The Study of Effect of Alternate Furrow Irrigation on Quality and Quantity of Sugarcane at Different Stages of Growth

Boroomand-Nasab, S.[1] and Noori, M.[2]

[1-] Professor, Irrigation Dept., Islamic Azad University, Ahwaz, Iran.
[2-] Experienced top researcher, Karun Agro Industry, Inc.
boroomand@scu.ac.ir

Abstract: Sugarcane is one of the important crops in Khuzestan province which consumes large amount of water, specially in the warm season. In this study in order to optimize water consumption in a high efficiency, five treatments with three replications using randomized complete block design were applied in Karun Agro Industry, Inc. The first treatment was contained of conventional irrigation method which was used in the area (untreated as an example of witness). The second treatment was alternate furrow irrigation method during the growth season. The treatments third, forth and fifth were irrigated by alternate furrow irrigation method in the portion of the growing season and then shifted to the conventional irrigation method for the remaining of the growing season. These treatments were sequentially included with the alternate furrow irrigation method, at the beginning of the growing season, during the mid-stage growing season and finally at the late stage of growing season. The results indicated that there were no significant differences between all treatments, but the third treatment showed an increased of 8.02 tons/ha of sugarcane and 2.08 tons/ha sugar more than the conventional irrigation method. With the view of percent of recovery sugar, sequentially treatments fourth, fifth, and third have showed about 5% in surface area in better performance in comparison with the conventional method. The results also, indicated that water use efficiencies of treatments second and first were 0.51 kg/m3 and 0.38 kg/m3 respectively. Therefore, it can be concluded that the alternate furrow irrigation system in general can cause an increase in cane yield and water productivity.
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Introduction:

With reference in limitation of water natural resources in arid and semi-arid areas of Iran , it is better to use the irrigation water in an acceptable level; so, that with much less water usage, we can gain an economical yield of water use efficiency for the growth of crops. One of the important parameters to optimize usage of irrigation water in unit area, is to increase yield production by properly knowing how to use water at a high efficiency level in this matter.

Sugarcane has been planted in wide range areas of the province Khuzestan and is being irrigated by furrow irrigation method. This plant needs a large amount of water consumption, specially during the warm seasonal growth in this area and it is very sensitive to deficit irrigation. On the other hand, it is not a good practice to keep its root system in flooding conditions for a long period of time; specially, when the water table level is high, which it could covers the zones of elongations of the roots. Thus, it will cause a gradual suffocation of the root systems. Then the leaves and branches of the plant are turning in yellow color and finally, the growth of the stems will be completely decreased. Meanwhile, productivity of the crop yield will face a very severe decrease. Therefore, the irrigation management, with the aim of saving in water losses for proper usage of irrigation ad also yield.

Fischbach and Mulliner(1974), conducted a research project in a type of soil with the textural analysis of silty clay loam, using alternate furrow irrigation method with a spacing of 0.76 m distance in between each furrow. They found out that at the average of 29% reduction in consumption of water usage in compare with the conventional method, only 4.7% cane in yield reduction can be gained in productivity.

Sepaskhah(1996), by using the alternate furrow irrigation method for sugar beet plant, under the conditions of high level of underground water tables, showed that, this conditions can cause an overall high usage of water volume. Therefore, the amount of tuber productivity for sugar beet root systems with the interval of 6 days of irrigation period through the alternate furrow irrigation method in compare with the conventional irrigation method with the interval of 10 days of irrigation period could come to the same amount. Also, the total amount of water usage by volume for the agricultural purposes by the average of 23% had been decreased.

Sheyni Dasht-e-gol et al. (2006), at Amir Kabir sugarcane cultivation areas, Iran, had conducted a

research project, with three treatments. The treatments were alternate furrow irrigation method, constant furrow irrigation method, and conventional irrigation method. The results indicated that, the treatment with the alternate furrow irrigation method had shown the least minimum amount of water usage by volume for agricultural purposes. It had also shown that the highest water use efficiency could cause to increase productivity of 0.72kg/m^3 of refined sugar and cane production. Khoramiyan (2001), used the alternate furrow irrigation method for corn plant. He concluded that the amount of productivity by using the alternate furrow irrigation method in comparison and contrast with all other treatments until starting of flowering stage of the corn plants, could reach much higher. Also, the total amount of water saved by volume through this method of treatment in compare with the conventional furrow irrigation method was about 49.8%.

In order to verify and to study the effect of the alternate furrow irrigation method on the sugarcane productivity, and to reach to an optimum level of water use efficiency, a research project was applied, using a randomized complete block design for irrigation management of cp69-1062 variety of sugarcane new planted series in Karun Agro Industry, Inc., Iran.

Materials and Methods:

In order to carry out this research project, a field with texture of silty clay type soil. Furrows spacing were 153 cm and slope of the furrows were considered to be about 0.0007. The lengths of the furrows were about 240m. After applying the first round of irrigation period from end of Sep. 2005 to end of Mar. 2013, the same regular irrigation method was applied for the all treatments.

With the beginning of the growing season of the sugarcane plants which was around the end of Mar., 2013, the following treatments were applied:

1)Untreated, with the conventional irrigation method as was used at the sugarcane areas(FAI), from the end of Sep., 2005 to end of Sep., 2013.

2)Alternate furrow irrigation method (AFAI), from the end of Mar., 2013 to the end of Sep., 2013.

3)Alternate furrow irrigation in the first stage of the growing period(DFAI), from the end of Mar., 2013 to the end of May, 2013.

4)Alternate furrow irrigation in the second stage of growing period(MFAI), from the end of May, 2013 to the end of Jul., 2013.

5)Alternate furrow irrigation in the final stage of growing period(LFAI), from the end of Jul., 2013 to the end of Sep., 2013.

After applying the third, fourth, and fifth treatments, for the rest of growing season, irrigation events were shifted to the conventional method.

All the five treatments were carried out with three replications by applying a randomized complete block design statistical procedures. The total numbers of experimental furrows in each treatment were six.

Soil samples for determining soil moisture levels up to 100cm depths were taken before and two days after each round of irrigation periods. These, soil samples with three different depth, of 0-33cm, 33-66cm, 66-100cm were taken and were sent to the laboratory for this purpose. The amounts of field capacities and wilting points for all treatments were also measured accordingly. The amounts of growth rate in length of the plants were taken every week. Finally, the sugarcane plants were harvested on the surface. Areas of 90m^2 from the third and forth furrows of each experimental plot were selected to estimate the amounts of sugarcane yield and also to estimate the amounts of the refined sugar. By using statistical software of SAS, the collected data were analyzed.

Discussion and Conclusion:

The amounts of water deposited during irrigation events of those irrigated and non-irrigated furrows, were 145.3 cm and 139 cm respectively. This result shows, there is no significant differences between the amounts of water volumes that were reserved inside the furrows in the all treatments. The total amount of consumptive water used in the research field, at the beginning of the planting season until the harvesting season; and with the consideration of all rounds of the irrigation periods, (which were 27 rounds) are shown in Table 1. The total amounts of consumptive water used during the growing season and the total amounts of consumptive water used for the whole project are also shown in Table 1.

Table 1. The total amounts water used for the treatments in cubic meter per hectare.

Month	FAI	AFAI	DFAI	MFAI	LFAI
Apr.	1350	750	750	1300	1300
May	2800	1550	1550	3100	3100
Jun	5800	4000	5600	3500	5800
Jul.	5360	3725	5600	3600	5760
Aug.	3900	2175	4200	3900	2250
Sep.	4200	2325	4350	4350	2400
Total	22870	14525	22050	19750	20610
Whole water used	36910	27035	35050	33750	34610

Table 2, shows, the treatments AFAI, DFAI, MFAI, and LFAI is reduced respectively in average 27, 5, 8.5, and 6.2 percent saving water in comparison with the untreated treatment. However, Pandian et al. (1992), found 43-46 percent of water reduction in comparison with the conventional furrow irrigation method. Also Samadi and Sepaskhah (1996), concluded which can save 29 percent of water in the alternate furrow irrigation in comparison with the constant one, for beans plant. Based on the results which show in the Table 2, there were not any significant differences between the amounts of sugarcane yield in all different irrigation treatments at 5% and 1% levels in comparison with the control (untreated-as an example of witness) could be seen. But from the stand point of the percent of refined sugar based on the Duncan multiple range test, for each of the treatments under three categories of a, b, and c, significant differences at 5% level could be seen. In this way the fourth, fifth, and third treatments have the highest yields in this respect. The second treatment had the least volume amount of water used and the highest amount of water use efficiency. The least yield producing treatment was related to the control treatment (FAI). However, by comparison the treatments second through fifth and the control one, it is a clear indication that showing, more ventilation of soil in these treatments, cause increases in the percent of the refined sugar.

Table 2. Comparison of the results in the treatments.

Treatments	Sugarcane yield (ton/hec)	Refined sugar yield (ton/hec)	Refined* sugar yield (%)	Volume of water used m^3	Water use efficiency	Amount of saved water in comparison with the witness (%)
FAI	137.84	14.05	10.2**c**	36910	0.38	-
AFAI	132.04	13.73	10.4**bc**	27035	0.51	27
DFAI	145.86	16.03	11.06**abc**	35050	0.46	5
MFAI	137.45	15.53	11.3**a**	33750	0.46	8.5
LFAI	140.54	15.74	11.2**ab**	34610	0.45	6.2

*difference in the word in the Table (column 3) shows significant differences between the treatments.

Regardless to the available results, it is advisable under the conditions in which the shortages of water could not be exist, it is recommended to use, alternate furrow irrigation method from end of May to end of July (the mid-stage of growing season). It is also advisable to use the AFAI treatment if we want to design an irrigation planning under deficit irrigation in experimental treatment two (AFAI) the alternate furrow irrigation by 27% saving in usage of the volume amount of water in comparison with control treatment (untreated as an example of witness), and also without any kind of yield reduction, (second treatment) is recommended as the superior treatment and is advisable to be used. It is also recommended in a limited water resources condition, the AFAI treatment is applied. The AFAI treatment can save about 27% in usage of water in comparison with the FAI(untreated) treatment, and also without any kind of yield reduction.

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