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PHYSICAL-MECHANICAL PROPERTIES OF ONION SEEDS AND SOIL

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Abstract. The physical and mechanical properties of the soil and onion seeds, such as the size, shape, mass, density, and the static coefficient of friction on various surfaces play an important role in the development of the dosing working bodies of the seeder. Uzbekistan has recently created various new varieties of onions. Therefore, there is a need to study the physical-mechanical properties of onion seeds of the new varieties to substantiate the parameters of the dosing devices of seeders.

Keywords: soil, humidity,agricultural, soil density, plant, onion seeds, mechanic, product,

INTRODUCTION

Nowadays, onions are grown as the main and repeated crop in our republic. One of the most important parameters in onion cultivation is to ensure that the number of bushes per unit area is at the level of agrotechnical requirements, as this creates an opportunity for good development of seedlings, that is, the equal distribution of the five important factors necessary for the plant (light, temperature, moisture, air, and nutrients) among the seedlings is achieved.

Currently, in Uzbekistan, onions are grown as both primary and secondary crops. The development of new technologies and technical means that ensure high-quality soil preparation and sowing onion seeds is impossible without determining the patterns of changes in the physical and mechanical properties of the soil and onion seeds. However, in the conditions of Uzbekistan, the physical and mechanical properties of the soil and onion seeds have not been sufficiently studied. The purpose of the study is to study and analyze the physical and mechanical properties of the soil and onion seeds cultivated in Uzbekistan. The results determining the moisture content, density, and hardness of the soil and geometric dimensions, the weight of 1000 seeds and the static coefficient of friction of onion seeds of the varieties “Sumbula”, “Istikbol” and “Zafar”, the most common in Uzbekistan, are presented. The main physico-mechanical properties of the soil during the period of planting onion seeds were studied according to GOST 20915-2011. The geometric dimensions of the seeds (length, width, and thickness) were determined using a micrometer, and their mass was measured on an electronic scale MN-390. According to the

results of the research, the soil prepared for planting onion seeds has a moisture content of 13.4 in 0-5, 5-10, 10-15, and 15-20 cm layers, respectively; 15.1; 17.4 and 18.6%; density: 1.10; 1.14; 1.22 and 1.25 g/cm^3, and the hardness 0.50, 0.64, 0.76, and 0.89 MPa. The minimum value of the natural slope angle of the soil (300) was observed at values of 7-8% of the soil moisture. As the soil moisture increases or decreases from this value, the natural slope angle increases. The coefficient of static friction of the seeds was determined by the method determining the minimum slope angle at which they slide on the friction surface. The coefficient of friction of seed grades “Sumbula”, “Istiqbol” and “Zafar” consists of: for painted steel correspondingly 16˚03', 17˚03' and 16˚48', for neopainted steel - 18˚15', 19˚42' 18˚24′, aluminum - 20˚00′, 20˚45′ and 20˚27′, plastic - 26˚00′, 27˚33′ and 26˚42′, rubber - 24˚15′, 24 ˚42′ and 24˚24′. The seeds of early-early “Sumbula” and mid-early “Istiqbol” and “Zafar” onion varieties have the following main physical and mechanical properties: the length from 3.0 mm to 3.2 mm, width from 2.1 mm to 2.3 mm up to 1.8 mm to 1.9 mm thick. The mass of 1000 onion seeds, depending on the variety, ranges from 3.79 to 3.83 g. On a plastic surface, the maximum friction angle measured for the onion seeds was 2658, while the lowest value measured in cast steel was 1651. Friction angles of the seeds of the prospect variety are higher than those of the Sumbula and triumph types on all surfaces.

The sowing rate is one of the main factors for high yield and is determined by the biological properties of seeds, the size, mass, soil conditions, availability of feed area and the planting period [1]. In Uzbekistan, onion seeds are planted on 28-30.000 hectares as main crops and 20.000-22.000 hectares as repeated crops, the average yield is 22-25 tons per hectare, and the total yield is 600-700.000 tons [1]. Farmers are planting an average amount of 15-22 kg of seeds per hectare in order to get a guaranteed harvest. Valuable seeds, which are spent more than the norm, are the reason for the large expenditure and the increase in the cost of the product on the scale of the Republic.

One of the means to solve this issue is the development of high-precision seeders for sowing onion seeds, especially new varieties.

Due to the lack of special seeders in Uzbekistan, the planting of seeds of a new onion variety is carried out by foreign seeders that are not adapted to local conditions, and artificial devices that do not have a scientific basis. These devices cannot plant seeds in rows and at the same depth. In this regard, great attention is being paid to the development of energy-resource-efficient equipment and devices that implement several technologies during the planting onion seeds.

The development of new technologies and technical means ensuring high quality soil preparation and sowing onion seeds is impossible without determining the pattern changes in the physical and mechanical properties of the soil and onion seeds.

Physical-mechanical properties of soils prepared for sowing seeds in Uzbekistan are humidity, density, hardness, friction coefficients, natural angles of inclination of the soil. The physical and mechanical properties of soils before the main treatment were studied by scientists [10-19], and before planting vegetable crops in [17] and other scientists studied the physical and mechanical properties of the soil [20]. Works [20-22] and other are devoted to the study of the physic-mechanical properties of onion seeds. However, the research conducted is not enough to solve the tasks set in the development of advanced seed drills.

The physical-mechanical characteristics of the Gujarati white onion variety-1 onion seeds have been discovered by Indian and other scientists [23]. They measured the onion seed sphericity, density, mass of a thousand seeds, and the coefficient of friction (2011), examined the physical characteristics of three onion types [24], comparing them to granular seeds: Agrofound light red (ALR), Agrofound dark red (ADR) [25], and Agrofound light red (ADR). In addition to the physico-mechanical characteristics of onions grown in China, which include linear dimensions, mass, form index, pulling force, compression, and shear forces, other properties of onion seeds have been determined, including their frictional, mechanical, and aerodynamic properties [26].

The goal of the research is to examine and evaluate the mechanical and physical characteristics of the soil and onion seeds grown in Uzbekistan.

Materials and methods

Experiments on the working conditions of the seeder that sows onion seeds in many rows were carried out in the experimental farm fields of the Agricultural Mechanization Scientific Research Institute and the Scientific Research Institute for vegetables, potato crops, and potatoes. The main physico-mechanical properties of the soil were studied during the planting period of onion seeds according to the state standard 20915-2011 [4]. Studies on the size and mass characteristics of seeds were carried out by evaluating the variation series with the average values of mass measurements.

To determine the soil moisture and density, samples were taken with five repetitions from four layers, i.e. 0-5, 5-10, 10-15 and 15-20 cm deep, from five places diagonally across the field into a 503 cm^3 cylinder. The cylinder was immersed vertically into the soil, the excess soil was carefully removed using a knife, and the mass soil inside the cylinder was measured on an electronic balance in the field itself. The obtained indicators were

recorded in the field notebook. After that, the soil samples in the cylinder for each layer were poured onto a paper sheet, thoroughly mixed, and to determine the moisture content of the soil, 30-40 g samples were immediately placed in aluminum cups and closed with a lid. The mass of the boxes containing soil samples was measured with an accuracy of ±0.01 g on an MN-390 electronic balance and recorded in the field notebook with the numbers of the boxes. After that, the bags were opened in the laboratory, placed in a special oven, and dried for 8 hours at a temperature of 105°-107°C. The bags containing the dried soil samples were cooled for 30 minutes, and their masses were re-measured repeatedly.

Soil hardness was determined in layers 0-5, 5-10, 10-15, and 15-20 cm using a measuring device developed in the All-Russian Research Institute for Use of Machinery and Petroleum Products in Agriculture, consisting of three conical cones with a base surface of 1 cm^2 and a sharpening angle of 22-30'. Before conducting the experiment, the hardness measuring device was calibrated and the calibration coefficient was determined.

The soil overall condition was assessed at a depth of 0-10 cm, using special probes with diameters of 50, 25, and 10 mm. The mass of the remaining and passing through the last probe soil fragments was measured on an RP-100-SH-13 balance, and their proportion in relation to the total mass was calculated as a percentage.

Results and discussion

The results on the soil moisture, density and hardness are presented in Table 1.

Table 1

Moisture, density and hardness of the field soil prepared for planting onion seeds

Soil layer, cm	Humidity, %	Density, g/cm^3	Hardness, MPa
0-5	13.4	1.10	0.50
5-10	15.1	1.14	0.64
10-15	17.4	1.22	0.76
15-20	18.6	1.25	0.89

As it can be seen from the data in Table 1, the soil moisture, density and hardness increased with the increase in the depth. The soil moisture in 0-5, 5-10, 10-15, 15-20 cm layers is 13.4; 15.1; 17.4 and 18.6%, density 1.10; 1.14; 1.22 and 1.25 g^-cm^3, and the hardness is 0.50; 0.64; were 0.76 and 0.89 MPa. It meets the agrotechnical requirements for planting onion seeds.

The natural slope of the soil is also of great importance when choosing and determining the parameters for the working bodies of the seeder. When the planter is

working, the soil settles at the angle of natural spillage and falls into the groove formed by it at the bottom of the planter, which affects the depth of seed placement. We used a device consisting of a funnel 1, handle 2, column 3, and a support board 4 to determine the natural slope angle of the field soil prepared for sowing (Fig.1). The soil falling through the funnel passes through a hole with a diameter of 20 mm and forms a cone-shaped pile, the diameter of the base of this pile and the height h are measured [1].

Taking into account the dependence of the natural slope of the soil on its moisture content, its value was determined for soils with different moisture content from 5.0 to 18.9%. The samples were taken from the 0-10 cm soil layer. Experiments were carried out 15 times, and their results are presented in Table 2.

Table 2

Natural slope angle of soil at different moisture levels

Soil moisture, %	5.0	6.9	7.8	10.4	13.6	17.0	18.9
Natural slope angle, °	33	30	31	33	38	39	41

As it can be seen from the data in Table 2, the minimum value of the natural slope angle of the soil is observed at the soil moisture around 7-8%. As the soil moisture increases or decreases from this value, the natural slope angle increases. This is due to the minimum angle of friction of soil particles at 7-8% humidity. As soil moisture decreases, the friction angle of soil particles increases as a result increasing the shear strength.

The percentage of particles with a size between 0 and 10 microns was 96,8%, with no particles larger than 50 microns.

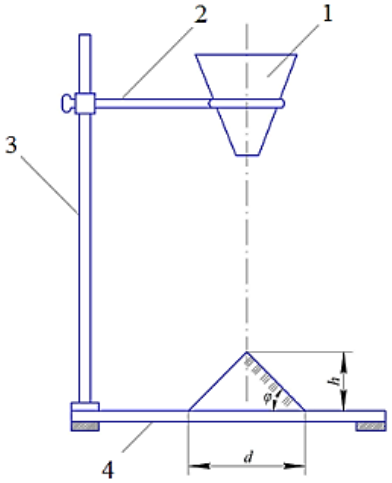

Fig. 1. **Device for determining the soil natural fall angle:**

1 funnel; 2nd handle; 3rd column; 4th base board

One of the main factors affecting the quality of sowing seeds in seed drills is the physical-mechanical properties of seeds. Therefore, it is important to determine the physical-mechanical properties of seeds, i.e. geometric dimensions, mass of 1000 seeds and the coefficient of static friction in every research work. In our research, the seeds of the early-ripening "Sumbula", mid-ripening "Istiqbol" and "Zafar" varieties of onions, which are planted in large areas in the Republic, were selected and their physical and mechanical properties were studied (Table 3) [5]. To determine the geometric dimensions of onion seeds and the mass of 1000 seeds, a certain amount samples were taken from the seeds of each selected variety. From the received samples, 100 samples were randomly selected from the total mass to determine their geometric dimensions and 1000 samples to determine their mass. Geometric dimensions (length, width, thickness) were determined with an accuracy ±0.01 mm using a micrometer. The mass was measured on an electronic scale MN-390 with an accuracy ±0.01 g [6-8].

Table 3

Geometric dimensions of onion seeds and mass of 1000 seeds

No	Seed varieties	1000 seed mass, g	Geometric size, mm	x_{max},	x_{min},	x_{ave},	±σ	V, %
1	"Sumbula"	3.82	length	3.5	2.6	3.0	0.27	8.9
			one	2.7	1.7	2.1	0.27	11.9
			thickness	2.5	1.3	1.9	0.27	13.9
2	"Istiqbol"	3.79	length	3.6	2.3	3.2	0.26	8.3
			one	3.1	1.6	2.2	0.25	10.9
			thickness	2.6	1.1	1.8	0.24	13.5
3	"Zafar"	3.83	length	3.7	2.0	3.1	0.3	9.8
			one	3.6	1.5	2.3	0.26	11.4
			thickness	2.3	1.0	1.8	0.21	11.7

From the data in Table 3, it can be said that the average geometric dimensions of the seeds of the onion varieties obtained for the study were found to be in the following range: length from 3.0 mm to 3.2 mm, width from 2.1 mm up to 2.3 mm, thickness from 1.8 mm to 1.9 mm and mass of 1000 pieces from 3.79 g to 3.83 g. The results obtained are mostly consistent with the research results by other scientists. For example, K Kuhmazov's research shows that the average size of the onion seeds of Bessonovsky Local variety varies within the following limits: length 3.02-3.12 mm; width 2.23-2.30 mm; thickness 1.64-1.70

mm; In accordance with this, they can be attributed to the average size group with an average equivalent size of 2.26 mm [20].

To determine the coefficients of static friction of the seeds, the method known from the literature and widely used - the method determining the minimum angle inclination of the seeds sliding on the friction surface was used. Table 4 shows the results determining static friction angles for the varieties of onion seeds.

Table 4

Angles of static friction of onion seeds

Friction surface	Value indicators for varieties		
	"Sumbula"	"Istiqbol"	"Zafar"
Painted steel	16˚03′	17˚03′	16˚48′
Unpainted steel	18˚15′	19˚42′	18˚24′
Aluminum	20˚00′	20˚45′	20˚27′
Plastic	26˚00′	27˚33′	26˚42′
Rubber	24˚15′	24˚42′	24˚24′

Depending on the type of the friction surface, the friction angles of the seeds had different values. The average temperature of the sliding angle was 21.4 degrees Celsius. The smallest values of the friction angle of onion seeds were on painted steel, and the largest values were on the plastic surface. It was found that the friction angles of the seeds of the Istikbol variety are greater than the friction angles of the Zafar and Sumbula varieties on all surfaces.

CONCLUSIONS

1. In the 0-5, 5-10, 10-15, 15-20 cm layers of the soil prepared for planting onion seeds, the humidity is 13.4; 15.1; 17.4 and 18.6%, density 1.10; 1.14; 1.22 and 1.25 g^-cm^3, and the hardness 0.50, 0.64, 0.76 and 0.89 MPa.

2. The natural curvature of the soil surface was observed at 7-8% of the value of the moisture content of the soil (30°). An increase or decrease in the moisture content of the soil from this value will result in an increase or decrease of the natural curvature.

3. The smallest value of the friction angle for onion seeds was found on the metal surface at 16°51′, and the largest value was on the plastic surface at 26°58′. The seeds of the Istiqbol variety had friction angles on all surfaces that were larger than those of Zafar and Sumbula varieties. The seeds of early-early "Sumbula" and mid-early "Istiqbol" and "Zafar" onion varieties have the following main physical and mechanical properties: length from 3.0 mm to 3.2 mm, width from 2.1 mm to 2.3 mm up

to 1.8 mm to 1.9 mm thick. The mass of 1000 onion seeds, depending on the variety, was in the range of 3.79 - 3.83 g.

REFERENCES

[1] Ibragimov, A., Karakhanov, A., Abdurakhmanov, A., Eshdavlatov, A., Uteniyazov, P., Khadzhiev, A. Research Results for a New Onion Seed Drill. Agricultural Machinery and Technologies, 2020, No 14(4). pp. 12-16.

[2] Рудаков, Г.М. Технологические основы механизации сева хлопчатника (Technological bases of mechanization of cotton sowing). Tashkent: Fan, 1974, 284 p. (In Russian).

[3] Sergienko, V.A. Технологические основы механизации обработки почвы в междурядьях хлопчатника (Technological bases of soil tillage mechanization in cotton row spacing), 1978. 110 p. (In Russian).

[4] ГОСТ-20915-2011. Испытания сельскохозяйственной техники. Методы определения условий испытаний (Testing of agricultural machinery. Methods for determining test conditions), 2013. 28 p. (In Russian).

[5] Punil G., Rajvir Y., Shubham Z., & Trushal D. (2019) Determination of physical and mechanical properties of onion (Gujarat white onion-1) seeds, *International Journal of Chemical Studies 7*(*4*): 3082-3085

[6] Chhina R., Sharma A. Studies on physical properties of onion seeds (*Allium cepa* L.), *Progressive agriculture*. *43*(*1*): 76-80. 2011.

[7] Pandiselvam R., Kailappan R., Pragalyaashree M., & Smith D. Frictional, mechanical and aerodynamic properties of onion seeds, *International journal of engineering research & technology*. 2(10):2647-2657. 2013.

[8] Yang H., Wang B., Gu F., Wu F., Zhang Y., Hu Z. Determination of some physical and mechanical properties of onion, INMATEH - *Agricultural Engineering*, Vol. *68*, No. *3*. 324-332. 2022.