The Effect of Irrigation and Fertilization on Cotton Growth and Development under Greek Conditions

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ABSTRACT

The effect of two irrigation levels and two N-fertilization practices on the growth and productivity of two Greek cotton varieties (e.g. Zeta-2, Korina) was investigated in a field experiment carried out in central Greece, in 1997. The irrigation levels are 320 mm/yr (I_2) which is normal for the study area, and an amount by 20% lower, viz. 250 mm/yr (I_1). The fertilization practices include a) classical dressing with 160 kg N/ha (F_1) and b) same amount of total N applied by fertigation (F_2). The experimental design was split-split plot with five blocks. The development and growth features of cotton were determined in five distracting samplings throughout the growing period. Fiber percentage and quality characteristics were also determined. It was found that the lower irrigation did not affect the final seed- and lint-cotton yield. Contrarily, the lower irrigation exhibited a significant positive effect on crop earliness, especially for the cultivar Zeta-2, which performed by about 500 kg/ha and 200 kg/ha greater yield respectively of seed- and lint-cotton at the first pick. No effect of fertilization practice on the yield was found at any of the pickings. This was especially the case for "Zeta-2" which performed identical yields for the two fertilization practices. The plants receiving the higher irrigation (I_2) performed a leaf area index (LAI) rather greater than the I_1 plants, viz. 4 vs. 3.1 at the beginning of August. Also the plants under the common fertilization practice exhibited higher LAI at the first stages but these differences were disappeared later. The fiber length was the only cotton quality character significantly affected by the treatments. The combination of low irrigation and fertigation gave the longest fiber length. The above results give evidence that irrigation and fertilization in cotton may be reduced in accordance to the imposed low input agriculture in the future without a serious variation in the cost/benefit ratio. This can be of particular importance especially for adverse years when an early crop is highly required.

Introduction

The intensification of cotton cultivation which aims mainly at yield maximization, has led to an unreasonable chemical fertilization and over-irrigation and consequently to the increased crop production cost and environmental pollution. Cotton production under growing systems with low inputs of irrigation and fertilization are imposed also by EC, Common Agricultural Policy, and must be studied intensively (Galanopoulou-Sendouca, 1998). Recently, novel systems of fertigation are adopted by some farmers in Greece but the lack of research data leads to wrong applications.

This study aims at the evaluation of two irrigation levels and two N-fertilization practices and their effects on the growth and productivity of two Greek cotton cultivars, with final objective the optimization of cotton production. The study will last at least three years. In this paper the results of the first year experimentation in 1997 are presented.

Materials and methods

One field experiment was carried out at Stefanovikio, Central Greece, in 1997, with a split-split-plot design in five replications. Main plots were two levels of irrigation: a) the traditional one based on plant appearance and corresponding to 55% of evapo-transpiration needs; and b) the reduced irrigation equivalent to 80% of the traditional one, corresponding to 45% of the evapo-transpiration needs. Effective rainfall was taken into consideration for assessing the irrigation treatments. Figure 1 presents the amounts of effective rainfall, irrigation depth per application, and the maximum crop evapo-transpiration as it is calculated according to FAO (1977) and according to the modified for Greek conditions plant coefficients by Papazafiriou (1991). The total water amounts applied to the plots per irrigation level are presented in Figure 2.

Sub plots were two nitrogen fertilization practices: a) the traditional one (basic and surface nitrogen application), and b) the fertigation (application of nitrogen fertilization as basic dressing, and in later

Proceedings of the World Cotton Research Conference-2. Athens, Greece, September 6-12, 1998. pp.405-407.

stages through drip irrigation). Total amount of fertilization was 160 kg N/ha for both practices.

Two Greek cultivars were evaluated as sub-subplots: Corina of intermediate earliness of maturity and Zeta-2 of later maturity.

Growth analysis, based on plant sampling at five stages during the plant cycle was done per plot. The prevailed environmental conditions, concerning temperature and rainfall, are considered as favourable. Experimental data were analyzed using Microsoft Excel and MStat software.

Results and Discussion

Yield. Irrigation and fertilization in the first harvest did not significantly affect seed cotton yield (Table 1). However, a significant interaction of irrigation x variety was found. Zeta-2 was favoured at the first harvest by reduced irrigation, exhibiting earliness of maturity in contrast to the earlier cv. Corina that was not affected. However, as the weather conditions in October and November permitted all bolls to open, the final yield was slightly higher with increased irrigation.

Fertigation increased only slightly the yield (10 g/m_2) as compared to the traditional fertilization. No significant interaction of irrigation x fertilization was found, probably because both irrigation treatments satisfied the crop-water needs for an adequate productivity. Also, the total N-dressing in all cases seemed to satisfy the crop requirements for this element, independent of the application practice.

Boll weight. High irrigation affected positively boll weight in both harvests. Additionally, in the second pick, a significant interaction between irrigation level and variety was found, with high irrigation having a more positive effect on Corina than on Zeta-2 (Table 1). Boll weight was not affected by fertilization.

Leaf area. Plants under higher irrigation showed a leaf area index (LAI) at the beginning of August greater than the lower irrigated plants (4 versus 3.1) resulting in a late maturation. This difference remained until the end of September. LAI was also affected by fertilization practice. The traditionally fertilized plants exhibited significantly greater LAI in early July than those under fertigation (2.3 versus 1.7). This result should probably be attributed to the general delay of the application of N-fertilization in the case of fertigation. However, the difference in LAI disappeared later in the season as the plants under fertigation showed a more rapid leaf development, and finally yielded even slightly better than the others.

Quality characteristics. Lint percentages and micronaire indexes were not affected either by irrigation or fertilization practice. Only fiber length was positively affected by fertigation and by the combination of reduced irrigation and fertigation.

Conclusions

The above results give evidence that cotton irrigation may be reduced according to the imposed low input agriculture. The effectiveness of fertigation was not proved, probably due to the delayed application. However, although fertigation was applied in a later stage without decreasing the yield indicates that the N-fertilization can be reduced through fertigation.

References

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Table 1. Effect of two irrigation levels and two fertilization methods on yield and boll weight of two cotton cultivars.

Treatment	Seedcotton (g/m2)		Lint Cotton (g/m2)		Boll Weight (g)	
	Total	1st Pick	Total	2nd Pick	1st Pick	2nd Pick
Irrig 1 (250 mm)	411	336	169	139	6.7	5.4
Irrig 2 (320 mm)	435	311	177	129	6.9	5.9
Significance	ns	ns	ns	ns	**	**
Fert 1 (traditional)	418	323	171	134	6.8	5.7
Fert 2 (fertigation	428	324	175	134	6.8	5.6
Significance	ns	ns	ns	ns	Ns	ns
Conna	401	337	169	144	6.0	4.8
Zeta-2	445	310	177	125	7.6	6.5
Significance	**	*	ns	***	***	***
Irrig 1 X Conna	384	337 a	162	143 a	5.9	4.4 d
Irrig 1 X Zeta 2	439	335 a	175	135 a	7.5	6.3 b
Irrig 2 X Corina	419	337	176	144 a	6.1	5.1 c
Irrig 2 X Zeta 2	451	285 b	178	114 b	7.8	6.7 a
Significance	ns	*	ns	*	Ns	*
CV %	10.13	10.4	10.53	10.98	4.62	3.94

ns = non significant * p = 0.05 ** p = 0.01 *** p = 0.001

Figure 1. Cumulative ETcrop and irrigation with rainfall.

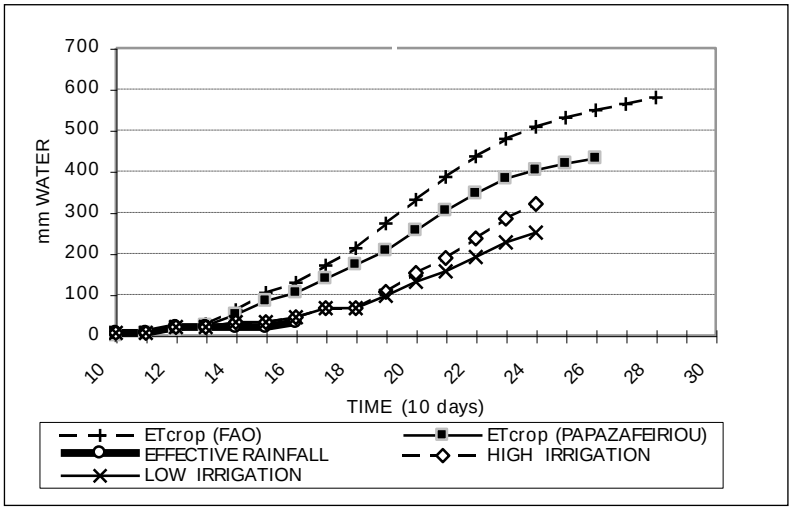

Figure 2. ETcrop – Irrigation and rainfall.