Development of technical means for laying an irrigation hose for drip irrigation during ridge cultivation of cotton

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Abstract. The article presents the results of research on the development of a technology for growing cotton with targeted and uniform moistening of the root systems of plants, which jointly contributed to the creation of optimal conditions for machine harvesting of raw cotton by ensuring early ripening (for 2–3 weeks) and a high yield. Among the measures reducing the labor intensity, further improvement of technology and means of mechanizing cotton sowing is important. The cotton cultivation on the ridge by the soil cultivation theory creates possibilities for adding the arable layer during a high growing season of cotton, which allows for obtaining friendly shoots, developing plants and obtaining a large amount of cotton-raw that ripe early. There is no sign of moisture accumulation in the soils, resulting in soil dusting, structure destroying and soil crusting, forcing creating a "drip irrigation system" providing plants with water and fertilizer if necessary. The use of "drip irrigation" guarantees higher yields and saves labor, water and energy resources. For the use of drip irrigation systems on farms with flexible perforated irrigation tapes laid in the upper part of the bed along its entire length, it is carried out simultaneously with the sowing of cottonseeds, which makes it possible to exclude manual layout of irrigation hoses, i.e., a time-consuming manual operation to start urgent irrigation work.

1 Introduction

The purpose of work is to create the conditions for machine picking of raw cotton by ensuring early ripening (for 2–3 weeks) and a high yield.

The application of the modern agricultural technology for cotton cultivation and sowing removes the top soil layer, leading to crusting after heavy rains and snow, caused by rainy springs, dry summers and autumns. High-crop agricultural background for machine harvesting cotton requires developing suitable and appropriate conditions for dealing with such problems, which necessitates creating an optimal density of the arable layer, maintaining it while cultivating cotton in beds and ridges. Various technologies are now available to accelerate development and early harvest [1–6]. However, they do not give positive results in cotton cultivation.

2 Materials and methods

The physical foundations of temperature regulation are based on changes in the heat balance and thermophysical properties of the soil, its surface, soil heat and temperature conductivity regulation.

Covering the surface with dark substances (peat) leads to a significant decrease in albedo, and, accordingly, to an increase in energy absorption by the soil. Remember, albedo is the ratio of reflected short-wave energy to incoming energy. To reduce the albedo means, first of all, to reduce the reflection of radiation by the soil, to increase the flow of heat into it. These are traditional techniques that are often referred to as surface mulching. Mulching the surface during warm periods leads to a decrease in soil temperature, to its shading. Thus, in the broadest sense, mulching reduces the amplitude of soil surface temperatures, "smooths" its dynamics. Another technique based on changing the balance components is associated with a decrease in the heating value of the surface air layer more precisely, using the heat radiation of the soil to heat the very same soil. It sounds paradoxical, but this is a very effective technique: combing the soil surface. This technique leads to the fact that the soil from the lateral surfaces receives solar radiation and, with the same lateral surfaces of the ridges, radiates heat to the lateral surfaces of the nearby ridges. This radiated by the lateral surface of the ridge is not lost, but is acquired by those adjacent to it. Overall, the soil loses less heat and accumulates less. In addition, when combing the soil surface increases, it again consumes more total energy of solar radiation than the leveled soil surface. This is shown schematically in figure 4.

However, it is necessary to take into account that in the case of imparting such wavy mesorelief to the surface, an increase in evaporation will also occur. Such beds will dry faster, being physical analogs of small "wicks" that evaporate moisture much faster than a leveled soil surface.

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The weather has been changing entailing problems with harvesting raw cotton requiring 90% of bolls opening, whereas the MX-1.8 cotton picker harvests up to 90% of the cotton per pass with the horizontal spindle collecting more than 90% [7–9], dealing with the agricultural equipment for growing cotton by irrigating with flexible perforated hoses in the beds tested by the State Center for Testing and Certification of Agricultural Technology and Equipment of the Republic of Uzbekistan. The advantages of bed sowing allow establishing a favorable microclimate for the cotton root system and conditions for harvesting cotton when it ripens early (for 2–3 weeks).

3 Solution technique

The objectives are achieved by rigidly attaching the opener to the former-compactor, completing the seeder with a fertilizer applicator and a drip irrigation hose handler, improving the irrigation, service life of the irrigation equipment and its contact with the soil, decreasing irrigation water jets, where the seeder sows seeds straightly forming a compacted bed with irrigation hoses on the bed ridge, equipped with water outlets for uniform plant moistening. The seeds are sown on the bed ridge in the layer of applied mineral fertilizers [10–20], formed during sowing and watering through drip irrigation hoses laid on the crest of the beds [21–29], using the device shown in Figure 1, where the seeder working bodies include a sequentially located working body 1, a fertilizer container 2, a pipeline 3, a bed former, a visor 4 that smoothly passes into the upper roof 6, a body 5 similar to mirror-mounted skimmers at the entrance and a trapezoid at the exit with the side shields and cover of the body being gradually narrowed.

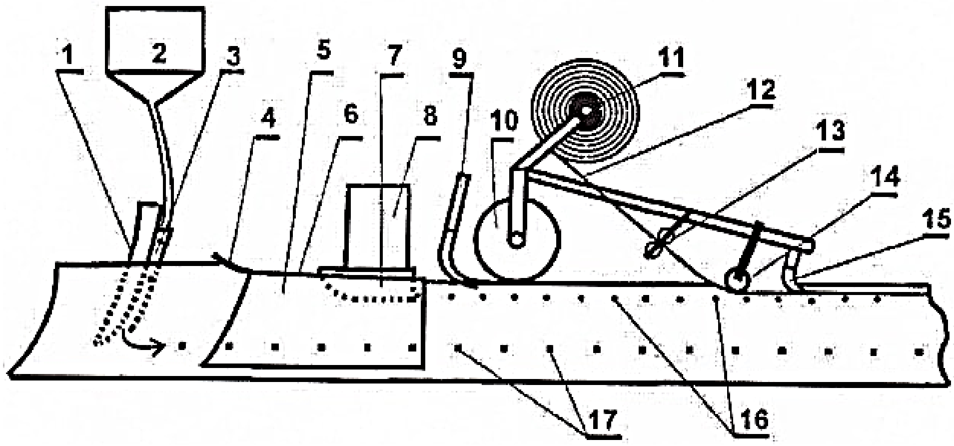

Fig. 1. Seeder diagram

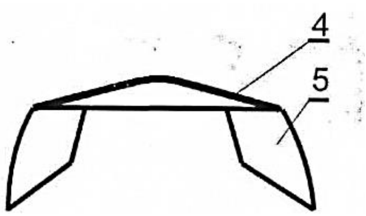

Fig. 2. Shaper circuit

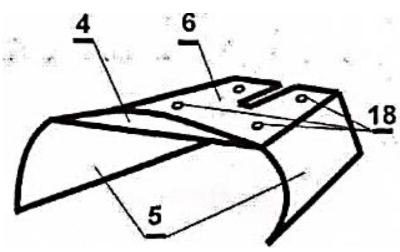

Fig. 3. Mounting scheme

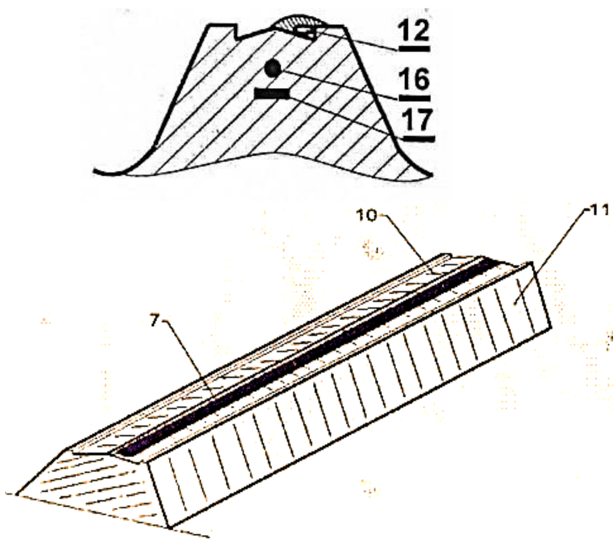

Fig. 4. Ridge layout with irrigation hose, seeds and fertilizers locations

Figure 4 shows the opener 7, can 8, seeding harrow 9, roller 10, winding reel 11, hose 12, guide rollers 13, pressure roller 14, harvester 15, seeds 16, applied fertilizer 17; the bed former is in Figure 2; the isothermal former with 18 holes for the bolts is in Figure 3. When the seeder moves forward, the working body places fertilizers into soil, raking dumps of the former-compactor 5, compressed in the horizontal direction of the soil ridge prepared before sowing with a specific shape, which narrows the former body cross-section, pressing beds. The opener sows seeds on the bed ridge with the harrower covering the seeds, compressing the soil by the press roller and squeezing out bed ridge recesses for the drip irrigation hose, winding the hose from the drum through the guide rollers and the rolling roller, while the harvester fills the hose with soil, when per pass of the seeder, a compacted bed (whose cross section is shown in Figure 4), local and targeted fertilization, sowing seeds and laying an irrigation hose take place.

The advantages of drip irrigation are saving irrigation water, fertilizers, reducing the cost of combating weeds, elastic plastic design of the hose and water outlets on one side with flanges along the edges, which are round holes, whose ratio to the diameter of the irrigation hose is d / D = 1 / (30 ... 40) at a distance of L = 80 ... 400 mm from each other, with the hose design shown in figure 5 equipped with the hose 2 filled with water 8 and the water outlet 3, flanging 4.

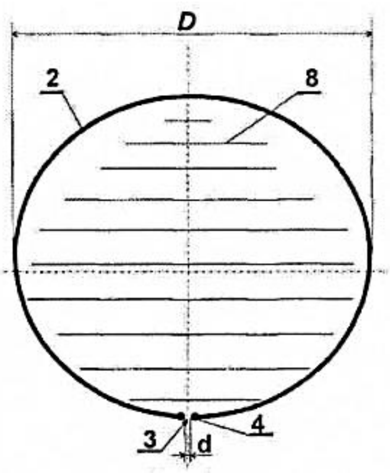

Fig. 5. Water outlets in the hose

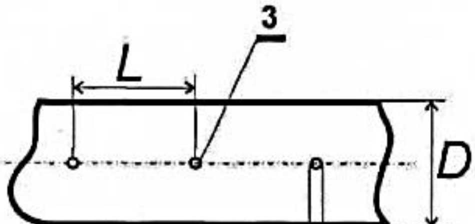

Fig. 6. Distance of water outlets in the hose

Figure 6 shows the water outlets 3 on the hose section with a relatively simple design, where the ratio of the holes diameter to the hose diameter is 1/1 (30...40) allowing a uniform water flow at low pressure by means of the downward hose location, reducing the soil pressure by the dropper. The laying of the irrigation hose allows contacting the outlets, acting to compensate the water jet pressure with a thin soil layer on top, protecting from the sunrays, lying on the bed ridge for drip irrigation with water outlets on the soil where the deviation from the outlet axis to the soil surface should not exceed 150 degrees.

4 Results and Discussion

The hose must have the outlets that are perpendicular to the soil surface. At the same time, Yangiyul District at the testing ground of the State Center for Certification and Testing of Agricultural Machinery and Technologies showed that the contact is also achieved when the outlet axis deviates from the soil surface by 150 degrees, using a GRANDFAR-1 water pump with a capacity of 30 cubic meters per hour per hectare with locally sourced irrigation hoses. Irrigation hoses are flexible, 250-300 microns thick, expanding or narrowing in diameter if required, self-cleaning from the silt layers, with the irrigation hoses length from 100 to 250 meters at a distance from 7 to 10 cm. Watering can be organized immediately after sowing, when the standard water consumption for furrow surface irrigation was 6000 m^3, but the consumption in case of the proposed irrigation on the ridge was 2000 m^3 without irrigation furrow openings and manual thinning.

Figure 7 shows irrigation hose laying, including the bed section 1, irrigation hose 2, water outlet 3, track 5, soil layer 6, contour 7, root system 8, and angle deviations, in the field on the bed ridge along the trail of the seeder figured roller, with water outlets and the hose hermetically sealed on the one end and connected to an irrigation water source at a pressure of (0.1... 0.3 atm.) on the other. Water fills the hose, flows out through the holes meeting soil resistance, reducing the head, providing watering similar to drip irrigation, serving as a pressure compensator for the jet without water seepage through side surfaces.

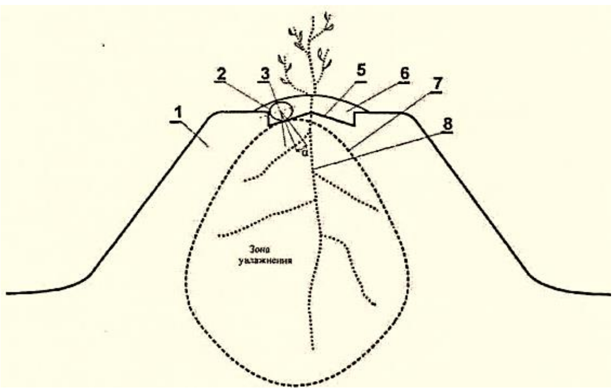

Fig. 7. Irrigation hose laying

5 Conclusion

1. This method of laying makes it possible to organize re-irrigation of seeds with a simultaneous supply of selective herbicides to destroy weeds in the plant's protective zone. During the growing season, we can organize irrigation with fertilizers as needed and in the right amount, along with watering. At the end of the growing season, with the last watering, a liquid desiccant is supplied to desiccate the plant, thereby ensuring the completeness of defoliation of the leaves of the plant. This provides the possibility of full opening of the capsules and creates conditions for machine picking of

raw cotton by ensuring early ripening (for 2–3 weeks) and high yield.

2. The economic effect of the proposed method is determined by reducing labor costs and the cost of reseeding, combining operations of targeted fertilization and sowing, and increasing the yield and quality of harvesting due to a better agricultural background (straightness of bushes in a row).

3. The proposed irrigation method saves water and fertilizers, simplifies the irrigation hose design, increases its service life, improving irrigation hose and crop production.

References

1. B.M. Khudayarov, U.T. Kuziev, B.R. Sarimsakov, Int. J. of Res. Cult. Society 45–49 (2019)
2. B.M. Khudayarov, U.T. Kuziev, B.R. Sarimsakov, Int. J. of Res. Cult. Society 111–116 (2019)
3. K. Astanakulov, E3S Web of Conf. **264**, 04074 (2021)
4. B.M. Khudayarov, U.T. Kuziev, B.R. Sarimsakov, R.F. Khudaykulov, in *Construction Mechanics, Hydraulics and Water Resources Engineering*, Int. Sci. Conf. CONMECHYDRO (2020), pp. 23–25
5. B.M. Khudayarov, U.T. Kuziev, B.R. Sarimsakov, Int. J. of Res. Cult. Society **3(10)**, 45–49
6. K.D. Astanakulov, G.G. Fozilov, B.Kh. Kodirov, I. Khudaev, Kh. Shermukhamedov, F. Umarova, IOP Conf. Ser.: Earth and Environ. Sci. **614**, 012130 (2020)
7. A. Rizaev, Z. Malikov, A. Yuldashev, D. Kuldoshev, D. Temirov, A. Borotov, Mater. Sci. and Eng. **1030**, 012175 (2021)
8. A. Rizaev, R. Matchanov, A.T. Yuldashev, D.A. Kuldashev, N.B. Djuraeva, N. Karimov, N.A. Ashurov, IOP Conf. Ser.: Mater. Sci. and Eng. **1030(1)**, 012173 (2021)
9. R. Matchanov, A. Rizayev, K. Astanakulov, A. Tolibaev, N. Karimov, IOP Conf. Ser.: Earth and Environ. Sci. **677**, 052021 (2021)
10. B.M. Khudayarov, A. Mambetsheripova, U.T. Kuziev, B.R. Sarimsakov, IOP Conf. Ser.: Mater. Sci. and Eng. **1030**, 012159 (2021)
11. B.M. Khudayarov, U.T. Kuziev, B.R. Sarimsakov, N. Abdiyev, The Int. J. of Eng. and Adv. Technol. **9**, 4847–4849
12. F.M. Mamatov, E. Eshdavlatov, A. Suyunov, *Jour of Adv Research in Dynamical & Control Systems* (2020)
13. F. Mamatov, I. Ergashev, S. Ochilov, X. Pardaev, *Jour of Adv Research in Dynamical & Control Systems* (2020)
14. N. Aldoshin, F. Mamatov, I. Ismailov, G. Ergashov, *19th International scientific conference engineering for rural development Proceedings* (2020)
15. U. Umurzakov, B. Mirzaev, F. Maмatov, H. Ravshanov, S.A. Kurbonov, Earth and Environ. Sci. **403**, 012163 (2019)
16. B. Mirzaev, F. Mamatov, D. Chuyanov, X. Ravshanov, G. Shodmonov, R. Tavashov, X. Fayzullayev, *XII International Scientific Conference on Agricultural Machinery Industry*
17. B. Mirzaev, F. Mamatov, I. Ergashev, H. Ravshanov, Sh. Mirzaxodjaev, Sh. Kurbanov, U. Kodirov, G. Ergashev, E3S Web of Conf. **97**1 (2019)
18. F. Mamatov, B. Mirzaev, M. Shoumarova, P. Berdimuratov, D. Khodzhaev, Int. J. of Eng. and Adv. Technol. (IJEAT)
19. F. Mamatov, B. Mirzaev, Z. Batirov, S. Toshtemirov, O. Tursunov, L. Bobojonov, CONMECHYDRO, IOP Conf. Ser.: Mater. Sci. and Eng. **883** (2020)
20. B. Mirzaev, F. Mamatov, I. Avazov, S. Mardonov, E3S Web of Conf. 9705036 (2019)
21. N. Aldoshin, O. Didmanidze, B. Mirzayev, F. Mamatov, *Proceeding of 7th International Conference on Trends in Agricultural Engineering* (2019), pp. 20–26
22. B. Mirzaev, F. Mamatov, N. Aldoshin, M. Amonov, *Proceeding of 7th International Conference on Trends in Agricultural Engineering* (2019), pp. 391–396
23. B. Mirzaev, F. Maмatov, I. Ergashev, Yo. Islomov, B. Toshtemirov, O. Tursunov, *Procedia Environmental Science, Engineering and Management* 395–404 (2019)
24. F. Mamatov, B. Mirzaev, P. Berdimuratov, Kh. Turkmenov, L. Muratov, G. Eshchanova, IOP Conf. Ser.: Mater. Sci. and Eng. **883**, 012145 (2020)
25. F. Mamatov, B. Mirzaev, O.A. Tursunov, E3S Web of Conf. **97**, 05035
26. B.J. Ahmedov, B.S. Mirzaev, F.M. Mamatov, D.A. Khodzhaev, M.K. Julliev, InterCarto, InterGIS **26**, 547–560
27. F. Mamatov, B. Mirzaev, O. Tursunov, S. Ochilov, D. Chorieva, ICECAE IOP Conf. Ser.: Earth and Environ. Sci. **614**, 012169 (2020)
28. Z. Shamsutdinov, Sh. Ubaydullaev, N. Shamsutdinov, B. Mirzaev, F. Mamatov, N. Chorshabiyev, ICECAE IOP Conf. Ser.: Earth and Environ. Sci. **614**, 012164 (2020)
29. U. Umurzakov, F. Mamatov, N. Aldoshin, B. Mirzaev, ICECAE IOP Conf. Ser.: Earth and Environ. Sci. **614**, 012168 (2020)