Cultivation of Cotton in Uzbekistan and Xinjiang (NW China) Using Drip Irrigation

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***Abstract*: The article highlights the importance of cultivation of major crops - cotton, both in the Republic of Uzbekistan and China, the problems arising from the use of furrow irrigation with surface water shortages in these countries. Proposals on the application of drip irrigation of cotton under cultivation for the purpose of rational use of water. Presents conclusions and expected results in the implementation of drip irrigation of cotton, given the calculations of irrigation norms and fertilizer, obtained data analysis.**

***Keywords*: cotton, drip irrigation, cotton yield, irrigation efficiency, fertilization, furrow irrigation, water saving.**

I. INTRODUCTION

Cotton is an important raw materials of the textile industry, food industry and national defense industry. It is possible to get more than one hundred raw materials from cotton. The stable industrial crops, both in Xinjiang and Uzbekistan, are cotton.

The essential part of Xinjiang's economic structure is agriculture. The cotton growing is the leading branch of the agriculture production in Xinjiang. It produces both the largest quantity and the finest quality cotton in the country. Xinjiang is home to China's chief producers of cotton and a major export. It makes up sixty percent of the total for the whole nation.

In the economy of Uzbekistan, an important place also belongs to agriculture sectors thereof and the first of all to the cotton growing. Up to forty percent of agricultural land is used for cotton growing.

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Plenty of sun and high temperature in summer facilitate the cultivation of such heat-loving crop as cotton both in Xinjiang and Uzbekistan. Two areas belong to the regions, which have the most favorable conditions for cotton cultivation. Xinjiang is the biggest arid zone in China and has typical continental climate. Its average annual rainfall is 150 mm (southern Xinjiang has an average annual rainfall of only 100 mm and northern Xinjiang, 250 mm). Some mountain areas enjoy an annual rainfall of 1,000 mm. In southern Xinjiang the average temperature is 14.5 °C. In northern Xinjiang it is 8 °C. The lowest temperature ever recorded was -49 °C, whereas Turpan once registered a high of 47.6 °C. Annual sunshine in Xinjiang amounts to 2,600-3,000 hours, and the annual solar radiation is estimated to be 130-140 kcal/sq.cm. The annual evaporation in southern Xinjiang amounts to 1600-2000 mm and in northern Xinjiang, 1200-1400mm. Xinjiang is abundant in water resources but distributed unevenly in time and place [7]. Uzbekistan is located in the middle of the Central Asia, between two big rivers of Syrdarya and Amudarya which go to Aral Sea. The climate of Uzbekistan, presenting the same characteristics of Xinjiang, is sharply continental. It is one of the driest areas where a very low precipitation level is accompanied by its uneven distribution all over the Uzbekistan. The yearly precipitation over the most of the country does not exceed 200-300 mm. The lower Amudarya and deserts have the lowest level of precipitation of less than 100 mm a year. The amounts is slowly growing eastwards and south-eastwards of desert plains and sharply raises nearer to mountain regions up to 900-950 mm. Uzbekistan enjoys an abundance of sun. Annual sunshine in Uzbekistan amounts to 2980-3130 hours. The hottest summer month is July. The average temperature in this period 25-35 °C. The summer temperature of 42-47 °C is an usual phenomenon on plains and at foothills of Uzbekistan [6]. The surface water is also distributed over the territory in a very irregular way. Approximately the two thirds of total territory of Uzbekistan occupied by vast plains have very few sources of water. The soil formation, both in Xinjiang and Uzbekistan, is sandy-loam and loamy-sand in cotton cultivation areas.

II. PROBLEM

Agriculture both in Xinjiang and Uzbekistan depends mostly on artificial irrigation, that is why the canals and reservoirs are required not only for preservation of oases but also for the development and irrigation of new lands. That was a reason of various canals which are under construction since days until now.

Most of the irrigation systems in both places is still flood irrigation with low water using efficiency.

Some irrigated areas have water shortage problem during the vegetation period. This situation is more sever in southern part of Xinjiang.

Rivers in both area are continental ones except Irtish river which goes to Arctic Ocean. The surface and ground water go to the low-lying area and finally evaporate. In the other hand, with the excessive irrigation the ground water table is raised up. These course sever salination in the land. In order to solve salinity problem, the washing process is carried out. This does not solve the problem, on the contrary the land is becoming more saline [3].

In addition, the result of excessively irrigated cultivation in both areas, the worsening environmental problem has come up. The water of rivers is transferred to other places, thus there is no enough water supply for Aral Sea in Uzbekistan and Lop Nur in Xinjiang the water level has declined by tremendously and the shore line has passed away by tens of kilometers. Some rivers are became seasonal rivers. All this reduces the vegetation of the area, expand the desert and create many complications.

Continuous expansion of cotton industry in Xinjiang demands increases in both per hectare yield of cotton and area under the crop, cotton production depends upon optimum availability of water throughout the crop growth period. It is important to rationally use limited water resources by adopting appropriate irrigation technologies that not only increase cotton yield per unit area, but also per unit of water use.

The basic concept of the drip irrigation method is to supply an amount of water needed by the plant within a limited volume of the soil, as often as needed. Drip irrigation can improve the irrigation efficiency. Research has indicated 40 to 70% saving in water and 10 to 100% increase in yield are possible depending on the crop under irrigation [2, 4].

III. OBJECTIVE

Two field experiments, one in Xinjiang and one in Uzbekistan, are conducted to establish a more efficient drip irrigation and fertilization system for cotton growing.

IV. METODOLOGY

The experiments will be conducted during 3 successive seasons at the research farms, to study the response of cotton to drip irrigation and fertilization. The soil of the experimental site will be sandy loam in the root zone. In the drip irrigation, four irrigation levels and three levels of fertilization will be implemented and resulted in 12 experimental plots for four replications. The plots will be 50 m long and 7.2 m wide. Each plot has 8 rows 90 cm apart with 10 cm spacing between plants. Each plot will be irrigated through two laterals set 1.8 m apart (2 rows/ lateral) and spacing of 1 m between drippers (20 plants/dripper). There is a population of 4,000 plants in each plot.

According to the evapotranspiration of cotton field, under drip irrigation system, the necessary water supply is 600 mm over 100 days, a 6 mm daily consumption. Based on the nutrient requirement of cotton, the doses of 265 kg N per hectare, 170 kg P_2O_5 per hectare and 100 kg K_2O per hectare for 110,000 plant will be applied during the vegetation period. About 20 per cent of each will be given before sowing, the rest of them will be supplied through the irrigation water in accordance with experimental treatments.

The amount of water supply per plot will be calculated as following.

6 mm/day = 60 m^3/ha/day = 60,000 liter/ha/day,
60,000 liter/ha/day / 110,000 plants/ha =
= 0.55 liter/plant/day,
0.55 liter/plant/day x 4,000 plants/plot =
= 2,200 liter/plot/day

The amount of fertilizer supply per plot will be calculated as following.

1. Nitrogen:
220 kg/ha / 110,000 plants/ha = 2 g/plant
2 g/plant / 100 days = 0.02 g/plant/day
0.02 g/plant/day / 0.55 liter/plant/day = 0.0364 g/liter
0.0364 g/liter = 36.4 ppm
2. Phosphorus
32 kg/ha / 110,000 plants/ha = 1.2 g/plant
1.2 g/plant / 100 days = 0.012 g/plant/day
0.012 g/plant/day / 0.55 liter/plant/day = 0.0218 g/liter
0.0218 g/liter = 21.8 ppm
3. Potassium
77 kg/ha / 110,000 plants/ha = 0.7 g/plant
0.7 g/plant / 100 days = 0.007 g/plant/day
0.007 g/plant/day / 0.55 liter/plant/day = 0.0127 g/liter
0.0127 g/liter = 12.7 ppm

According to these calculations the experiments will be:

Variance	Drip irrigation cycle	Quantity of water, m^3/plant	Fertilizer reat		
			N	*P_2O_5*	*K_2O*
1	after 3 days	6.6	1g/pl= 18.2ppm	0.6g/pl= 10.9ppm	0.35g/pl= 6.4ppm
2	after 5 days	11.0	1g/pl= 18.2ppm	0.6g/pl= 10.9ppm	0.35g/pl= 6.4ppm
3	after 7 days	15.4	1g/pl= 18.2ppm	0.6g/pl= 10.9ppm	0.35g/pl= 6.4ppm
4	after 9 days	19.8	1g/pl= 18.2ppm	0.6g/pl= 10.9ppm	0.35g/pl= 6.4ppm
5	after 3 days	6.6	2g/pl= 36.4ppm	1.2g/pl= 21.8ppm	0.7g/pl= 12.7ppm
6	after 5 days	11.0	2g/pl= 36.4ppm	1.2g/pl= 21.8ppm	0.7g/pl= 12.7ppm
7	after 7 days	15.4	2g/pl= 36.4ppm	1.2g/pl= 21.8ppm	0.7g/pl= 12.7ppm
8	after 9 days	19.8	2g/pl= 36.4ppm	1.2g/pl= 21.8ppm	0.7g/pl= 12.7ppm
9	after 3 days	6.6	3g/pl= 54.6ppm	1.8g/pl= 32.7ppm	1.05g/pl= 19.1ppm
10	after 5 days	11.0	3g/pl= 54.6ppm	1.8g/pl= 32.7ppm	1.05g/pl= 19.1ppm
11	after 7 days	15.4	3g/pl= 54.6ppm	1.8g/pl= 32.7ppm	1.05g/pl= 19.1ppm
12	after 9 days	19.8	3g/pl= 54.6ppm	1.8g/pl= 32.7ppm	1.05g/pl= 19.1ppm

Plant sampling:

Samples of 25 plants will be taken from the central four rows and the following parameters will be recorded:

a. date of emergence;
b. number of plant population;
c. phenological measurement:

- plant height rate (June 1, July 1, August 1 and September 1)
- number of true leaves (June 1)
- number of sympodials (July 1, August 1 and September 1)
- number of buds (July 1)
- number of flowers (July 1)
- number of green bolls (August 1 and September 1)
- number of open bolls (August 1, September 1 and October 1)

d. weight of 25 bolls seed cotton

e. yield of per hectare

Soil sampling:

In order to determine followings, soil samples will be taken from 10 cm depth layers of soil profile, till 150 cm deep, before sowing and after harvesting.

a. rate of nutrient elements(humus, nitrate nitrogen, labile phosphorus and exchange potassium),

b. water conductivity

c. volume and specific weight

Analysis of data:

The data will be analyzed using a two-way ANOVA (cycle of irrigation and rate of fertilizer being the two factors). Mean comparison will be done using DAM (dispersion analysis method).

V. RESULT AND DISCUSSION

Based on the results of research works carried out in the sandy-loam and loamy-sand in cotton cultivation areas for the study using drip irrigation on the background of various norms of fertilizers obtained the following results:

- to obtain high yields in the cultivation of cotton with drip irrigation is necessary irrigation rate 11 m^3/plot, during irrigation cycle after 5 days.

- the optimum fertilizer rate was N – 0.0364 g/liter, P_2O – 0.0218 g/liter, K_2O – 0.0127 g/liter, in which obtained the highest yield to 44.2 centner per hectare.

- in optimal conditions of drip irrigation of cotton (in the variant 6) in comparison with furrow irrigation, water savings amounted to 49.2%.

VI. CONCLUSION

1. Establish optimal drip irrigation cycle and nutrient rate for cotton growing in irrigated areas of Xinjiang and Uzbekistan.

2. By using drip method saving considerable amount of irrigation water.

3. Lessening the stress on scare water resources and making betterment in ecological condition.

4. By using drip method increasing crop yield and improving the quality of cotton.

REFERENCES

1. Cameira, M.R.; Santos Pereira, L. Innovation Issues in Water, Agriculture and Food. Water 2019, vol.11, no.6, 1230.
2. A.B.Mamataliev, Drip Irrigation of Oil Crops. International Journal for Innovative Research in Multidisciplinary Field. ISSN: 2455-0620. INDIA. Vol. 5, Issue 1, Jan. 2019. pp. 92-95.
3. M.Kh. Khamidov, A.B. Mamataliev, Drip Irrigation of Oily Crops. Monograph. Tashkent, 2015.
4. M.Kh.Khamidov, Kh. Shukurlaev, A.B.Mamataliev, Agricultural Hydrotechnical Melioration. Textbook. Tashkent, 2008. pp. 115-129.
5. R.S. Varshney, Modern methods of irrigation. GeoJournal. January 1995, vol. 35, Issue 1, pp 59–63.
6. Akhmedov E.A., Saydaminova Z.A. Republic of Uzbekistan. Reference Book. Tashkent, 1994. pp. 96-100.
7. Manfred Domrös, Peng Gongbing, The Climate of China. Springer-Verlag, Berlin, Heidelberg 1988.

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