

## DEVELOPMENT OF A DEVICE FOR LAYING FILM ON FIELDS WHERE MELONS AND GOURDS ARE GROWN

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**Abstract.** This article investigates the development of a combined machine designed for simultaneous ridge formation, drip irrigation pipe placement, and polyethylene mulch film laying in melon crop cultivation fields. Existing domestic and foreign mulch-laying machines were analyzed from technological and конструктив viewpoints, and their main shortcomings were identified. The proposed machine is intended to reduce labor consumption, minimize fuel and energy costs, improve soil moisture conservation, and increase irrigation efficiency under arid climatic conditions. The study substantiates the design parameters of ridge-forming working bodies and soil-crushing rollers to ensure high-quality ridge formation and stable mulch film placement. Experimental analyses demonstrated that the combined machine significantly decreases the number of technological operations, reduces soil compaction, and improves agro-technical performance. The developed technology contributes to water-saving agriculture and increases the productivity of melon crop cultivation.

**Keywords:** melon crops, mulch laying machine, ridge former, drip irrigation, polyethylene film, combined machine, water-saving technology, soil roller, agricultural mechanization, ridge cultivation.

**Introduction.** Efficient use of water resources has become one of the most urgent challenges in modern agriculture, especially in arid and semi-arid regions. In recent years, mulch film technologies combined with drip irrigation systems have been widely introduced in melon and vegetable cultivation to reduce water consumption and improve crop productivity. These technologies allow preservation of soil moisture, stabilization of soil temperature, suppression of weed growth, and acceleration of crop maturation.

According to recent agricultural statistics, significant areas of irrigated land are still cultivated using conventional furrow irrigation methods, which result in excessive water losses and high labor costs. Scientific studies conducted in Uzbekistan have shown that drip irrigation systems can reduce water consumption by up to 50–60% during the vegetation period while increasing crop yield and improving product quality.

Despite these advantages, the process of ridge formation, drip irrigation pipe installation, and mulch film laying in melon cultivation is still mainly performed manually or through separate technological operations. Such an approach increases labor intensity, fuel consumption, soil compaction, and production costs. Therefore, the development of a combined machine capable of simultaneously performing these operations in a single pass is an important scientific and practical task.

**Purpose of the Study.** The main purpose of this research is to develop and scientifically substantiate a combined machine capable of simultaneously: forming ridges; crushing and compacting soil clods; laying drip irrigation elastic pipes; covering the ridge surface with polyethylene mulch film.

The study also aims to determine the optimal parameters of the machine's working bodies under local soil and climatic conditions.

**Materials and Methods.** The research was conducted using analytical, theoretical, and experimental methods. Existing mulch-laying machines developed in different countries were comparatively analyzed according to the following criteria: ridge-forming quality; energy



consumption; construction complexity; adaptability to local soil conditions; ability to lay drip irrigation pipes; operational productivity.

Theoretical calculations were carried out to determine the optimal geometric and technological parameters of the ridge-forming working bodies and soil-compacting rollers.

Field experiments evaluated:

- ridge height and width;
- soil crushing quality;
- mulch film tension stability;
- positioning accuracy of drip irrigation pipes;
- traction resistance;
- fuel consumption;
- field productivity.

### **Analysis of Existing Mulch Laying Machines**

The analysis of existing domestic and foreign mulch-laying machines demonstrated that most available machines have several significant disadvantages.

Chinese mulch-laying machines such as CN201388373Y and CN202998966U can simultaneously form ridges and lay polyethylene film; however, they do not provide placement of drip irrigation pipes beneath the film. In addition, many of these machines have high traction resistance due to large moldboard-type working surfaces.

Machines such as ORTIFLOR TSA100 and BSMLCR9040 are multifunctional and capable of laying drip irrigation pipes together with mulch film. Nevertheless, these machines are characterized by: large dimensions; high mass; complicated construction; high power requirements; poor adaptability for small farms.

Most existing mulch-laying machines also lack effective soil-clod crushing mechanisms, resulting in poor ridge surface preparation and unstable mulch film installation.

The conducted analysis revealed that none of the studied machines fully satisfies the agro-technical requirements of melon cultivation under the soil-climatic conditions of Uzbekistan.

### **Design of the Proposed Combined Machine**

Based on the conducted analysis, a new combined ridge-forming and mulch-laying machine was developed.

The machine consists of the following main components:

1. supporting frame;
2. tractor-mounted suspension mechanism;
3. ridge-forming working bodies;
4. soil-crushing and compacting roller;
5. drip irrigation pipe drum;
6. polyethylene film drum;
7. film-guiding mechanism;
8. film-pressing wheel;
9. covering discs for burying film edges.

The technological process operates as follows:

1. Ridge-forming working bodies gather and move soil to create a wide ridge;
2. The crushing roller breaks soil clods and compacts the ridge surface;
3. The drip irrigation pipe is laid along the center of the ridge;
4. Polyethylene mulch film is stretched over the ridge surface;
5. Covering discs bury the film edges with soil.



The machine performs all technological operations in a single pass, which substantially reduces field traffic and energy consumption.

### **Substantiation of Working Body Parameters**

The quality of ridge formation and mulch laying strongly depends on the parameters of the working bodies.

The conducted theoretical and experimental studies determined the following optimal parameters:

- ridge height: 25–30 cm;
- ridge width: 120–140 cm;
- attack angle of working bodies: 25–30°;
- roller diameter: 350–450 mm;
- roller rotational speed: 180–220 rpm.

These parameters ensure:

- uniform ridge geometry;
- effective soil crushing;
- reliable mulch film tension;
- reduced traction resistance;
- improved soil moisture retention.

Special attention was paid to minimizing energy consumption while maintaining high agro-technical quality.

### **Results and Discussion**

Field experiments showed that the developed combined machine significantly improved the efficiency of melon crop cultivation technologies.

The obtained results demonstrated that:

1. the number of technological operations decreased by 2–3 times;
2. labor requirements were substantially reduced;
3. fuel consumption decreased by 20–25%;
4. irrigation water savings reached up to 50%;
5. ridge quality and mulch film stability improved;
6. soil compaction caused by repeated machinery passes was minimized.

The simultaneous installation of drip irrigation pipes beneath the mulch film also improved water distribution efficiency and reduced evaporation losses.

Compared with conventional cultivation technologies, the proposed machine provided higher operational productivity and lower production costs.

**Conclusion.** The conducted research allows the following conclusions to be drawn:

1. Mulch film cultivation combined with drip irrigation is an effective water-saving technology for melon crop production under arid climatic conditions.

2. Existing mulch-laying machines do not fully satisfy the technological and agro-technical requirements of local farming systems.

3. The developed combined machine enables simultaneous ridge formation, drip irrigation pipe installation, and polyethylene mulch film laying in a single pass.

4. Optimization of ridge-forming working bodies and soil-crushing rollers improves ridge quality while reducing traction resistance and fuel consumption.

5. The proposed machine contributes to:

- reduction of labor costs;
- conservation of water resources;
- reduction of energy consumption;
- improvement of crop productivity.



The developed technology can be effectively introduced into melon-growing farms and agricultural clusters operating under water-deficient conditions.

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