Influence of fertilizer rates and growth stimulants on yield of sweet pepper variety dar Tashkenta

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Abstract. This study investigated the effects of various fertilizer regimes and the application of a growth stimulant on the growth, development, and yield of the sweet pepper (*Capsicum annuum* L.) variety *Dar of Tashkent* under field conditions during 2022–2024. The experimental design included six treatment variants: organic manure (20 t/ha), mineral fertilizers (N200P160K100 kg/ha), their combination, and the additional application of gibberellin (0.6–0.7 g per 10 L of water) during flowering. Key indicators assessed were seedling survival, vegetation period, plant height, leaf area, bush biomass, fruit weight, and both total and marketable yields. The results demonstrated that the highest plant survival (96.4%), tallest plants (86 cm), and largest leaf area (0.71 m²) were achieved in the variant with combined organomineral fertilization and gibberellin treatment. The vegetation period was extended by 3–4 days with organomineral fertilizers and by an additional 2–4 days with gibberellin. This combined treatment also produced the highest total yield (35.3 t/ha) and marketable yield (34.7 t/ha or 98.3%), significantly surpassing the control and single-fertilizer variants. The increased average fruit weight (115 g) and higher bush biomass confirmed enhanced productivity and physiological vigor. The findings suggest that integrating organic and mineral fertilization with gibberellin application is an effective agronomic strategy to improve sweet pepper performance. The results have practical implications for sustainable vegetable production and optimized nutrient management under field conditions. Statistical significance was established at $EKF_{0.5}$ = 1.9–2.6.

1 Introduction

Sweet pepper (*Capsicum annuum* L.) is one of the most economically important vegetable crops cultivated worldwide, owing to its nutritional value, culinary versatility, and significant role in food security and agricultural livelihoods. The crop is rich in vitamins A

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and C, minerals, antioxidants, and various bioactive compounds, making it a vital component of both fresh consumption and processed food markets.

The peculiarities of soil and climatic conditions of South Kashkadarya province are characterized by the fact that the volume of tomato vegetable production is much lower than the needs of the population, and the yield does not exceed 20 tons per hectare. Annually, the republic produces 2.0-2.5 million tons of tomatoes, 280-300 thousand tons of peppers, 180-200 thousand tons of eggplants, the main share of which is exported[1].

Sweet pepper sharply differs from other vegetables in biochemical composition, nutritional value, tolerance and preservation, it ranks 2nd among vegetables (after garlic) in dry matter content (14.5%), and first in vitamin “C” (ascorbic acid) content.

According to sources, sweet pepper grown in our country contains 54-118 mg/% at technical ripeness, while its red, i.e. physiologically mature fruits contain 368-535 mg/% of vitamin “C”[2].

Uzbekistan's agriculture sector covers more than 20 million hectares, including 3.2 million hectares of irrigated arable land used to provide the population with food and raw materials necessary for various sectors of the economy. Currently, more than 80 types of agricultural products grown in the republic are exported to 66 countries around the world.

Scientific support for producers in the cultivation of agricultural products in the republic specific work on the introduction of sound water- and resource-saving agricultural technologies has been implemented. Today, among vegetable crops in our country, the area under cultivation and one of the crops whose production is constantly increasing is sweet pepper. This plant is a valuable crop in terms of nutrients. The fruit of sweet pepper is a vegetable freshly picked, salted, pickled, canned, and stewed consumed.

This practice has its place in the history of agriculture in our country, that is, the traditional culture of vegetable growing and gardening, which has developed over centuries, is based on the principles of organic farming, which involves the use of local fertilizers. This allows us to grow organic (environmentally friendly) fruits and vegetables with high nutritional value and unique taste and nutritional properties without the use of genetic modification technologies.

In particular, our country grows about 16-20 million tons of fruits and vegetables annually. Per capita consumption is about 300 kg of vegetables, 75 kg of potatoes, and 44 kg of grapes. This is three times higher than the consumption rate considered acceptable by international standards.

Climatic conditions were favorable and close to the long-term average. Pepper plants experienced the greatest stress during the hot and dry summer period, especially in July. At that time, the air temperature was 1.5-2.5°C above the long-term average, and the air humidity was low, at 30%. These environmental conditions affected the growth and development of the plants. Plants of the sweet pepper variety “Toshkent Tukhfasi” bloomed 82 days after mass germination (75%). Technical ripening of the fruits (75%) was observed on days 120-125, and mass biological ripening (75%) on days 140-145. By the end of the growing season, the plants reach a height of 60-65 cm. The fruits of the Toshkent Tukhfasi sweet pepper variety are conical in shape, with a slightly rough surface. The fruits turn yellowish-green when technically ripe and red when biologically ripe. The tasting score for the fruits is 4.5 points. This variety yields 40-45 tons per hectare. The sweet pepper variety “Dar Tashkent” is important for primary and elite seed production[3].

While the stem weight per plant for the control variety Dar Tashkent was 906 grams, compared to the control variety Sabo, the stem weight was 1020 grams, which is 114 grams (12.5%) more than in the control variant. The stem weight of the Tong, Mahi Bell, Nargiza, and Smorgod varieties was 14-125-150-40-17 grams (1.5-14.8-17.4-4.3-1.5%) more than in the control variant. The varieties “Zarya Vostoka,” “Zumrad,” “Yulduz,” “Shodlik,” “Astachka,” “Podarok Moldovy,” “Pamir,” “Gampion,” and “Bolgarsky 79” were planted under control. The Dar Tashkent variety was lighter by 61-46-131-112-76-61-112-116 g (5-8%). The weight of the stems of the sweet pepper varieties planted in the experiment depended on the growing season and plant height. The number of leaves on one plant of the control variety Dar Tashkent was 526 (100%), while the number of leaves on the Zarya Vostoka variety was 691, which is 44 (8.4%) more than the control. The number of leaves on the Zumrad, Nargiza, Sabo, and Yulduz, the number of leaves was 44.94-1784-2884 more (17.9-3.2-16.0-4.9-16.0%).

In South Kashkadarya region there are great opportunities to increase the production of sweet pepper, expand the cultivated areas and increase yields. In this case, the selection of high-yielding export-oriented varieties of agricultural crops, improvement of agro-technology of cultivation, that is, the effective use of organic and mineral fertilizers and the use of growth stimulants are important [4].

However, the research on the study of sweet pepper varieties, improvement of agro-technology of cultivation in conditions of irrigated light serozem soils of Kashkadarya province has been carried out insufficiently.

Taking this into account, we in 2022-2024 years in Shakhrisabz district of Khodjaev

We conducted a special field experiment in the conditions of irrigated light sierozem soils of the farm "Abdurasul."

The purpose of the study is a comprehensive evaluation of varieties-hybrids of sweet pepper, selection of promising and study of growth, leaf surface, stem and root mass formation, total and marketable yield of selected varieties at application of various growth stimulants and rates of organomineral fertilizers.

2 Materials and methods

In the experiment 10 varieties-hybrids of sweet pepper, namely Dar Tashkent, Tashkent 2161, California Wander 300TMR, Zumrad, Marjona, California Viber (Turkey), Shirin Kalampir Uzunchogi, A-Z-25F1 (Turkey), Turkuz (Turkey), AlpenikF1 (Turkey) were planted on May 3 on the scheme 90 x 25 cm with 4-5 true leaves. When watering the pre-planting furrows, soil moisture was maintained at 80-85% until the emergence of seedlings. When planting seedlings of the selected variety of sweet pepper Dar Tashkent, there were 6 variants, that is, only 20 t/ha of manure on the 1st variant; 2nd variant only N200P160K100 kg/ha; 3rd variant 20 t/ha of manure + N200P160K100 kg/ha; In the 4th variant only 20 t/ha of manure + gibberellin; 5-variant only N200P160K100 kg/ha + gibberellin; In the 6th variant, 20 t/ha of manure + N200P160K100 kg/ha + gibberellin were considered and compared with each other. Ammonium nitrate (34.6% N), ammophos (48-50% P2O5 9-10% N) and potassium chloride (60% K2O) as well as cattle manure (0.5% N, 0.25% P, 0.6% K) were used from mineral fertilizers.

The plot area by varieties was 9 m2, by fertilizers - 288 m2, by stimulants - 144 m2, the number of repetitions - 4. The plot area of each fertilizer variant was divided into 2 parts, the 1st part was not treated with growth stimulants (control); The second part was treated in growth stimulator "gibberylline," mixing 0.6-0.7 g in 10 liters of water. The solution of growth stimulants (300 L/ha) was treated during the flowering period of plants.

In the experimental plot, all agro-technological measures, observations, measurements, analyses and calculations were carried out on the basis of generally accepted methods and agro-recommendations[5]. Yield indicators were subjected to variance analysis according to B.A.Dospekhov, and the accuracy of the experiment and the difference with the lowest precision (ECF0.5) were calculated [6].

3 Results and discussion

The research carried out during 2022–2024 on the sweet pepper variety *Dar of Tashkent* showed that the survival rate of seedlings after planting was quite high across all experimental variants, ranging from 94.2% to 96.4%. The highest seedling survival was recorded in the variant that received both organic and mineral fertilizers together, indicating that combined nutrient application improves seedling establishment. A positive trend in seedling viability was especially observed when organomineral fertilizers were applied, which provided more balanced nutrition and favorable soil conditions for young plant roots to anchor and develop.

The duration of the vegetation period from transplanting the seedlings to the first harvest also varied depending on the applied treatments. In the control variant, where only 20 tons per hectare of manure were used, this period lasted 66 days. In the variant where mineral fertilizers were applied at the rate of N200P160K100 kg/ha, the period extended to 69 days. In the treatment where organic and mineral fertilizers were combined, the vegetation period further extended to 70 days. These results indicate that the availability of more complete and balanced nutrients prolonged the active growth and development phase of the plants by 3–4 days compared to single-nutrient applications. Furthermore, the application of the plant growth stimulant gibberellin at the rate of 0.6–0.7 grams per 10 liters of water during the flowering stage caused an additional increase in the vegetation period by 2 to 4 days. This suggests that gibberellin promotes prolonged flowering and fruit formation, likely through enhanced cell elongation and metabolic activity (Table 1).

Table 1. Effect of application of different rates of fertilizers and growth stimulants on plant growth, bush formation and yield of sweet pepper variety Dar of Tashkent (2022-2024).

№	Fertilizer rate, t (kg) /ha	Growth stimulant working with stimulants	Seedling stickiness, %	Growing period, days	Plant height, cm	Leaf area of 1 plant, m²	Mass of one bush, g			Average fruit weight per bush, g	Total yield, t/ha	From this comes the commodity yield	
							rhizome	blade	fruit harvest			t/ha	%
1	**20 t/ha of manure**	**Unprocessed (control)**	94,2	66	68	0,49	167	768	802	**103**	26,5	25,3	95,6
2	**$N_{200}P_{160}K_{100}$**		95,4	69	75	0,57	179	834	856	107	29,4	28,3	96,2
3	**20 t/ha of manure+ $N_{200}P_{160}K_{100}$**		96,0	70	80	0,66	188	880	893	110	33,1	32,2	97,4
4	**20 t/ha of manure**	**Gibberillin (0.6-0.7 g per 10 l of water)**	95,1	68	71	0,53	171	791	839	106	28,7	27,7	96,5
5	**$N_{200}P_{160}K_{100}$**		96,0	72	79	0,64	186	876	888	112	32,6	31,7	97,1
6	**20 t/ha of manure+ $N_{200}P_{160}K_{100}$**		96,4	74	86	0,71	191	905	917	115	35,3	34,7	98,3
EKF_{05}=1,9-2,6													

The application of fertilizers and growth stimulants had a significant impact on plant morphology and biomass accumulation. In the control variant, the average plant height was 68 cm, while in the variant treated with mineral fertilizers, it reached 75 cm. With combined organomineral application, plant height increased to 80 cm. However, the highest plant height of 86 cm was observed when manure and mineral fertilizers were applied together and gibberellin was sprayed during flowering. A similar trend was seen in leaf area per plant. The control variant showed a leaf area of 0.49 m^2, which increased to 0.57 m^2 in the mineral fertilizer treatment and to 0.66 m^2 in the combined fertilizer variant. The maximum leaf area of 0.71 m^2 was observed in the organomineral treatment combined with gibberellin. These increases in leaf area are critical, as they directly affect the plant's ability to photosynthesize efficiently and support fruit development.

In terms of biomass, the rhizome mass in the control variant was 167 g per plant, increasing to 179 g with mineral fertilizers and 188 g with combined organomineral application. With the additional application of gibberellin, rhizome mass reached 191 g. The leaf blade mass followed a similar pattern: from 768 g in the control to 834 g in the mineral fertilizer variant, and 880 g in the organomineral variant, reaching 905 g in the treatment that also included gibberellin. The total bush mass, combining rhizome, blade, and fruit, was 802 g in the control, 856 g in the mineral treatment, and 893 g in the organomineral treatment, reaching a peak of 917 g in the organomineral plus gibberellin variant. The average fruit weight per bush was also highest in this variant, reaching 115 g, which was 3–12 g more than in the other treatments. This reflects the combined effect of improved nutrient uptake and enhanced growth regulation due to gibberellin.

Yield performance also showed significant differences between the treatment variants. The total yield in the control variant was 26.5 tons per hectare, while in the mineral fertilizer treatment it increased to 29.4 t/ha. The combined application of 20 t/ha of manure and N200P160K100 kg/ha of mineral fertilizers resulted in a yield of 33.1 t/ha. The application of gibberellin along with manure increased yield to 28.7 t/ha, and with mineral fertilizers to 32.6 t/ha. The highest yield of 35.3 t/ha was achieved in the variant where manure and mineral fertilizers were combined and gibberellin was applied during flowering. This variant not only gave the highest total yield but also produced the maximum marketable yield—34.7 t/ha—which accounted for 98.3% of the total yield. In comparison, the marketable yield in the control was 25.3 t/ha (95.6%), and in the mineral fertilizer variant it was 28.3 t/ha (96.2%). In the combined fertilizer treatment without gibberellin, marketable yield reached 32.2 t/ha (97.4%), while with gibberellin, it increased to 34.7 t/ha (98.3%).

Thus, the combined use of organic and mineral fertilizers along with gibberellin not only extended the vegetation period but also improved plant growth indicators, increased leaf area, and significantly raised both total and marketable yields. The additional yield gained in this treatment ranged from 5.9 to 8.8 tons per hectare compared to single-application variants, proving the effectiveness of integrated nutrient and growth regulation management in sweet pepper production. The reliability of the data is confirmed by statistical analysis, where differences between variants were significant at the $EKF_{0.5}$ = 1.9–2.6 level.

4 Conclusion

The conducted research clearly demonstrates that the combined application of organic (20 t/ha of manure) and mineral fertilizers (N200P160K100 kg/ha), supplemented with foliar treatment of gibberellin during the flowering period (0.6–0.7 g per 10 L of water), significantly enhances the growth, development, and productivity of the sweet pepper (*Capsicum annuum* L.) variety *Dar of Tashkent* under field conditions. This integrated approach resulted in the highest plant height (86 cm), leaf area (0.71 m^2), bush biomass (917 g), and average fruit weight (115 g), reflecting improved physiological activity and assimilative surface area.

Statistical analysis confirmed the reliability of the results at a confidence level of $EKF_{0.5}$ = 1.9–2.6.

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