Comparison between drip and surface irrigation of cotton in southern Spain

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Responses of four cotton cultivars to irrigation in a mediterranean environment

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Cotton production in Southern Spain (Andalucia) is often limited by environmental conditions. If cotton acreage is to expand, growers need to overcome the climatic limitations by shortening the growing season. In view of the importance that irrigation management has in controlling growth and earliness of cotton (Grimes and El-Zik, 1982), techniques such as drip irrigation might be useful in growing short-season cotton. Since controlled plant water stress is desirable for earliness and maximum yield, (Grimes and Yamada, 1982), drip irrigation offers the option of deficit irrigation maintening the desired level of plant water potential. It would be desirable to assess if such deficit high-frequency irrigation regime is advantageous over standard irrigation practices for promoting earliness and high yields of short-season cotton.

One of the areas within Andalucia most favorable for growing cotton is Las Marismas located in the southwest. Soils in Las Marismas are highly saline but subsurface drainage and reclamation have been carried out over the last twenty years on over 50,000 ha and presently, irrigated agriculture is quite successful. In the lower part of Las Marismas, there are about 3,000 ha where leaching has been incomplete because of difficulties in managing a shallow water table which is highly saline. In this particular area, cotton yields are low and variable due to salinity. We report here results of experiments conducted to evaluate the feasibility of drip irrigation of cotton in saline and normal soils of Andalucia.

Five experiments were conducted between 1983 and 1985 comparing drip to surface (furrow) irrigation. Two experiments were carried out in Las Marismas under salinity conditions while three were conducted in the experimental farm. In addition, we followed in 1985 two commercial drip installations of 24 and 54 ha, respectively. We report here selected results from some of the experiments.

Results and discussion

Table 1 summarizes the results of the 1983 salinity experiment. Final yields by early December were very high and did not differ either between water application treatments or between number of rows per drip line. There were substantial differences in earliness, however, as the deficit-irrigation treatment was fully harvested by the end of October.

The 1985 yield results were very similar to those of Table 1. A comparison to furrow-irrigated plots nearby showed a yield advantage of over 2000 kg/ha of seed cotton for drip systems.

Table 1 : Yields of seed cotton (kg/ha) 1983. Values indicate amounts harvested at the indicated date and are averages of four replicate plots. Values followed by the same letter are not significantly different at the 5% probability level.

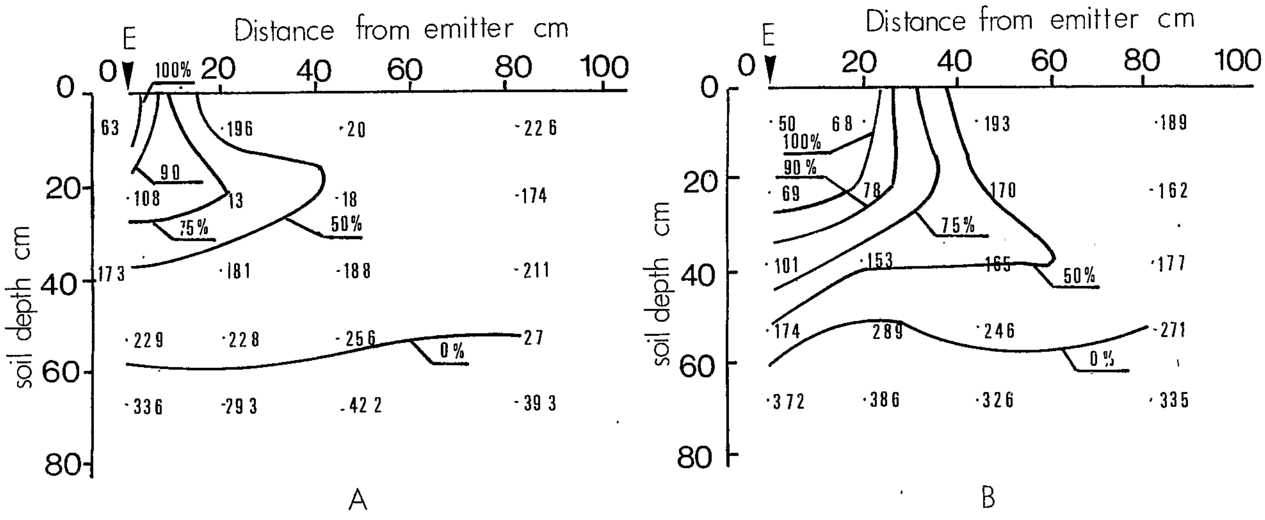
	Harvest date		
Treatments	10 - 15	10 - 31	12 - 4
100 % ET	-	3655 b	5505 e
75 % ET	4152 a	5770 c	5770 e
1 row/drip line	4321 a	4888 d	5739 e
2 rows/drip line	3983 a	4537 d	5536 e

To interpret the excellent results obtained with drip irrigation under the marginal soil conditions described above, the salinity of the soil solution was measured at various locations away from the emitter, six times during the growing season. Figure 1 presents the distribution of soil salinity for one representative plot of each treatment measured on August 30.

The results obtained using drip irrigation in Las Marismas offer a viable alternative to current conventional irrigation practices in those areas. The question is raised, however, as to whether similar results could be obtained in situations where surface irrigation can be managed optimally on well drained, non-saline soils. Two hypothesis may be advanced to explain the possible advantages of localized irrigation in cotton production. Carmi and Shalhevet (1983) have hypothesized that a restricted root volume

Figure 1

Soil salinity (EC, dS/m) distribution for A) 75 % ET and B) 100 % ET measured at various depths and locations away from the emitter. The isolines indicate yield levels below the threshold EC values as given by Maas and Hoffman (1977)



alters the distribution of assimilates in cotton favoring reproductive growth and that such response is independent of plant water status. In drip irrigation the root system is normally concentrated in a small soil volume around the emitter and the effect postulated by Carmi and Shalhevet (1983) - presumably mediated by growth regulators - could increase the harvest index under drip irrigation. In addition, the limited root zone, which is characteristic of localized irrigation, could present greater rhizosphere resistance to water transport and induce mild water stress known to be beneficial for cotton production (Grimes and Yamada, 1982).

An experiment was designed in 1984 to test the hypothesis outlined above under field conditions. Midday leaf was maintained nearly constant in the drip irrigation treatments although the level differed by about 0.7 MPa between the two treatments. In contrast, leaf under surface irrigation in soil of unrestricted depth fluctuated between -1.3 and -1.8 MP a within an irrigation cycle. If the resistance to water transport in the rhizosphere was greater under drip than under surface irrigation, lower leaf values in drip should be expected. A detailed comparison of the diurnal patterns of leaf under drip and surface irrigation was carried out in 1984 and is presented in Figure 2. The data points are averages of six daily curves which were run at days when midday leaf was identical for the 100% ET drip and the surface irrigation treatment. Points in any daily curve were the averages of eight individual readings at each time of day. The only major difference observed was between the 50% ET and the other two treatments. While there was some tendency toward lower in mid-morning and afternoon in the 100% ET drip treatment, the differences between drip and surface irrigation were not statistically significant. Therefore, under the conditions of this experiment, drip irrigation on a restricted root zone did not induce lower leaf values throughout the day than surface irrigation did on soil of unrestricted depth.

A second aspect evaluated in the 1984 experiment was the influence of rooting volume on assimilate partitioning and harvest index (HI). Presumably, as suggested by Carmi and Shalhevet (1983), the HI of the 100% ET drip treatment should have been greater than that of the surface irrigation treatment as the root system in drip was confined to a potential maximum volume of approximately 50 liters/plant. However, HI values were 0.44, 0.38 and 0.31 for the 50% ET drip, surface and 100% drip treatments. This ranking followed that of the estimated seasonal ET values which were 445, 540 and 750 mm, respectively, for the three treatments. It appears that the level of plant water stress is of paramount importance in controlling HI of cotton and that a restricted root volume, by itself, did not induce a favorable change in HI under the field conditions of our experiment.

A detailed study conducted at Cordoba during 1985 showed results indicated in Table 2 for normal and low water and nitrogen inputs. There were no yield differences between drip and furrow irrigation. This suggests that, if water management is optimal, there is no yield advantage for drip irrigation in cotton under the normal soil and climate conditions of Southern Spain.

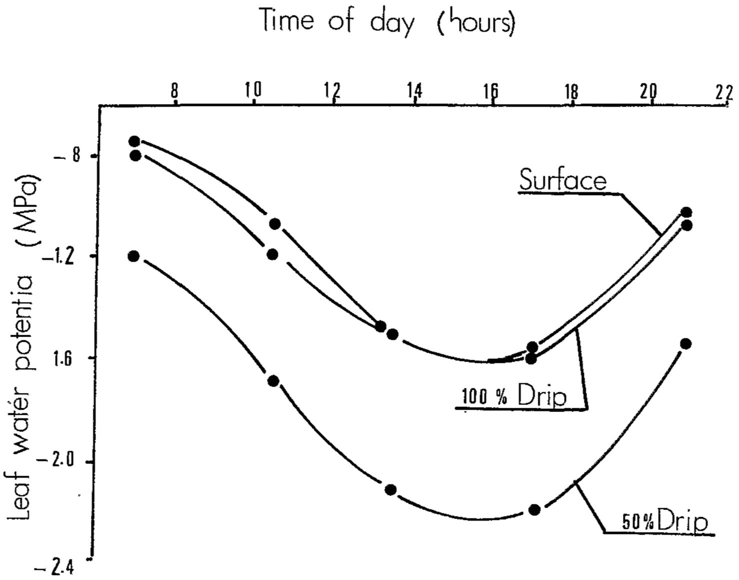


Tableau 2 : Yields of seedcotton (kg/ha) - Cordoba 1985
N.I. : Normal input, L.I. : Low Input

Irrigation system	Input	Yields (kg/ha)
Drip Irrigation	N.I. L.I.	4 340 4 030
Surface Irrigation	N.I. L.I.	4 580 4 560

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