Drip irrigation and new fertilizer application technology for cotton variety C-8286 in the condition of global climate change

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Abstract. Prior studies have demonstrated that using furrow irrigation to develop the growing stage of upland cotton in Uzbekistan dictates when to schedule irrigation. The paper presents additional research on cotton irrigation timing variety C-8286 and how it affects irrigation crop water productivity and seed-lint yield as well as new fertilizer application technology under furrow and drip irrigation technology. Field research was carried out in silt loam soils of Samarkand province, Uzbekistan, in 2021 and 2022. When developing the irrigation schedule Fc with regard to field water content capacity (Fc), the stages of development from germination to blooming and from blooming to boll creation, and maturity were taken into consideration. The optimal development, growth, and output of seed lint for the. C-8286 cotton variety were achieved in drip irrigation technology with irrigation scheduling of 75-75-70% of Fc, wetting front layer of 50-50-50 cm during the abovementioned three growth stages, respectively where the seed-lint yield totaled 5.20 t ha^{-1}. Irrigation scheduling of 75-75-70% Fc for cotton variety C-8286 and drip irrigation ought to be regarded as appropriate procedures for both aforementioned types of cotton grown on silt loam soils in Samarkand province and for comparable soil-climatic circumstances of Uzbekistan and Central Asia.

1 Introduction

The difference between day and night temperatures has been distorted due to global warming. Although it used to be 50 degrees (Celsius) during the day, in the evening the temperature declined to 19-20 degrees, and at night it was moderate. Today, the soil in Uzbekistan warms up to 40-45 degrees during the day, and the temperature does not decline below 35 degrees at night. As a result of global climate change, conducting a number of scientific and research activities aimed at determining the impact of cotton varieties on water and nutrient

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requirements, growth and development, yield accumulation and changes in cotton fiber quality indicators is one of the urgent tasks of today [1, 2].

The largest annual temperature rise rate recorded during the last half-century in Uzbekistan was 0.22 degrees, while the lowest was 0.36 degrees, according to observations of the country's temperature dynamics. On the basis of this, the average annual temperature in Uzbekistan can be raised by 2-3 degrees in the north and by 1 degree in the south after 20 years. Climate change will lead to 10-15% more water evaporating from water surfaces and 10-20% more water being utilized as a result of increased plant transpiration and irrigation rates [3].

Question can arise, how much water is used to irrigate 1 hectare of land in Uzbekistan today? In the conditions of Uzbekistan, 18,000 m^3 ha^{-1} of water resources was used for 1 hectare irrigated land in the 1990s, but today this figure has decreased by 40%. In particular, due to the state's stance in the direction of economical utilization of Uzbekistan's water resources, the overall quantity of water used has been reduced by 20% compared to the 1980s [4].

According to the information of the The Minister of Water Resources in the Uzbekistan Republic, Sh. Khamraev, it can be noted that Uzbekistan will take the 16th place in the world in terms of implementing water-saving technologies by 2022, including drip irrigation technology, and it will occupy the 1st place among the countries of Central Asia [5-6].

According to research conducted by Kevin Bronson in the irrigated lands of Texas and Arizona in the southwestern regions of the United States, Internal Nitrogen Use Efficiency (iNUE) is the most important factor in increasing fiber yield. It was determined that the average nitrogen application was 91 and 133 kg per hectare, the fiber yield was 1535 and 1790 kg, and the average nitrogen uptake was 128 and 177 kg ha^{-1} [7-15].

In the studies carried out in the USA, it was found that when phosphorous fertilizers dissolved in water were used frequently and constantly, i.e., every 2 days for 4 hours, the efficiency of phosphorus use was higher than that of simple drip irrigation. It was found that the amount of phosphorus in plant parts was up to 25% [7-10].

A special feature of fertilizer application in the cultivation of cotton with drip irrigation technology is that nutrients are applied with irrigation water, that is, mineral fertilizers are dissolved and supplied with irrigation water directly to the layer where the roots are spread out. The holes of the drippers of the irrigation system do not clog quickly while choosing water-soluble types of fertilizers. Potassium and phosphorus fertilizers are less soluble in water. Therefore, it is better to apply these fertilizers before plowing or before sowing by using the conventional methods. Nitrogenous fertilizers have the greatest solubility. Therefore, nitrogen fertilizers are added to the water during the crop care season [8, 9].

2 Materials and methods

Field trials were conducted in 2021 to 2022 a long time within the condition of ancient watered knoll sierozem soils with mechanical composition of sediment soil with profound >2 m water table in Samarkand territory, Uzbekistan. During the 2021 to 2022 years upland cotton varieties S-8286 were investigated in the following irrigation scheduling 75-75-70% Fc.

In Central Asia, climate is parched conjointly mainland [9]. In test location, the normal temperature changed from 15.8 to 16.2^{O}C. Yearly precipitation sums from 300 to 400 mm. Nearly 90 % precipitation happens from harvest time till spring. Inquire about strategy were taken after by "Methods of field experiments" distributed by Uzbekistan Cotton Investigate Organized [10]. The test format was a total randomized piece plan with three replications. Each reproduced plot estimate equaled to 240 m2 with 8 cotton columns and wrinkle length of 100 m (4.8 m x 50 m). Cotton push dispersing equaled to 60 cm.

The soil physical properties comprised of particle-size examination, field capacity, invasion, BD, porosity and dampness substance were recognized by standard strategy. Particle-size examination was decided on arbitrarily chosen tests by the sedimentation strategy utilizing sodium hexametaphosphate as a scattering operator. Soil dampness substance was decided by the gravimetric method.

Within the field, water system water run on and run off was measured with water measuring weir "Chippoletti", where the width of water passing portion equaled to 0.25 and 0.50 m. In each wrinkle, the water system water was measured by utilizing weir Tompson. In trickle water system, water measuring controller were utilized for water estimation. Wetting root zone layer of the soil from germination till blossoming was 0-70 cm, blossoming to boll arrangement 0-100 cm and development 0-70 cm in wrinkle water system. Distinctive root zone layers were chosen in dribble water system innovation. The water system planning Fc rates were moreover considered abovementioned development stages. For illustration, water system planning 75-75-70, 75% for germination till blossoming, 75% blooming to boll arrangement, 70% for development.

The field's capacity was determined by flooding a randomly selected area (2 m × 2 m) within the field, covering the overflowed area with a polyethylene sheet, and measuring the soil's moisture content every day for two to five days, until stabilization was achieved at all soil depths. To establish Fc-based irrigation planning, field capacity (Fc) was determined by increasing it by 10 cm steps up to a depth of 100 cm. In the profundity layer of 0-100 cm, the soil's field capacity (Fc) was 0.30 m3 m-3 (VWC). The determination of penetration capacity was made during the recent seeding and at the end of the season using conventional metallic infiltrometers with two rings, one with an internal diameter of 0.2 meters and an external width of 0.4 meters. The two rings were buried up to a depth of 0.15 meters, and continuous six-hour observations were made. Every season, using the center technique, the soil bulk thickness (BD, Mg m-3) was measured at intervals of 10 cm from the surface to 100 cm of soil profundity, sometime after sowing.

3 Results and discussion

In the 2021 season, cotton variety C-8286 was irrigated 5 times with irrigation scheme of 0-1-3-1 in irrigation scheduling of 75-75-75-70% Fc under furrow irrigation. There was no need to irrigate during the 2-4 leaf period, because soil moisture did not decline to 75% in this phase. During the budding phase, cotton was irrigated once at the rate of 844.4 m^3 ha^{-1}, during the flowering-yield accumulation phase 3 times at the rate of 972.2-1050 m^3 ha^{-1}, in the maturation phase 1 irrigation event at the rate of 900 m^3 ha^{-1}, and seasonal irrigation rate totaled 4791.6 m^3 ha^{-1}. The duration of irrigation was 16-21 hours, the interval between irrigations was 21-24 days. In the drip irrigation technology, total number of irrigation events was 10 with irrigation scheme of 1-2-5-2, 1 irrigation event was in the 2-4 leaf period at the rate of 162.5 m^3 ha^{-1}, 2 irrigation events was in the squaring phase at the rate of 225-237.5 m^3 ha^{-1}, 5 irrigation events was in the flowering-yield accumulation phase at the rate of 237.5-250 m^3 $ha^{-1}$and 2 irrigation events was at the rate of 212.5-225 m^3 ha^{-1} during the maturation phase, seasonal irrigation rate totaled 2287.5 m^3 ha^{-1}, irrigation duration was 6.5-10 hours, irrigation intervals equaled to 9-15 days.

In the drip irrigation technology, irrigation events number totaled 8 times with irrigation scheme of 1-1-4-2, 1 irrigation event at the rate of 196.6 m^3 ha^{-1} during the 2-4 leaf stage, 1 irrigation event at the rate of 258.3 m^3 ha^{-1} during the squaring phase, and 4 irrigation events at the rate of 265.3-278.7 m^3 ha^{-1} in flowering-yield accumulation phase, 2 irrigation events at the rate of 239.8-242.6 m^3 ha^{-1} during the maturation phase, seasonal irrigation rate totaled 2026 m^3 ha^{-1}, duration of irrigation was 8-12 hours, irrigation intervals was 12-17 days.

The effect of drip irrigation and new fertilizer application technology on cotton yield was measured by harvesting (picking by hand) cotton yield in 4 rows of each treatment in the experimental field. In this case, in 2021, when the conventional mineral fertilizers N-200, P-140, K-100 kg ha^{-1} were applied, the average yield equaled to 4.04 t ha^{-1}, and when water-soluble fertilizers were used at the same rate, the yield totaled 4.31 t ha^{-1}. While applying drip irrigation technology by using mineral fertilizers at the rate of N-200, P-140, K-100 kg ha^{-1} in the conventional fertilizer application treatment yield formed 4.39 t ha^{-1} in comparison with water soluble fertilizer application treatment the yield formed 5.08 t ha^{-1} (table 1).

In 2022, the highest yield was obtained in treatment No 8, which was drip-irrigated and water-soluble mineral fertilizers N-200, P-140, K-100 kg ha^{-1} were applied in less amounts in the form of easy assimilation according to the development periods of the plant, and the yield was 5.32 t ha^{-1} while 1.21 t ha^{-1} higher yield was obtained compared to the 2 control treatment in which mineral fertilizers N-200, P-140, K-100 kg ha^{-1} were used, i.e. furrow irrigated and conventional fertilizer application with tractor was applied. A higher yield of 0.77 t ha^{-1} was achieved due to water-soluble fertilizers and 0.92 t ha^{-1} due to drip irrigation technology (table-1).

Table 1. The influence of drip irrigation and new fertilizer application on seed-lint yield of upland cotton variety C-8286, t ha^{-1} (2021-2022 years)

No	**Irrigation technologies**	**Mineral fertilizer rates, kg ha^{-1}**	**Seed-lint yield of cotton, t ha^{-1}**			**Additional yield, t ha^{-1}**	
			2021	**2022**	**Average**	**According to fertilizer application**	**According to drip irrigation technology**
1	Furrow irrigation (conventional)	N-150, P-105, K-75 (control)	3.71	3.66	3.69	-	-
2		N-200, P-140, K-100 (control)	4.04	4.11	4.08	-	-
3		N-150, P-105, K-75 (new fertilizer application)	3.92	3.99	3.96	0.27	-
4		N-200, P-140, K-100 (new fertilizer application)	4.31	4.40	4.36	0.28	-
5	Drip irrigation	N-150, P-105, K-75 (farmer experience)	4.17	4.13	4.15	-	0.47

6		N-200, P-140, K-100 (farmer experience)	4.39	4.55	4.47	-	0.40
7		N-150, P-105, K-75 (new fertilizer application)	4.76	4.91	4.84	0.69	0.88
8		N-200, P-140, K-100 (new fertilizer application)	5.08	5.32	5.20	0.73	0.85
LSD_{05} = 0.34 t ha^{-1} for irrigation technologies, LSD_{05} = 0.31 t ha^{-1} for fertilizer application							

4 Conclusion

The following conclusions are based on research findings from the years 2021–2022, which focused on the development of new technologies for applying fertilizer to C–8286 cotton varieties and creating furrows and drip irrigation in meadow sierozem soils with medium mechanical composition and groundwater levels of 2-3 m in the fields of the "Maroqand sifat textile" cluster in Ishtikhon district, Samarkand province, in the central zone of Uzbekistan.

It should be noted that the highest yield from cotton variety C-8286 were obtained in drip irrigation technology with irrigation scheduling of 75-75-70% Fc and wetting front layer of 50-50-50 cm where an additional yield equaled to 0.73 t ha^{-1}.

It can be concluded that, in the drip irrigation technology, the new type of absolutely water-soluble fertilizers are better absorbed by the plant, and cotton grows better and has more yield during the period of operation in comparison with compared to the traditional fertilization system. In addition, drip irrigation technology enabled achieving 0.40-0.47 t ha^{-1} in conventional fertilization and 0.85-0.88 t ha^{-1} seed-lint yield of cotton in new fertilizer application technology.

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