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SUBSTANTIATION OF THE SHAPE AND GEOMETRIC DIMENSIONS OF THE RIDGE FOR SOWING ONION SEEDS

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Annotation. *This article presents an analysis of the role of onions, among other vegetable crops, in human life, the timing of sowing onion seeds, and key agrotechnical measures for achieving high onion yields. Furthermore, it substantiates the analysis related to onion seed sowing dates and emphasizes the importance of selecting optimal sowing times for each region. Additionally, based on the soil and climatic conditions of Uzbekistan, the article presents the results of theoretical research conducted to determine the geometric dimensions of the planting ridges for sowing onion seeds and recommends their optimal geometric parameters.*

Аннотация. *Мақолада сабзавот экинларидан пиёзни инсон ҳаётидаги тутган ўрни, пиёз уруғини экиш муддатлари хамда пиёздан юқори ҳосил олиш учун муҳим агротехник тадбирлар ҳақида таҳлил натижалари келтирилган. Шунингдек пиёз уруғини экиш муддатлари билан боғлиқ ҳолда таҳлиллар, ҳар бир ҳудуд учун мақбул экиш вақтларини танлашнинг аҳамияти асослаб берилган. Шу билан бир қаторда, Ўзбекистоннинг тупроқ-иқлим шароитларидан келиб чиқган ҳолда пиёз уруғи экиладиган пуштанинг геометрик ўлчамларини асослаш бўйича олиб борилган назарий тадқиқот натижалари ҳамда оптимал геометрик параметрлари тавсия этилган.*

Аннотация. *В статье представлены результаты анализа роли лука как овощной культуры в жизни человека, сроков посева семян лука, а также важных агротехнических мероприятий для получения высокого урожая. Также обосновывается важность анализа, связанного со сроками посева семян лука, и выбора оптимального времени посева для каждого региона. Наряду с этим, представлены результаты теоретических исследований по обоснованию геометрических размеров гряд, на которые высеваются семена лука, исходя из почвенно-климатических условий Узбекистана, и рекомендованы их оптимальные геометрические параметры.*

Keywords. *Vegetable, onion, seeds, bed, combs, soil, breadth, expressions, research.*

Калит сўзлар. *Сабзавот, пиёз, уруғ, пушта, эгат, тупроқ, кенглик, ифода, тадқиқот.*

Ключевые слова. *Овощ, лук, семена, грядка, гребен, почва, широта, выражения, исследования.*

Introduction. The growth of the population, the rise in living standards, and the broadening of worldviews are leading to an increased demand for high-quality, mineral-rich food products. Among the food products in our daily lives, vegetables hold a special place. To fully meet the population's demand for vegetables, it is necessary to drastically increase their cultivation and introduce new equipment and technologies. This can be achieved by increasing yields while reducing manual labor and lowering production costs. To this end, great attention must be paid to the specialization of vegetable farming, strengthening its technical resources, and improving its mechanization.

Among vegetable crops, onions hold a special place. Considered one of the most widely consumed food products in the world, onions not only make food delicious and nutritious but are also a powerful remedy with medicinal properties. This miraculous vegetable has long been used

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in India's Ayurvedic medical system and in Traditional Chinese Medicine as the best remedy for colds. In Uzbekistan, onion seeds are known to be sown in three periods: early spring, winter (as a "to'qsonbosti" or ninety-day crop), and autumn. According to literature, the recommended sowing rate for onion seeds is 10-12 kg/ha for spring planting and 14-16 kg/ha for autumn and winter planting. Sowing in early spring is common and begins as soon as field access is possible– in late February and early March. If planting is delayed, germination is sparse, and yields decrease. Spring-sown onions typically mature in September and store well throughout the winter, which is why they are used for winter storage.

Late-season sowing is done in late November and early December, before the onset of continuous cold weather. The seeds do not germinate during the winter but sprout in early spring as the days begin to warm. If planted too early, they can also sprout during warm winter spells and may be damaged by frost. For this reason, pre-winter sowing is not considered very reliable.

Autumn sowing is carried out in August and September. Onions sown in August are thinned as early as October-November, with a second thinning in March. Autumn-sown onions develop a strong central stalk, and the bulbs tend to rot during storage. Therefore, they are not suitable for winter storage.

Research Methodology and Findings. Key agrotechnical measures for obtaining a high onion yield include the following: selecting suitable land; soil cultivation; preparing the field for planting; preparing seeds for planting; distributing seeds evenly across the nutrient area; planting seeds to the specified depth; crop care; and harvesting.

According to agrotechnical requirements, vegetable seeds should be planted in soil with a density of 1.1–1.2 g/cm3 and covered with a soft, uncompacted layer. This allows the seeds to settle well in the soil and retain sufficient moisture. The main goal of introducing new technologies and methods in agriculture or improving existing ones is to ensure resource efficiency, and to increase product quality and yield [1,2].

Studies have shown that planting onion seeds on ridges is more effective than planting on flat ground, as it creates optimal conditions that allow for earlier germination and better development.

Currently, under the conditions in Uzbekistan, all agrotechnical measures related to ridge-planting technology are being implemented in accordance with the "Model Technological Maps for the Cultivation of Agricultural Crops and Product Yield for 2016–2020," approved by the relevant ministry [3].

Analyses show that the processes of land cultivation on farms across the republic have been improving in recent years. This can also be seen in the scientific research conducted on creating technology and technical equipment for ridge-planting, as well as their introduction into agricultural production. For example, in [4, 5, 6, 7, 8, 9], the authors of these publications expressed the following views on the advantages of ridge-planting technology:

- compared to currently used methods, ridge sowing achieves an increase in the field surface area;
- due to the increased planting area, the degree of heat absorption by the soil in spring is up to 2.2 times higher;
- it becomes possible to sow seeds in rows and individually on the ridged area;
- when creating ridges, it is possible to form and use irrigation furrows;
- the likelihood of excess rainwater accumulating on the field surface is reduced, and it becomes easier to drain excess water through irrigation furrows; as a result, the probability of sown seeds becoming diseased and fields developing a hard crust decreases;
- seed consumption is reduced;
- in ridged fields, the direct impact of sunlight creates a favorable environment for the early germination of seeds underground and for the proper warming of the plant's root system.

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According to agrotechnical requirements and the data provided in the technological map, in the conditions of Uzbekistan, onion seeds are sown or broadcast onto ridges that are 70 cm wide [3]. Therefore, the shape and geometric dimensions of the ridges for planting onions can be presented as follows (Fig. 1).

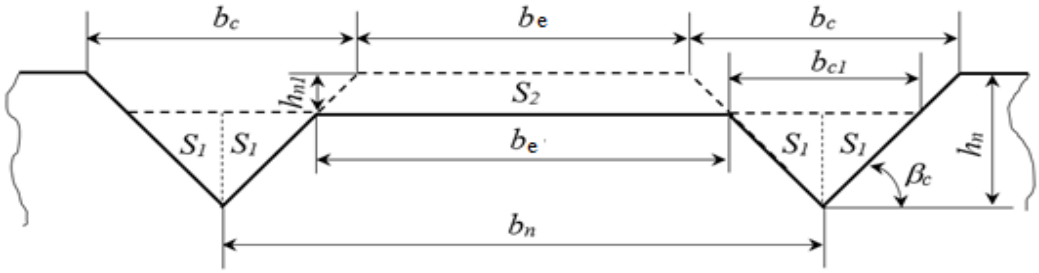


Figure 1. Geometry of the onion planting furrow

According to Figure 1, the geometric parameters of the trapezoidal ridge for planting onion seeds include the following: the ridge width (bn), the planting furrow width (b_e), the irrigation furrow width (b_c), the irrigation furrow depth (h_n), and the slope angle of the irrigation furrow wall relative to the horizontal (β_c). To form this trapezoidal ridge, a certain amount of soil is cut by a furrow opener and thrown upwards by the working body's housing onto the two sides, i.e., onto the flat field surface. The relationship between the cross-sectional areas of the cut soil and the soil thrown onto the flat field surface is as follows.

$$S_2 = 2S_1 \tag{1}$$

Based on Figure 1, the width of the ridge can be expressed as follows:

$$b_n = b_e + b_c, \tag{2}$$

where b_e – the width of the sowing furrow, m; and bs is the width of the irrigation furrow, m.

If we take into account that the width of the ridge for sowing onion seeds is 70 cm and the width of the sowing furrow is 40 cm, then the width of the irrigation furrow can be determined from expression (2).

$$b_c = b_n - b_e = 70 - 40 = 30 \text{ cm}.$$

The angle of inclination, β, of the irrigation furrow walls can be expressed as follows:

$$\beta_c = arctg\frac{2h_n}{b_c}. \tag{3}$$

Here, h_n is the depth of the irrigation furrow, m.

According to the data in [1], the irrigation furrow depth hn is 10-15 cm. Taking into account that the soil deforms due to subsidence or is leveled and compacted by a coulter after ridge formation, we can assume the maximum depth of the irrigation furrow to be 15 cm and proceed to calculate the slope angle of the furrow walls, β_c.

Considering that the irrigation furrow depth is hn=10-15 cm, according to the data in [1], and that it deforms due to soil subsidence or compaction when leveled with a coulter after ridge formation, we will calculate the slope angle of the furrow walls (βc) by assuming the maximum furrow depth to be 15 cm.

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$$\beta_c = arctg\frac{2\cdot 15}{30} = 45^0 .$$

To form a ridge, we must determine the height of the soil layer to be removed from the irrigation furrow and transferred to the level field surface. First, we determine the cross-sectional areas, S_1 and S_2, of the soil layers taken from the irrigation furrows and deposited onto the level field surface.

$$S_1 = \frac{1}{4} b_{c1}(h_n - h_{n1}), \quad (4)$$

$$S_2 = \frac{(b_e + b_{e1})}{2} h_{n1} . \quad (5)$$

where b_{c1} is the base of the area to be cut for opening an irrigation furrow on a flat field surface, in meters (m); hn1 is the height of the soil layer cut by a furrow opener and deposited onto the ridge surface, in meters (m); $b_{э1}$ is the initial width of the sowing furrow on a flat field surface, in meters (m).

Considering that the slope angle of the irrigation furrow walls is β_c =45°, it follows that the triangle with area S_1 is a right-angled isosceles triangle. In that case, expression (4) can be written as follows:

$$S_1 = \frac{1}{4} b_{c1}^2 = \frac{1}{2}(h_n - h_{n1})^2 . \quad (6)$$

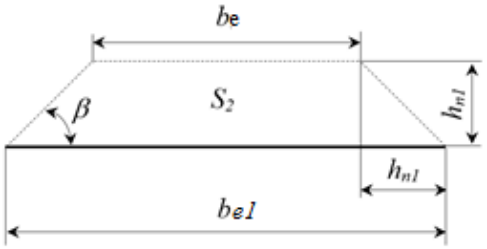


Figure 2. Diagram for determining the cross-sectional area of the soil layer to be spread on a flat field surface

Taking into account that $b_{e1}=b_{e1}+2h_{n1}$ according to Figure 2, we can then write expression (5) as follows:

$$S_2 = b_e h_{n1} + h_{n1}^2 . \quad (7)$$

Substituting expressions (6) and (7) into expression (1), we obtain the following:

$$(h_n - h_{n1})^2 = b_e h_{n1} + h_{n1}^2 . \quad (8)$$

The height of the soil layer deposited on a flat field surface is determined from expression (8).

$$h_{n1} = \frac{h_1^2}{2h_1 + b_e} . \quad (9)$$

If we perform a numerical solution of expression (9), the height of the soil layer deposited onto the flat field surface is found to be 3.21 cm.

According to Figure 1, the height of the soil layers taken from the irrigation furrows can be expressed as follows:

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$$h_{n2} = h_n - h_{n1} \quad (10)$$

Executing a numerical solution of expression (10) reveals that the height of the soil layers taken from the irrigation furrows is 11.79 cm.

Conclusions. Research and analysis have shown that, according to established agrotechnical requirements, the depth must be at least 11.78 cm when forming a 70 cm wide ridge for planting onions.

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