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Impact of Novel Albit-BR Bio-preparation on Growth, Yield and Quality Characteristics of Tomato Cultivars Raised under Open Field Conditions in Moscow Region

B.K. Yakob[1,2], M.S. Gins[1,3], A.K. Zlotnikov[4]

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ABSTRACT

Background: Tomato (*Solanum lycopersicum* L.) is the second-most important vegetable, following potato for its nutritional, health and economical values worldwide. However, climate change, coupled with the indiscriminate application of inorganic chemicals, is causing tremendous challenges in agricultural production systems.

Methods: In the study, seven different doses "Albit-BR" (0.1, 0.5, 1, 2.5, 5, 10 and 50 L/ha) were used to compare their effect against the control (water alone) in four tomato cultivars namely fonaric, malets, revansh and talisman. The experimental field was laid out in a randomized complete block design (RCBD) with each treatment being replicated three times.

Result: As per the results of the interaction of the variety and the bio-preparation, it was noted that the plants of the varieties treated at a dose of 2.5 liters/ha produced the highest total yields for fonarik (76.48 t/ha), malets (84.35 t/ha) and talisman (85.88 t/ha), while for the revansh variety those plants that received 5 l/ha produced the highest yield (81.06 t/ha). Thus, to maximize the production potential of the tomato crop, it is recommended to choose the Talisman variety and, out of seven doses of the "Albit-BR" bio-preparation, it is better to apply it at a dose of 2.5 liters/ha.

Key words: Albit-BR, Cultivars, Replication, Tomato, Yield.

INTRODUCTION

Tomato is one of the most widely cultivated horticultural crops worldwide (Castrosanto *et al.,* 2021). Tomatoes contain high levels of antioxidants that are beneficial to human health. Among them, polyphenols and carotenoids are important antioxidant substances in tomato fruits, which have anticancer and immunomodulatory effects (Ali *et al.,* 2020). Although tomato comprises a great deal of nutrients that could help in maintaining the health of humans, its sustainability is jeoparadized by the ongoing climate changes, indiscriminate application of synthetic fertilizers and by the use of poor quality irrigation water. Despite the concerns arising regarding the availability of a sufficient quantity of organic materials for agricultural needs, organic nutrient sources are prioritized over synthetic chemicals (Krithika *et al*., 2025).

Previous studies have shown that the application of biostimulants such as seaweed extracts, protein hydrolysates and beneficial microorganisms can significantly enhance tomato growth, yield, nutrient uptake efficiency and fruit quality under both optimal and reduced N conditions (Mauro *et al.,* 2024; Paradiso *et al.,* 2024; Ganugi *et al.,* 2023 and Cozzolino *et al.,* 2021). Albit-BR is also one of the biological products obtained by composting sprouted grains of field crops, which was developed by the Scientific and Production Limited Liability Company Albit (Pushchino, Moscow region). In the field trial conducted in 2019 in the Tula region on gray forest soils, with the Albit-BR preparation applied at the sowing of white mustard in the fields of LLC "Tesnitskoye." showed that the preparation at a dosage of 1 L/ha reduced the number of pathogenic fungi of the genus Fusarium by 67% (Kurakov *et al*., 2020). Hence, the study was conducted in three consecutive years starting from 2023 until 2025 with the aim of evaluating the effect of the bio-preparation Albit-BR on the growth, development, yield and quality characteristics of tomato cultivars.

[1]Department of Agro-Biotechnology, Faculty of Agriculture, RUDN University, Moscow, Russia.
[2]Hamelmalo Agricultural College, Keren, Eritrea.
[3]Federal State Budgetary Scientific Institution Federal Scientific Vegetable Center, VNIISSOK, Moscow Region, Russia.
[4]Albit Scientific and Industrial LLC, Pushchino, Moscow Region, Russia.

Corresponding Author: B.K. Yakob, Department of Agro-Biotechnology, Faculty of Agriculture, RUDN University, Moscow, Russia. Email: bahranknfe@gmail.com

ORCIDs: 0009-0002-4034-9090, 0000-0001-5995-2696

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MATERIALS AND METHODS

Description of the study site

The three years study (2023-2025) was conducted in the Federal State Budgetary Scientific Institution Federal

Scientific Vegetable Center, VNIISSOK, Moscow Region to assess the effect of the biostimulant or bioremediant on the growth, yield and quality traits of tomato cultivars.

Methodology of the study

The study comprised four tomato cultivars namely, Fonaric, Malets, Revansh and Talisman and seven different doses of Albit-BR bio-preparation. The seven doses of the bio-preparation were 0.1 L/ha, 0.5 L/ha, 1 L/ha, 2.5 L/ha, 5 L/ha, 10 L/ha and 50 L/ha and these were applied one day before seedling transplanting and they were all compared against the control (lone water). The experimental field was laid out to fit a randomized block design (RBD) with each treatment being replicated three times.

Chlorophyll content

Chlorophyll a, b and total chlorophyll content were measured during the incipience of flowering by crushing 0.25 g of leaf sample in 2 mL of 80% acetone, then samples were filtered through whatmans filter paper and the final volume was completed to 25 mL (Ali *et al.,* 2021). The chlorophyll content was determined according to the method used by Najafzadeh and Safari (2022), the absorbance were measured at wave lengths 645 and 663 nano-meters (nm) and the values in mg g^{-1} of fresh weight were determined using the following equations.

$$\text{Total chlorophyll} = \text{Chl a} + \text{Chl b}$$

Quantification on a mg/g was made through:

$$\text{Ch a} = \frac{[12.7\ (\text{Abs } 663) - 2.69\ (\text{Abs } 645)] * V}{1000 * W}$$

$$\text{Ch b} = \frac{[22.9\ (\text{Abs } 663) - 4.68\ (\text{Abs } 645)] * V}{1000 * W}$$

Where,
V and W= Volume of solvent and weight of leaf tissue.

Carotenoids

Both beta-carotene and lycopene were evaluated using the technique reported by Fernandes *et al.* (2022). The fruit samples of 500 mg were vigorously shaken with 10 mL of acetone/hexane mixture (4:6, v/v) for 1 min and filtered through Whatman 4 filter paper. Finally the absorbance was measured at 453, 505, 645 and 663 nm and the content of carotenoids (β-carotene and lycopene) were obtained by using the following equations and expressed in mg per 100 g of fresh weight (Fw).

$$\beta\text{-carotene (mg/100 mL)} = 0.216 \times \text{Abs}663 - 1.220 \times \text{Abs}645 - 0.304 \times \text{Abs}505 + 0.452 \times \text{Abs}453$$

$$\text{Lycopene (mg/100 mL)} = -0.0458 \times \text{Abs}663 + 0.204 \times \text{Abs}645 - 0.304 \times \text{Abs}505 + 0.452 \times \text{Abs}453$$

Statistical analysis

The data collected was analyzed using gene-stat software (version 2011) through analysis of variance and the mean comparison was made at 5% level of significance using the critical difference (CD) or least significant difference (LSD) values.

RESULTS AND DISCUSSION

Plant height

When treating four tomato varieties with the Albit-BR bio-preparation, a significant effect was found on plant height in all three consecutive years of research, as well as on the average values of these years (Table 1). When the role of the bio-preparation was assessed on the basis of the average values of the three years, all the four tomato cultivars were noticeably influenced by the application of Albit-BR for their plant height. Out of the seven doses applied, 2.5 l/ha produced the tallest plants in fonarik (66.67 cm) and in Revansh (79.89 cm) whereas the tallest plants in malets (90.33 cm) and talisman (90.33 cm) cultivars were recorded from 0.5 l/ha and 1 l/ha, respectively. The significant increase of the plant height in the current study may have been resulted due to the fact that Albit-BR has the potential to increase the nitrogen content of the soil (Zlotnikov *et al.,* 2020a) where this nutrient plays a crucial role in the cell division there by leading to increased plant height.

Number of leaves

The interaction of the variety and the bio-preparation had a significant impact on the number of leaves for all three years, as well as on the average values for three years (Table 2). As for the average number of leaves over three years, the effect of using the Albit-BR bio-preparation caused a significant effect only in the Malets variety when the bio-preparation was used in doses from 1 to 10 l/ha. The largest number of leaves (29.72) was obtained from the Malets variety treated with the Albit-BR bio-preparation at a dose of 2.5 l/ha. The fact that Albit-BR replenishes the soil with nutrients through nitrogen fixation, decomposition and humification (https://albitbr.com), could possibly cause improvements on the number of leaves produced by the tomato plants. In line with the current outcomes, Mzibra *et al*. (2021) found the significant effect of polysaccharide-enriched extracts (PEE) on the number of leaves in tomato plants.

Leaf area

The use of the Albit-BR bio-preparation led to a noticeable increase in the leaf area of all four tomato varieties during the entire three-year study period, as well as on average of these years (Table 3). With respect to the average leaf area of the three years, applying the bio-preparation at a dose of 2.5 l/ha showed the highest significant leaf area values in fonarik (147.27 cm^2), malets (131.5 cm^2), revansh (124.13 cm^2) and talisman (127.3 cm^2) cultivars. The significant effect of the bio-preparation Albit-BR in our study could be due to the positive effect of Albit-BR in improving the number of saprotrophic mucoral fungi (Zlotnikov *et al*., 2020b) which are associated with the replenishment of soil fertility. In line with our current results, Abdelkader *et al*. (2021)

Table 1: Height of tomato plants of various varieties under the influence of various doses of the biological preparation Albit-BR (cm) (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	54.34	86.78	69.22	84.89	73.81	-
0.1 l/ha	59.22	87.44	77.11	89.45	78.31	6.10
0.5 l/ha	59.22	90.33	74.00	89.56	78.28	6.06
1 l/ha	61.44	87.06	72.89	90.33	77.93	5.58
2.5 l/ha	66.67	89.78	79.89	89.22	81.39	10.27
5 l/ha	64.89	87.72	78.22	90.11	80.24	8.93
10 l/ha	61.22	87.11	75.00	90.11	78.36	6.16
50 l/ha	59.55	84.89	74.44	86.89	76.44	3.56
Average for factor A	60.82	87.64	75.10	88.82	78.09	-
LSD_{05}, Average, cm=A-1.345, B-1.902, AB-3.805						

LSD: Least significant difference; CV: Coefficient of variation.

Table 2: Number of leaves of tomato varieties under the influence of various doses of Albit-BR biological preparation (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	19.00	24.50	23.78	22.78	22.51	-
0.1 l/ha	21.11	26.67	24.78	24.33	24.17	7.37
0.5 l/ha	20.67	25.17	23.83	23.78	23.36	3.78
1 l/ha	20.78	28.33	24.00	25.67	24.70	9.73
2.5 l/ha	21.55	29.72	25.06	24.33	25.17	11.82
5 l/ha	21.22	27.89	25.33	25.22	24.92	10.71
10 l/ha	20.89	27.78	24.56	25.11	24.58	9.20
50 l/ha	19.78	24.50	26.61	24.44	23.83	5.86
Average for factor A	20.62	26.80	24.74	24.46	24.16	-
LSD_{05}, Average = A-1.141, B-1.613, AB-3.226						

Table 3: The leaf area of tomato varieties under the influence of various doses of the biological preparation Albit-BR (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	118.37	112.37	103.27	97.93	107.97	-
0.1 l/ha	144.70	117.40	116.60	105.03	120.93	12.00
0.5 l/ha	136.57	121.07	110.50	106.60	118.70	9.94
1 l/ha	143.20	119.73	114.33	118.57	123.97	14.82
2.5 l/ha	147.27	131.50	124.13	127.30	132.58	22.79
5 l/ha	140.67	119.80	116.90	121.77	124.79	15.58
10 l/ha	142.60	127.03	113.67	114.30	124.42	15.24
50 l/ha	135.90	114.43	110.87	115.03	119.06	10.27
Average for factor A	138.67	120.40	113.79	113.33	121.57	-
LSD_{05}, Average, cm =A-3.789, B-5.359, AB-10.72						

showed the significant effect of the biostimulants: Rutfarmaxifol and radifarm on the leaf area of tomato plants.

Chlorophyll A

During the entire three-year research period, the use of the Albit-BR bio-preparation showed a significant increase in the chlorophyll A content in the leaves of all four tomato varieties (Table 4). Based on the averaged chlorophyll A content for the three years, the use of the bio-preparation at a dose of 2.5 l/ha, resulted in the highest values-1.368 mg/g, 1.308 mg/g, 1.326 mg/g and 1.364 mg/g in the Fonarik, Malets, Revansh and Talisman varieties, respectively. Similar to the current findings, Kalozoumis (2023) and Naboulsi *et al*. (2022) reported the significant increase of chlorophyll A through the use of the biostimulator albit and the biostimulant "Crataegus oxyacantha extract", respectively.

Chlorophyll B

When evaluating the effect of the use of the Albit-BR bio-preparation on the composition of chlorophyll B of the tomato cultivars, significant effect was noted throughout the three years (Table 5). As for the average chlorophyll B content for the three-year study, all four tomato varieties were significantly improved with the use of Albit-BR. Out of the seven doses, 5 l/ha produced the highest values-0.738 mg/g for the fonarik, 0.695 mg/g for the malets and 0.689 mg/g for the revansh, while the talisman had the highest value (0.729 mg/g) at 10 l/ha. In line with our results, the application of the commercial biostimulator "Microsense root" (Turan *et al*., 2023) and the biostimulator "*Crataegus oxyacantha* extract" (Naboulsi *et al*., 2022) showed significant increase of the chlorophyll B composition of tomato leaves.

Number of fruits

When assessing the combined effect of the variety and the bio-preparation doses on the number of tomatoes harvested, noticeable differences in the values of this parameter existed during all the three years, as well as the average values of these years (Table 6). The three-year average results indicated that the largest number of fruits in the fonarik (21.14), malets (44.4) and talisman (32.48)

Table 4: Leaf chlorophyll a content of tomato varieties influenced by various doses of Albit-BR biological preparation (mg/g) (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	1.16	0.98	1.01	1.10	1.06	-
0.1 l/ha	1.23	1.07	1.15	1.19	1.16	9.40
0.5 l/ha	1.29	1.08	1.16	1.24	1.19	12.29
1 l/ha	1.26	1.21	1.23	1.27	1.24	16.98
2.5 l/ha	1.37	1.31	1.33	1.36	1.34	26.42
5 l/ha	1.33	1.24	1.24	1.29	1.28	20.75
10 l/ha	1.27	1.16	1.24	1.31	1.24	16.98
50 l/ha	1.30	1.11	1.25	1.26	1.23	16.04
Average for factor A	1.28	1.14	1.20	1.25	1.22	-

LSD_{05}, Average, mg/g = A-0.0349, B-0.049, AB-0.099

Table 5: Leaf chlorophyll B content of tomato varieties influenced by various doses of Albit-BR biological preparation (mg/g) (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	0.64	0.54	0.53	0.57	0.57	-
0.1 l/ha	0.66	0.59	0.59	0.59	0.61	7.02
0.5 l/ha	0.64	0.52	0.60	0.57	0.58	1.75
1 l/ha	0.67	0.61	0.66	0.69	0.65	14.04
2.5 l/ha	0.69	0.65	0.64	0.70	0.67	17.54
5 l/ha	0.74	0.70	0.69	0.69	0.70	22.81
10 l/ha	0.68	0.61	0.67	0.73	0.67	17.54
50 l/ha	0.74	0.55	0.61	0.66	0.64	12.28
Average for factor A	0.68	0.59	0.62	0.65	0.64	-

LSD_{05}, Average, mg/g = A-0.0336, B-0.048, AB-0.095

varieties was obtained upon using the bio-preparation at a dose of 2.5 l/ha, however, the Revansh variety (33.8) showed the greatest value at a dose of 5 l/ha. Similar to the current results, application of the biostimulants like “seaweed extracts” and “humic acids” (Sani *et al*., 2020), as well as the biopreparation “Fitop” (Petrov and shakirov, 2018) increased the number of tomato fruits. Similarly the culture of microalgae “Chlorella vulgaris” also caused significant increase of the number of tomato fruits.

Total yield

The assessment of the effect of the bio-preparation Albit-BR on the total yield of each of the four tomato varieties revealed statistical significance for the entire study period, as well as for the average data for three years (Table 7). The pooled and averaged values for the three years revealed that, the total yield of tomato fruits reached the maximum levels in the fonarik (76.48 t/ha), malets (84.35 t/ha) and talisman (85.88 t/ha) varieties when the plants of these varieties were treated with Albit-BR bio-preparation at a dose of 2.5 liters/ha, while the Revansh variety showed the maximum yield (81.06 t/ha) at 5 l/ha. Since Albit-BR enhances the multiplication of the useful endophytic microflora (Zlotnikov *et al*., 2020a; Zlotnikov *et al*., 2020b), the microbes can lead to yield increase due to the effect of such microbes on the nitrogen fixation and the conversion of inaccessible phosphorus and potassium into accessible forms. In line to current results, the biopreparations *Basilus pumillus* (He *et al*., 2019) and rutfarmaxifol and radifarm (Abdelkader *et al*., 2021) in tomato and Seaweed extract, humic acid and chitosan in finger millet (Midde *et al*., 2026), increased the yield of these crops remarkably.

Beta-carotene content

The use of the Albit-BR bio-preparation on tomato varieties had a significant effect on the beta-carotene content of the tomato varieties during the entire study period, as well as on average values for these three years (Table 8). According to the average beta-carotene content obtained from the average of the three years results, the bio-preparation used at a dose of 2.5 l/ha in Talisman variety, 5 l/ha in malets variety and 10 l/ha in fonarik variety provided the highest

Table 6: The number of fruits harvested per plant in different varieties under the influence of different doses of the biological preparation Albit-BR (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	14.19	33.91	27.42	22.79	24.58	-
0.1 l/ha	16.65	37.60	29.70	27.29	27.81	13.14
0.5 l/ha	15.60	40.50	29.61	27.58	28.32	15.22
1 l/ha	18.42	41.04	30.03	29.70	29.80	21.24
2.5 l/ha	21.14	44.40	32.03	32.48	32.51	32.26
5 l/ha	19.10	42.11	33.80	30.11	31.28	27.26
10 l/ha	17.21	38.30	30.48	32.44	29.61	20.46
50 l/ha	13.16	37.40	28.12	28.89	26.98	9.76
Average for factor A	16.93	39.45	30.15	28.91	28.86	-

LSD_{05}, Average = A-1.086, B-1.536, AB-3.072

Table 7: Total yield of tomato varieties under the influence of various doses of Albit-BR biological preparation (t/ha) (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	48.66	60.61	64.67	57.76	57.93	-
0.1 l/ha	58.54	69.66	73.25	72.54	68.50	18.25
0.5 l/ha	55.99	71.75	71.47	72.82	68.01	17.40
1 l/ha	65.65	73.52	72.81	74.54	71.63	23.65
2.5 l/ha	76.48	84.35	78.02	85.88	81.18	40.13
5 l/ha	71.49	81.61	81.06	80.88	78.76	36.13
10 l/ha	65.66	76.58	73.46	83.03	74.68	28.91
50 l/ha	50.17	71.76	70.44	72.34	66.17	14.22
Average for factor A	61.58	73.73	73.15	74.97	70.86	-

LSD_{05}, Average, t/ha = A-2.523, B-3.58, AB-7.137

Table 8: Beta-carotene composition of tomato varieties as affected by various doses of Albit-BR biopreparation (mg/100 g) (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	1.87	2.03	2.38	1.84	2.03	-
0.1 l/ha	2.65	1.99	1.95	1.94	2.13	4.92
0.5 l/ha	1.89	2.13	1.86	1.99	1.97	-2.46
1 l/ha	2.55	1.98	1.85	2.06	2.11	3.94
2.5 l/ha	2.13	1.86	1.94	2.72	2.16	6.40
5 l/ha	2.00	3.16	2.04	1.89	2.27	11.82
10 l/ha	2.89	2.04	1.94	2.12	2.25	10.84
50 l/ha	2.02	2.29	1.94	1.88	2.03	0
Average for factor A	2.25	2.19	1.99	2.05	2.12	-
LSD_{05}, Average, mg/100 g = A-0.128, B-0.181, AB-0.362						

Table 9: Lycopene composition of tomato varieties as affected by various doses of Albit-BR biopreparation (mg/100 g) (Average data for three years).

Albit-BR doses	Tomato cultivars (Factor A)				Average for	Increase over
(factor B)	Fonarik	Malets	Revansh	Talisman	factor B	the control (%)
Control	12.51	13.33	15.17	12.87	13.47	-
0.1 l/ha	16.36	13.10	12.73	13.18	13.84	2.75
0.5 l/ha	12.91	13.79	12.77	13.33	13.20	-2.00
1 l/ha	15.39	13.11	12.52	13.68	13.68	1.56
2.5 l/ha	13.76	12.62	12.81	17.54	14.18	5.27
5 l/ha	13.43	18.61	12.73	12.83	14.40	6.90
10 l/ha	17.77	13.58	12.98	15.82	15.04	11.66
50 l/ha	13.53	14.44	13.01	13.02	13.50	0.22
Average for factor A	14.46	14.07	13.09	14.03	13.91	-
LSD_{05}, Average, mg/100 g = A-0.725, B-1.026, AB-2.052						

beta-carotene content: 2.377 mg/100 g, 2.718 mg/100 g, 3.157 mg/100 g and 2.891 mg/100 g, respectively. In harmony with our findings, significant increase of the betacarotene content of tomato fruits was reported when using the biopreparation Albit-BR (Yakob and Gins, 2025). In addition to this, the biostimulants "PGPM-1" (Quintarelli *et al*., 2025), "Radifarm" (Abdelkader *et al*., 2021) were also found to increase the carotenoid composition in tomato fruits.

Lycopene content

Although the use of the Albit-BR bio-preparation did not significantly increase the lycopene content in the Revansh variety during the three-year study period, all other three varieties showed higher lycopene content when treated with the bio-preparation during all three years, as well as when assessing the three-year averages (Table 9). As indicated in the three-year averages, despite the fact that the lycopene content in the Revansh variety was significantly reduced due to the use of the bio-preparation, a significant increase was found in all three other varieties. The highest lycopene content in the tomato varieties "Fonarik" (17.77 mg/100 g), "Malets" (18.61 mg/100 g), "Revansh" (15.17 mg/100 g) and "Talisman" (17.54 mg/100 g) was observed in doses of Albit-BR: 10 l/ha, 5 l/ha, 0 l/ha or control and 2.5 l/ha, respectively. The fact that biostimulants possess higher sulfate content (Mzibra *et al*., 2021), can enhance the absorption nutrients from the soil and improve the resistance to abiotic stress (Kocira *et al*., 2020) could increase the lycopene composition of the fruits. Similarly, "Bayfolan algae" (Mallick *et al*., 2024), trichoderma and seaweed extract (Sani *et al*., 2020) showed significant increase of the lycopene in tomato fruits.

CONCLUSION

When evaluating the effect of using the bio-preparation for each of the four tomato varieties based on the average results obtained over three years, it was found that the interaction effect is significant for all the parameters considered. Having found a noticeable effect of the bio-preparation on the total yield of each of the four tomato varieties, we found that the use of 2.5 l/ha of the bio-preparation

for the fonarik, malets and talisman varieties and 5 l/ha for the revansh variety resulted in the highest values-76.48 t/ha, 84.35 t/ha, 85.88 t/ha and 81.06 t/ha, respectively. In addition, Malets plants treated at a dose of 5 l/ha showed the highest values of lycopene (18.61 mg/100 g) and beta-carotene (3.157 mg/100 g) and these values significantly exceeded all other 31 interactions of the variety and the bio-preparation. Albit-BR treatment caused the highest increase of total yield for malets (39.17%), fonarik (57.17%) and talisman (48.68%) at 2.5 l/ha whereas for Revansh cultivar the highest yield increase (25.34%) was observed in 5 l/ha of Albit-BR when compared to their respective controls. Hence, it can be concluded that the bio-preparation should be applied within the range of 2.5 to 5 l/ha to achieve maximum production.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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