Perfection of technology of crops of seeds of water-melons in the conditions of a droughty climate

I A Kravchenko and I N Krasnov

Azov-Black Sea Engineering Institute – branch Don State Agrarian University of Zernograd, 21, Lenina Str., Zernograd, 347740, Russia

E-mail: vand2008@mail.ru

Abstract. Seeding of watermelons in the dried up soil are accompanied by a delay of shoots and even destruction of a part of plants. In an initial stage of growth and development watermelons are very water consuming. In this connection directions of scientific researches and constructive workings out on perfection of technology and means of preparation and crops of seeds of watermelons in the conditions of a droughty climate represent rather actual problem of an agricultural production.

1. Introduction

The yields of watermelon are high on light, fertile brown, chestnut and black earth soils. It is better to grow it on virgin and fallow lands.

In the crop rotation, it follows a layer of perennial grasses, well fertilized grain crops. The seeds of melons and gourds provide simultaneous shoots and the subsequent development of plants only on grain-sized and loosened soils, into which air freely flows. In the case of panning after seeding, which prevents the penetration of oxygen to the seeds, it suffocates and dies. At the optimum temperature, sufficient moisture and light grain size distribution of the soil, the germination of melon seeds is quick enough.

Figure 1. Standard form of watermelon seeds

Melons seeds consist of a shell and a kernel.
The seed kernel in melons consists of two seed lobes 2 (Figure 2), between which there is a corcule 3, consisting of a root 4 and a bud 6, connected by a stem 5.

![Figure 2. Standard structure of a watermelon seed](image)

The cover of a watermelon seed consists of 3 main layers of tissues: the outer epidermis (spongy tissue - hypodermis), which consists of very porous cells filled with air; a layer of stony cells that give strength to the seed coat; inner layer (tracheide), filled with air. In watermelon seeds, the epidermis is located in a single row of fine-palisade cells that contain pigment that gives the seeds their color.

![Figure 3. Shell structure of watermelon seed](image)

2. Materials and methods
In the initial period of growth and development, watermelons are very water consuming. When the root system is fully formed, the need for water decreases. At a favorable temperature of 25-35 degrees and sufficient soil moisture, the seeds begin to germinate on the 3rd - 4th day and germinate on the 9th - 10th day after seeding. In 5-6 days after germination, the first true leaf appears and then the third, fourth and fifth leaves with shortened internodes appear every 3-4 days. Then, the growth slows down. Plants take on the appearance of a small upright bush that has not formed whips.

For seeding it is better to take seeds that have been stored for 3-4 years. In order to accelerate the emergence of seedlings, they can be germinated by immersion into hot water (60-65 °C) for 4 minutes and then keeping them at a temperature of 30 °C for 3 days on a damp litter with a shelter.

The seeds of previous harvest must be warmed up with hot air before seeding at a temperature of 50 °C for 2 hours. Seeds are treated with arosan (5 g per 1 kg of seeds) in order to prevent fungal diseases.
It is not easy to provide such conditions for the preparation of seeding. Therefore, it is advisable to moisten the seeds and warm them up using our technology.

It is known that seed moisture is the water content of the seed as a percentage of the initial mass. Water enters the seeds in two ways: through the parent plant, it is the primary moisture and through the seed structures after the physiological separation of the seed from the parent plant, it is the secondary moisture. Primary water cannot cause seed germination, since it has no dissolved oxygen. However, it determines the rate of respiration of seeds. It is necessary to note that the intensity of respiration increases with the increase in secondary humidity. Both primary and secondary water is in the seeds in a bound and free condition.

The water in the seeds can be chemically bound, that is, it can be part of the molecules, or it can be bound physically with the colloids of the seeds. Such water is physiologically inactive. It cannot form an environment in which biochemical processes take place in the cell. Free water in seeds determines the activity of biochemical processes and primarily affects the intensity of respiration. The maximum moisture content of the seeds, above which free water appears, is called the critical moisture content (for watermelon seeds it is 10-11%).

The saturation capacity of watermelon seeds in the process of moistening has its own characteristics. Therefore, it is advisable to organize a cyclic supply of water to them according to the moistening time. It is necessary to note that the duration of grain moistening until it is saturated with moisture depends on the temperature of the water and the environment to a large extent.

Figure 4. Unit for moistening watermelon seeds: 1 – tanker; 2 – gate; 3 – charging chute; 4 – chain bucket; 5 – water tin; 6 – pump; 7 – flow meter; 8 – hose; 9, 10 – rotational sprayer

Taking into account that for the complete swelling of watermelon seeds, 48-50% of water from the mass of dry seeds is needed, the process of moistening them was carried out as follows. The seeds were loaded into tanker 1, in which they were irrigated with a rotational sprayer 10. The dose of initial irrigation of seeds was almost half of the total water requirement for the saturation with moisture and amounted to 25% of the initial weight of watermelon seeds. The water temperature was equal to 30 °C.

After 2 hours, the next stage of seed moistening followed. At this stage another 25% of the original seed mass was supplied. The water temperature was 35 °C. The total duration of seed moistening in this installation at an ambient temperature of at least 15°C was 4 hours. Heated water was supplied from tin 5 by pump 6 through pipeline 8. Water in tank 5 was heated using an electric heater.

After moistening, the seeds are disinfected. For the disinfection of melon seeds, a 1% solution of potassium permanganate is used or it is processed for 20 minutes in a 20% hydrochloric acid solution, with the obligatory subsequent washing of the seeds with clean water.

Then the seeds are dried for 1 hour with hot air at a temperature of 40 °C and sent to the area for the application of a moisture protective coating.
The need to apply a moisture-protective coating on watermelon seeds is explained by their biological characteristics. Watermelon seeds do not germinate well and give late shoots at soil temperatures below 14 ºС. The experiments show that the seeds of watermelon germinate better and then give simultaneous shoots when a stable average daily soil temperature is reached at a depth of their embedding of about 18 ºC. At the same time, soil moisture should be within 75–80%. We have to sow moistened seeds in dry soil in the required agrotechnical terms, but at an even low temperature.

3. Results

Figure 5 shows a standard form of the unit for the application of a moisture protective film on seeds in the technology of spring seeding preparation.

It contains: tanker 1; gate 2; a chamber for the application of vapors of the coating material to seeds 3; a chamber for the introduction of vapors of the coating material 4; steam generator 5; fan 6.

The unit works according to the following principle. Before processing the seeds, a certain portion of the moisture-protective coating is loaded into the chamber 5 for the introduction of material vapors, the heater is turned on, and after heating the material, the fan 6 is used to supply air to the bubbler, which is saturated with vapor of the coating material at the exit from the chamber 5.

Next, the gate 2 is opened and the seeds are fed into the chamber for the application of vapors of the coating material 3. The flow of seeds in the chamber body moves, falling, towards the flow of paraffin vapors and is covered with a moisture-proof film.

The size of the moistened seeds prepared for sowing is almost 40% larger than the original non-moistened ones. In addition, they have weakened strength properties and other coefficients of friction. It is recommended to sow them with seeders with pneumatic sowing device.

The seeding rate for small seeds is 2-3 kg, for large seeds it is up to 4-5 kg per 1 ha. Sowing patterns are different - 1.4 x 1.4; 2.1 x 1.4; 2.1 x 2.1; 2.8 x 2.1 m; large areas of supply are also used in arid zones of tropical deserts.

During watermelon seeding, it is important to observe the depth of seeding them into the soil. The optimal seeding depth for small-seeded varieties is 4–6 cm, for large-seeded varieties it is 6–8 cm. If the planting material is deepened more, it will be more difficult for it to hatch and it will affect the
germination time. In addition to the variety, the soil also influences the seeding depth. On sandy soils, seeds are deepened by 7–8 cm, on sandy loam - 5–7 cm, on loam - 4–5 cm.

Seedlings are thinned out, leaving 2-3 best plants in the nest. The rows are regularly loosened.

Figure 6. Standard form of the seeder SPB-8

The seeder SPB-8 (Figure 6) consists of a frame, 8 seeding sections, 4 fertilizer dispensers, 2 markers, fertilizer lines, a fan, two support-drive wheels, right and left gearboxes, corrugated pneumatic hoses, a linkage mechanism and hydraulic cylinders.

In order to ensure hill seeding of melons and gourds with the pneumatic seeder SPB-8, it is necessary to modernize the sowing apparatus of this seeder. For this purpose, each disc has suction and suction holes (Figure 7). The suction holes of the disc are located on the side of the seed chamber and the suction holes are on the side of the vacuum chamber. Suction holes with a diameter of 4-5 mm are located on the disc in groups of four holes in each group and there are four such groups on the disc. On the reverse side of the disc there are four suction holes in the form of a circle, uniting a group of suction holes by their area.

The seeding device of the SPB-8 seeder operates according to the following principle. The vacuum in the vacuum chamber of the sowing device is created by a centrifugal fan driven in rotation from the tractor PTO shaft. During the operation of the device, the seeds from the hopper come through the outflow channel into the seed chamber of the seeding device, in contact with the cells of the seeding disc. With the rotation of the seeding disc and the presence of the necessary vacuum in the vacuum chamber, the seeds are set in motion with the help of the agitator and sucked to the cells, which capture individual groups of seeds (four seeds in a group) and carry them out of the seed chamber.

Figure 7. Standard form of the disk for group watermelon seeding
Further, the seeds remaining on the disc are transported to the unloading zone of the cells, where, as a result of vacuum shielding and the impact of the flipper-guide, they are separated from the seeding disc in groups and adjusted by the guide along a certain trajectory they are dumped into the opener attached to the lower part of the apparatus body. As the cell moves further, the dosing cycle is repeated.

4. Conclusion

In order to ensure the given seeding pattern and the rate of seeding in the hill in accordance with agrotechnical requirements, we need to perform certain kinematic calculations.

We will make a row spacing of 1.4 m using the 2nd, 4th, 6th and 8th openers on an eight-row seeder. We will not load the rest of the openers with seeds.

The width of the hills equal to 1.4 m will be ensured by the selection of the gear inches from the support-drive wheel of the seeder to the seeding disc. Let us consider the kinematic diagram of the seeder drive.

The following factors have a significant effect on the process of seeds suction: the diameter of the suction hole, the magnitude of the vacuum, the rotational speed of the seeding disc. In order to take into account the influence of the geometric parameters of the seeding apparatus, we carried out calculations and experiments.

Crop rotation in the field at intervals of 3-4 years allows more efficient use of the soil. It gives a plant the opportunity to show its full potential for yield and, in many cases, leads to lower costs of chemical treatments. It is not advisable to grow a watermelon on the same field for more than two years in a row, as this contributes to the massive development of diseases, the increase in the number of pests, the decrease in yield and fruit quality.

The best fore crops for watermelon are winter wheat after black fertilized fallow, perennial grasses and silage corn.

References

[1] Goryachkin V P 1965 Collected works in 3 volumes. Vol. 1, 2 (Moscow)
[2] Kravchenko I A 1992 Intensification of the technological process of sowing seeds of watermelons with a melon seeder (Zernograd)
[3] Krasnov I N, Kravchenko I A, Kasyanenko A V, Tolstoukhova T N, Miroshnikov M A 2018 RF Patent No. 2653068. Unit for the application of a moisture-protective film on agricultural seeds (07 May 2018)
[4] Abezin V G et al. 1974 Mechanization of pumpkin crops sowing. Potatoes and vegetables.
[5] Buzenkov G M, Ma S A 1976 Machines for sowing crops. (Moscow: Machine building)
[6] Nesmiyan A Y 2016 Modeling the process of seed dosing of tilled crops with a pneumatic-vacuum seeder of precise sowing. (The Buryat State Agricultural Academy named after Filippov V.R.)