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EFFECTS OF DIFFERENT PLANTING SYSTEMS AND METHODS ON THE DEVELOPMENT OF UNDERGROUND ORGANS OF SWEET POTATO (IPOMOEA BATATAS L.)

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Abstract: This study investigates the effects of different planting systems and methods on the development of underground organs of sweet potato (Ipomoea batatas L.). The formation and development of storage roots, which represent the main yield-forming organs of sweet potato, were evaluated under varying soil moisture conditions, thermal regimes, and nutrient availability. Morphological and biological characteristics of the root system, including absorbing roots, adventitious roots, and storage roots, were analyzed throughout the growing season. The results demonstrated that planting density and cultivation method significantly influenced root morphology, dry matter accumulation, and storage root development. Cultivation under plastic mulch created favorable microclimatic conditions, resulting in enhanced assimilate translocation and improved storage root characteristics compared to open-field cultivation.

Key words: sweet potato, planting system, plastic mulch, fibrous root, storage root, adventitious root, dry matter.

Introduction. Sweet potato (Ipomoea batatas L.) is one of the most important root crops worldwide and ranks second after potato in terms of global significance. The crop is valued for its high nutritional content, adaptability to diverse agro-climatic conditions, and wide utilization for food, feed, and industrial purposes. The main economic yield of sweet potato is represented by storage roots, which serve as reserve organs accumulating carbohydrates and other assimilates produced through photosynthesis. The formation and development of storage roots depend on genetic factors as well as environmental and agronomic conditions. Among these, planting systems and planting density play a crucial role in determining soil moisture availability, thermal regime, nutrient uptake efficiency, and overall plant growth. Understanding how different planting systems affect the development of underground organs is essential for optimizing sweet potato productivity, particularly under arid and semi-arid conditions. Therefore, this study aimed to assess the influence of various planting systems and methods on the morphological characteristics and development of sweet potato underground organs.

Materials and Methods. The field experiment was conducted on light gray soils under the conditions of southern Uzbekistan. Two main cultivation systems were evaluated: open-field planting (traditional method) and planting under plastic mulch. The planting schemes included row spacings of 70 cm and 90 cm combined with intra-row spacings of 15, 20, 25, and 30 cm. Each treatment was arranged in a randomized design with three replications.

Throughout the growing season, systematic morpho-biological observations were carried out. The following parameters were recorded: number and length of absorbing roots, number and length of adventitious (cutting) roots, number, length, and diameter of storage roots, as well as dry matter content and moisture percentage. Root measurements were conducted at physiological maturity using standard agronomic and laboratory methods.

Table 1. Effect of different planting diseases on symptoms

Item No.	Planting system	Planting methods	Number of taproots per plant/ unit	Length of taproot per plant /cm	Number of taproots per plant/ piece	Taproot length per plant /cm	Number of storage roots per plant/ piece	Storage roots length per plant / cm	Storage root diameter per plant / cm	Storage roots dry mass /%	Humidity/%
1	Open field	70x15x1	16	22,0	8	22,0	4	9,0	13,2	27,71	72,29
2		70x20x1	14	24,0	5	23,5	3	11,0	14,5	27,71	72,29
3		70x25x1	13	26,0	4	25,0	3	13,5	16,3	27,71	72,29
4		70x30x1	11	30,0	3	27,5	2	16,0	17,5	27,71	72,29
5		90x15x1	14	23,0	7	23,0	4	12,0	15,2	27,71	72,29
6		90x20x1	12	25,0	5	24,5	3	14,0	17,0	27,71	72,29
7		90x25x1	10	28,0	3	26,5	3	17,5	19,8	27,71	72,29
8		90x30x1	8	33,0	2	29,0	2	20,0	21,4	27,71	72,29
9	Under plastic mulch	70x15x1	17	24,0	8	24,0	5	11,0	14,6	27,71	72,29
10		70x20x1	16	26,0	6	25,5	4	13,0	15,8	27,71	72,29
11		70x25x1	15	28,0	5	27,0	3	15,0	17,2	27,71	72,29
12		70x30x1	12	32,0	4	29,0	2	18,0	19,0	27,71	72,29
13		90x15x1	15	25,0	7	25,0	6	14,0	18,5	27,71	72,29
14		90x20x1	14	27,0	5	26,5	4	16,0	21,0	27,71	72,29
15		90x25x1	12	30,0	5	28,5	4	20,0	23,5	27,71	72,29
16		90x30x1	10	35,0	3	31,0	3	23,0	26,0	27,71	72,29

Results and Discussion. The results indicated that the morphology and development of the sweet potato root system were strongly influenced by planting systems and spacing. In comparison with open-field cultivation, plants grown under plastic mulch exhibited superior growth and root development. The mulching system contributed to improved soil moisture retention, reduced temperature fluctuations, and enhanced nutrient availability. Absorbing roots, responsible for water and mineral uptake, showed higher density and greater length under plastic mulch conditions. In open-field cultivation with dense planting (70×15 cm), the number of absorbing roots ranged from 11 to 16 per plant, with lengths of 22–30 cm. When row spacing increased to 90 cm, the number of absorbing roots decreased to 8–14 per plant, while their length increased to 23–33 cm. Under plastic mulch, absorbing root numbers increased to 12–17 per plant, and root length reached up to 35 cm, indicating improved root penetration and resource acquisition.

Adventitious roots played a critical role in vegetative propagation and storage root formation. These roots originated from stem cuttings and initially functioned as absorbing organs. Under wider spacing and plastic mulch conditions, adventitious root number and length increased significantly. In open-field conditions, adventitious roots ranged from 2–10 per plant with lengths of 22–27 cm, whereas under plastic mulch and wider spacing (90×25–30 cm), their number reached 7–8 per plant with lengths up to 31 cm. These roots later served as the basis for storage root development.

Storage root characteristics varied considerably depending on planting system and density. Across treatments, storage root length ranged from 9.0 to 23.0 cm, and diameter varied between 13.2 and 26.0 cm. The number of storage roots per plant ranged from 2 to 6. The highest storage root length, diameter, and dry matter accumulation were recorded under plastic mulch cultivation with a spacing of 90×25 cm. In this treatment, improved microclimatic conditions, including soil moisture (72.29%) and increased soil temperature by 2–3°C, enhanced photosynthetic activity and assimilate translocation to the roots.

In contrast, open-field cultivation, particularly under wider spacing, resulted in reduced storage root diameter and lower dry matter accumulation. Rapid soil moisture loss and greater temperature fluctuations limited nutrient uptake and assimilate storage. Consequently, dry matter content in open-field-grown storage roots was approximately 5–7% lower than that observed under plastic mulch conditions.

Conclusion. The study confirms that planting density and cultivation method have a significant impact on the morphological development of sweet potato underground organs. Cultivation under plastic mulch proved to be more effective than open-field planting, promoting improved root morphology, higher storage root yield components, and increased dry matter accumulation. The planting system of 90×25×1 under plastic mulch demonstrated the most favorable results in terms of storage root number, size, and quality. Therefore, plastic mulch cultivation is recommended as a scientifically and practically efficient method for enhancing sweet potato productivity under light gray soil conditions.

Figure 1. Types of sweet potato root crops

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