2020  | 91.35                        | 5.65                   | 2.74              | 6.65                | 6.11              |
|                   | 2021  | 95.45                        | 5.35                   | 1.99              | 6.50                | 5.75              |
| Average           |       | **93.40**                    | **5.50**               | **2.36**          | **6.57**            | **5.93**          |
| B7                | 2020  | 93.35                        | 5.65                   | 2.77              | 6.73                | 6.22              |
|                   | 2021  | 100.45                       | 5.55                   | 2.04              | 6.57                | 5.82              |
| Average           |       | **96.90**                    | **5.60**               | **2.40**          | **6.65**            | **6.02**          |
| B8                | 2020  | 100.40                       | 5.75                   | 2.70              | 7.97                | 7.12              |
|                   | 2021  | 101.50                       | 5.55                   | 1.99              | 6.91                | 5.95              |
| Average           |       | **100.95**                   | **5.65**               | **2.35**          | **7.44**            | **6.53**          |

### Table 4. Effect of various types and combinations of biological and organic fertilizers on the formation of melon plant biomass (mass bloom - fruit formation), 2020-2021.

| Prototype options | Years | Leaf width, cm | Leaf length, cm | Inflorescence quantity, pcs. | Fruit quantity, pcs. | Fruit diameter, cm | Average weight of the 1st fruit, g |
|-------------------|-------|----------------|----------------|-------------------------------|----------------------|-------------------|-----------------------------------|
| B1                | 2020  | 7.66           | 6.88           | 13.35                         | 1.40                 | 8.37              | 286.5                             |
|                   | 2021  | 7.65           | 6.33           | 11.20                         | 1.50                 | 8.39              | 293.3                             |
| Average           |       | **7.65**       | **6.60**       | **12.27**                     | **1.45**             | **8.38**          | **289.9**                        |
| B2                | 2020  | 10.28          | 8.79           | 20.00                         | 2.25                 | 10.66             | 530.6                             |
|                   | 2021  | 10.24          | 8.17           | 17.30                         | 2.20                 | 10.77             | 564.0                             |
| Average           |       | **10.26**      | **8.48**       | **18.65**                     | **2.22**             | **10.71**         | **547.3**                        |
| B3                | 2020  | 8.54           | 7.30           | 13.65                         | 1.55                 | 9.20              | 382.5                             |
|                   | 2021  | 8.37           | 6.68           | 11.70                         | 1.75                 | 8.78              | 387.1                             |
| Average           |       | **8.45**       | **6.99**       | **12.67**                     | **1.65**             | **8.99**          | **384.8**                        |
The biochemical fruit composition is allied to plant nutrition conditions. Optimal nutrition greatly improves the quality of grown products, and extra fertilizer rates, on the contrary, worsen.

The quality indicators of melon fruits as dry substance, total sugar content, vitamin C and NO₃-N, depending on the types of fertilizers, are shown in Table 5.

The recommended rate of chemical fertilizers (B 2), as a rule, had the highest content of dry substance, total sugar content, vitamin C and NO₃-N compared to other prototype options. The high nitrate content in fruits grown using synthetic fertilizers may be related to a faster release of NPK nutrients than with the organic applied method. The authors have reported on a faster supply of nutrients from inorganic fertilizers compared to organic sources in other similar studies [22-23]. Low NO₃-N values at control No. 1 are related to that there is no topdressing on these prototype options from inorganic fertilizers compared to organic sources in other similar studies [22-23]. Low NO₃-N content in the melon pulp did not exceed the maximum allowed concentration (90 mg/kg for melon), which indicates the safety of the grown products.

Vitamin C is an important water-soluble vitamin involved in many life processes, apart from its antioxidant properties [24]. The content of ascorbic acid in agricultural crops may vary depending on environmental factors and pressure, such as light intensity, temperature, humidity, and pollution [25]. According to bioorganic fertilizers, the highest content of ascorbic acid was saved up on such options as manure (B5) and poultry manure (B7). As to other prototype options, this indicator was consistently higher than the non-fertilized control (B1).

The sugar melon content is one of the main indicators of fruit quality. The highest content of total sugar content in fruits to non-fertilized control (B1) was observed during addition of poultry manure (B7) and biohumus (vermicompost) (B4).

The content of dry soluble substances in prototype options ranged from 11.24 to 14.95%. The lowest content on average was indicated in option, where biohumus was added under melon plants, at a rate of 10 t/ha. However, a literature review shows [26-27] that the content of dry substances on melon culture did not exceed 8.5% in scientific studies with other types of bioorganic waste.

|  | 2020 | 2021 | Average |
|---|----|----|-------|
| B4 | 9.03 | 8.98 | 9.00 |
|  | 7.59 | 6.68 | 7.13 |
|  | 14.05 | 12.10 | 13.07 |
|  | 1.70 | 2.00 | 1.85 |
|  | 9.41 | 9.48 | 9.44 |
|  | 413.9 | 408.5 | 411.2 |
| B5 | 10.42 | 9.53 | 9.97 |
|  | 8.68 | 7.20 | 7.94 |
|  | 16.70 | 13.70 | 15.20 |
|  | 2.00 | 1.95 | 1.97 |
|  | 10.36 | 9.76 | 10.06 |
|  | 510.2 | 522.9 | 516.5 |
| B6 | 8.78 | 8.66 | 8.72 |
|  | 7.33 | 6.66 | 6.99 |
|  | 12.88 | 10.55 | 11.71 |
|  | 1.55 | 1.60 | 1.57 |
|  | 9.14 | 8.79 | 8.96 |
|  | 384.9 | 396.9 | 390.9 |
| B7 | 8.87 | 9.26 | 9.06 |
|  | 7.32 | 7.05 | 7.18 |
|  | 13.10 | 13.15 | 13.12 |
|  | 1.65 | 1.85 | 1.75 |
|  | 9.27 | 9.50 | 9.38 |
|  | 392.1 | 470.6 | 431.3 |
| B8 | 9.93 | 9.38 | 9.65 |
|  | 8.06 | 7.01 | 7.53 |
|  | 13.75 | 11.95 | 12.85 |
|  | 1.90 | 1.75 | 1.82 |
|  | 9.63 | 9.27 | 9.45 |
|  | 458.9 | 443.4 | 451.1 |
Table 5. Effect of various types and combinations of biological and organic fertilizers on the quality indicators of melon fruits, 2020-2021.

| Prototype option | Dry substance, % | Total sugar content, % | Vitamin C, mg % | Nitrates, mg/kg (MAC-90) |
|------------------|------------------|------------------------|-----------------|--------------------------|
|                  | 2020  | 2021  | Average | 2020  | 2021  | Average | 2020  | 2021  | Average | 2020  | 2021  | Average |
| B1               | 11.1  | 14.1  | 12.6    | 8     | 5     | 6       | 15.2  | 15.5  | 15.3    | 18.0  | 17.6  | 18.4    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B2               | 15.0  | 15.6  | 15.3    | 8     | 5     | 6       | 20.6  | 17.4  | 19.0    | 21.1  | 21.1  | 21.1    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B3               | 7.39  |       | 11.2    | 0     | 4     | 2       | 16.8  | 16.6  | 16.7    | 18.4  | 18.5  | 18.4    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B4               | 9.78  |       | 12.4    | 0     | 9     | 8       | 17.2  | 16.6  | 16.9    | 17.1  | 18.5  | 17.8    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B5               | 10.1  |       | 13.2    | 7     | 5     | 1       | 17.4  | 16.3  | 16.8    | 25.0  | 19.8  | 22.4    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B6               | 14.9  |       | 14.9    | 6     | 5     | 4       | 17.0  | 16.5  | 16.7    | 18.4  | 17.6  | 18.0    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B7               | 13.0  |       | 13.9    | 2     | 0     | 6       | 17.2  | 16.5  | 16.9    | 25.0  | 20.8  | 22.9    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |
| B8               | 9.74  | 15.9  | 12.8    | 0     | 2     | 2       | 16.1  | 17.1  | 16.6    | 18.4  | 19.8  | 19.1    |
|                  |       |       |         |       |       |         |       |       |         |       |       |         |

Agricultural yield is the main KPI (key performance indicator) of agricultural technologies. So, against this background, we have qualified melon productivity along with other important indicators, depending on their nutrition conditions, in our research during the development of biological fertilizer systems.

As we can see from the data in Table 6, the recommended rate of chemical fertilizers (N120P120K150) and organic waste used in various standards increased melon yield to non-fertilized control (N0P0K0) due to that there were no nutrition conditions. The fruit yield, depending on the types of bioorganic fertilizers applied, ranged from 21.68 t/ha to 23.41 t/ha. The highest fruit productivity indicator was received under the option with full mineral fertilizer rates (B 2) - 24.21 t/ha. In general, the potential yield of the Prima variety is 20 t/ha. Therefore, we can conclude about the positive effect of fertilizers on the melon fruit productivity. The yield increase to non-fertilized control (B 1) in 2020, depending on the types of bioorganic fertilizers, amounted to 31.48-37.32%, and in 2021 - 38.12-46.44%, in turn. The highest fruit yield with the use of organic waste was received under the option where rotted manure was added to the melon culture at a consumption rate of 40 t/ha (B5).

Table 6. Effect of various types and combinations of biological and organic fertilizers for melon yield, 2020-2021.

| Prototype options | Yield, t/ha | Average | Increase in fruit yield |
|-------------------|-------------|---------|------------------------|
|                   | 2020  | 2021   | 2020  | 2021  | 2020  | 2021  | %       |
| B1                | 1731  | 15.74  | 16.52 | -     | -     | -     | -       |
| B2                | 23.96 | 24.47  | 24.21 | 6.65  | 8.73  | 38.42 | 55.46   |
| B3                | 23.03 | 21.12  | 22.07 | 5.72  | 5.38  | 33.04 | 34.18   |
| B4                | 23.29 | 21.87  | 22.58 | 5.98  | 6.13  | 34.55 | 38.94   |
| B5                | 23.77 | 23.05  | 23.41 | 6.46  | 7.31  | 37.32 | 46.44   |
| B6                | 22.86 | 20.51  | 21.68 | 5.55  | 4.77  | 32.06 | 30.30   |
|     | B7  | B8  |     |     |     |     |
|-----|-----|-----|-----|-----|-----|-----|
|     | 22.97 | 21.74 | **22.35** | 5.66 | 6.00 | 32.70 | 38.12 |
| P, % |     |     |     |     |     |     |     |
| LSD (least significant difference) | 3.95 | 2.02 |     |     |     |     |     |
| t/ha | 0.92 | 0.44 |     |     |     |     |     |

**5. Conclusion**

The research results showed using bioorganic fertilizers had a positive effect on melon fruit characteristics (growth parameters, yield and quality) in the Southeastern Kazakhstan. The yield increase to non-fertilized control (B1) ranged 31.23-41.71%, in turn. The highest productivity indicator was received under the option where rotted manure was added to melon at a rate of 40 t/ha. This is due to the positive effect of organic substances in the fertilizer composition on process development and growth parameters of melon. As to data received, we may conclude that the rotted manure at a rate of 40 t/ha can serve as an alternative method of fertilizing melon culture in the Southeastern Kazakhstan.

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