Effects of Previous Cultivation of Sugarbeet on the Subsequent Cultivation of Cotton

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ABSTRACT

The effect of previous cultivation of sugarbeet, legume, cotton and corn on the subsequent crops of cotton and corn was studied in a two - year rotation cycle at two Greek locations in 1994 and 1995. This paper only discusses the two cultivation systems, 1) sugarbeet - cotton and 2) cotton - cotton. The effect of sugarbeet in cotton cultivation is considered negative based on various field observations and the personal experience of farmers. Some of the supposed causes of this effect are evaluated. Growth analysis in cotton grown after sugarbeet showed that plants had a significant delay in appearance of squares, flowers and bolls, delayed weight development of vegetative and reproductive parts, delayed Leaf Area development and reduced chlorophyll, compared to cotton grown after cotton. This difference gradually declined or disappeared during plant life cycle. Thus although cotton grown after sugarbeet yielded less in the first picking, total yield was not inferior. Soil analytical data during the second year were not found to be influenced by the previous cultivation. Heavy rainfall in October 1994 and spring 1995 possibly leached residual N and balanced the differences between crops. In addition, no sugarbeet residues were left in the soil and it was hand harvested, possibly explaining the lack of effect on the C/N ratio and soil mycoflora. The increased soil compaction observed in plots planted to sugarbeet, combined with delayed cotton growth, support the hypothesis that the swollen sugarbeet roots increase soil compaction, prohibiting root penetration of the following cotton crop.

Introduction

Field observations and personal experience of farmers in Greece show that early cotton plant growth is retarded when cotton is grown in fields where sugarbeets were grown the previous year. Several hypotheses have been expressed but the supposed causes and the degree of this negative effect have not been studied (Galanopoulou - Sendouca, 1992). However, Christidis (1965) and Sficas (1988) do not mention any negative effect of sugarbeets on subsequent cotton crop. In addition Rather and Harrison (1951) report that sugarbeets leave the field in a desirable condition for most subsequent crops. The objective of this study was to evaluate: a) the effects of sugarbeet on following cotton growth and development and b) some of the supposed causes for the possible negative effect of sugarbeet.

Materials and Methods

Eight 2-year crop rotation systems were evaluated in a field trial at two locations in Central Greece: Velestino (Farm of the University of Thessaly) and Larissa (National Agricultural Research Foundation) during the period 1994 - 1995. The rotation systems were: CC, LC, SC, MC, CM, LM, SM and MM where the first letter stands for the 1st year crop (C=Cotton, L=Legumes, S=Sugarbeets, M=Maize) and the second for the 2nd year crop. The experimental design in the first year was a Randomized Complete Block with the four crops in eight replications and the 2nd year, a Split-plot in four replications with Cotton and Maize as main plots and the four crops of the previous year as sub-plots. In this study only the systems CC and SC are discussed. Plot size was 40 m^2 (10 m x 4 m) and the usual cultural techniques were applied for cotton (Cult.Corina) and sugar beets (Var. Kaw Educa) except that both crops were hand sown and picked. At both locations during the second year the seed cotton yield was evaluated in three pickings and the chlorophyll level (SPAD-501 of Minolta) at three plant stages. Appearance of squares and flowers and Mean Maturity Date (Christidis, 1965) were also estimated. In addition at Velestino, cotton growth analysis was carried out on plant samplings of 0.5 m per plot at five stages. Soil samples were taken from each plot at the beginning and end of the first year experiment and just before the establishment of the experiments in the second year for a) soil analysis (by Dr. D. Pateras at the Institute of Soil Mapping) and b) soil microbiological analysis (by Dr. J. Theochari, at the Institute of Fodder crops). In addition, during the spring of the second year, soil penetration resistance was measured by a Bush soil penetrometer, considered as a measure of root penetration resistance (Singh *et*

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al., 1992). Data were analyzed using MICROSOFT EXCEL and MSTAT statistical software.

Results and Discussion

Yield, phenological stages, chlorophyll content. The total seed cotton yield was not significantly affected by the previous crop but the early pick was numerically higher, especially at Velestino with the top yield in the CC system (Fig.1).

Sugarbeets delayed the appearance of squares and flowers. The same trend appeared in the Mean Maturity Date but differences were smaller and not statistically significant at Velestino (Table1). Chlorophyll content was lower when cotton was grown after sugarbeet than after cotton especially at Larrisa where the differences were statistically significant (Table 1).

Growth analysis. Cotton plants grown after sugarbeets showed a delayed leaf area development (Jul.3) but subsequently they exhibited higher Leaf Area Index than cotton plants grown after cotton. However, differences were not significant until the end of productive period (August 24) (Fig.2).

There was also a trend for shorter plants with less mainstem nodes in SC than in CC system but in most cases, differences were not significant. Also boll setting and boll opening was delayed in cotton plants grown after sugarbeet. However, these plants had more open bolls by the end of September than plants grown after cotton, showing that sugarbeet caused late maturity but not a yield reduction. These results are in agreement with yield and other indexes of earliness examined in this study (Table 2). In keeping with these results, dry weight of early vegetative and reproductive parts was significantly lower in the SC system in most cases significant but in subsequent stages they did not lag behind. On September 10 the late vegetative growth and the green bolls (representing mid and late production in that period) had heavier dry weights when cotton followed sugarbeet. Conversely, in this rotation, the early and mid-season open bolls (Sept. 10 and 30 respectively) had a lower weight but differences were not statistically significant (Table 3).

Soil analysis. Soil analysis in the second year was not influenced by the previous crop. Intense rainfall in October 1994 and Spring 1995 may have leached residual nitrogen, eliminating differences from the previous cultivation. Zinati and Christenson (1996) found that losses of N from previous sugarbeet cultivation in one year were insignificant while in a year with high rainfall, the losses estimated at 26% of the total available nitrogen occurred. The absence of any increase in the C/N ratio following sugarbeet, may be due to hand harvesting leaving less residues in soil than mechanical harvesting.

Soil microbiological analysis. A rich soil flora was found but no substantial correlation with the previous crop was proved. These results may be because there was no differentiation in C/N ratio, as no sugarbeet residues that could have resulted in the development of fungi or toxins, were left in the soil. The possible residual effect of toxin excretions by the sugarbeet roots was not evaluated in this study.

Soil resistance to compaction. The resistance of soil to compaction was not affected significantly by the previous cultivation, but in the sugarbeet plots, the penetration resistance was always numerically higher, especially at depths greater than 20 cm. This trend could have been accentuated if the sugarbeet had been mechanically harvesting, especially after the heavy rainfall of October 1994.

Conclusions

From the results of this two-year rotation cycle of cotton grown after cotton and sugarbeet the following indications and conclusions may be derived:

Cotton grown after sugarbeets showed generally and, in many cases significantly, a delayed appearance of squares, flowers, green and open bolls, delayed development of vegetative dry weight, reproductive parts and leaf area and reduced levels of chlorophyll, compared to the cotton grown after cotton. This delay was, in most cases, gradually reduced or eliminated so that, although the SC system yielded less early picked cotton, the total yield was not different from the CC treatment. The results are in agreement with observation that when cotton is sown after sugarbeets it results to an initial delayed growth and development that is gradually reduced.

The results do not support the possibility of increased C/N ratio and consequently soil mycoflora, when cotton is grown after sugarbeet. This may be due to the absence of sugarbeets residues left in the soil because of hand harvesting.

The trend of increased soil compaction observed in SC plots, in combination with the delayed cotton growth, enhances the hypothesis that the swollen sugarbeet roots increase soil compaction and prohibit root penetration of the subsequent cotton crop.

These data do not verify the hypothesis that sugarbeets have adverse effects to the subsequent cotton crop. However, since some trends were observed, it is considered necessary to further evaluate the effect of sugarbeets in the subsequent cotton crop, in multi - year studies to be conducted under conventional farm conditions.

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References

Galanopoulou - Sendouca, S. (1992): Crop Production II. Univ. of Thessaly. Volos.

Rather, H.C. and C.H. Harrison. (1951): Field Crops (2nd ed.) McGraw - Hill Book Company Inc., London. Pp. 378-381.

Singh K.K., T.S. Colvin, D.C. Erbach and A.Q. Mughal. (1992): Tilth Index: An approach to quantifying soil tilth. Trans of ASAE, (6):1777-1785.

Sficas, A. (1988): Crop Production II. Industrial Plants. Thessaloniki, Greece.

Christidis, B. (1965): Cotton. Thessaloniki, Greece.

Zinati, G.M. and D.R. Christenson. (1996): Estimating N losses under sugarbeet. In Agron. Abstracts, ASA, Madison, WI.Pp. 256.

Table 1. a) Date of square and flower initiation and mean maturity date (Number of days from June 1, 1995). b) Chlorophyll level (SPAD units) at the above three stages.

	Previous crop	Squares		Flowers		Maturity	
		Vel.	Lar.	Vel.	Lar.	Vel.	Lar.
a)	Cotton	10	25	36	46	97	112
	Sugarbeets	15	29	42	48	99	114
	L.S.D (0.05)	1.7	1.7	4.1	1.7	ns	1.7
b)	Cotton	53	52	46	52	43	51
	Sugarbeets	47	47	44	46	43	44
	L.S.D (0.05)	Ns	3.9	ns	3.7	ns	3.7

Table 2. Plant height (cm) and number of mainstem nodes, green bolls and open bolls per plant at five stages in 1995, at Velestino.

	Previous crop.	Jul. 3	Jul. 21	Aug.24	Sept. 10	Sept. 30
Plant height	Cotton	39	74	112	104	92
	Sugarbeets	39	69	81	88	90
	L. S. D (0.05)	ns	ns	16.9	ns	ns
Mainstem nodes	Cotton	10,4	14,8	19.0	17,1	16,1
	Sugarbeets	9,9	14,5	14,9	16,4	16,0
	L. S. D (0.05)	ns	ns	ns	ns	ns
Green bolls	Cotton	0	3,1	17,1	8,6	0,6
	Sugarbeets	0	2,5	11,2	6,5	0,2
	L. S. D (0.05)	ns	ns	4,9	ns	ns
Open bolls	Cotton	0	0	0	3,1	8,9
	Sugarbeets	0	0	0	2,3	10,3
	L. S. D (0.05)	ns	ns	ns	ns	ns

Table 3. Dry matter (g) of vegetative and reproductive parts of five cotton plants at five stages in 1995, at Velestino.

	Previous crop	Jul. 3	Jul. 21	Aug. 24	Sept. 10	Sept. 30
Stems	Cotton	43	84	115	121	148
	Sugarbeets	27	81	175	145	109
	L.S.D (0.05)	10.9	ns	39.9	16.3	ns
Leaves	Cotton	49	64	101	77	31
	Sugarbeets	33	67	123	105	20
	L.S.D (0.05)	ns	ns	ns	14.4	ns
Squares + Flowers	Cotton	19	26	13	10	-
	Sugarbeets	16	23	18	3	-
	L.S.D (0.05)	ns	3.1	2.8	ns	-
Green bolls	Cotton	-	30	348	126	7
	Sugarbeets	-	20	305	172	36
	L.S.D (0.05)	-	4.3	ns	28.5	ns
Open bolls	Cotton	-	-	-	115	299
	Sugarbeets	-	-	-	42	165
	L.S.D (0.05)	-	-	-	ns	ns

Figure 1. Effect of previous cultivation on seed cotton yield at two locations in 1995.

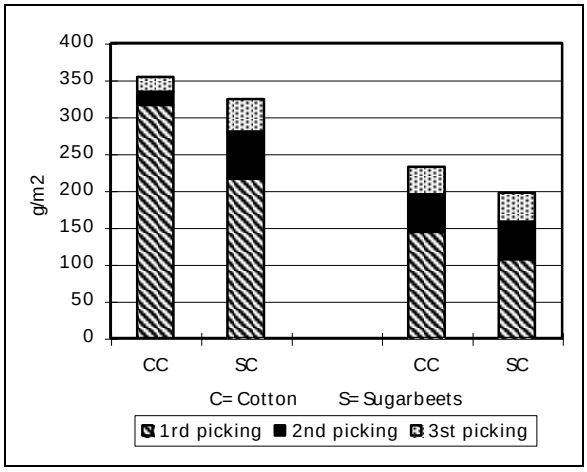

Figure 2. Effect of previous cultivation on cotton leaf area development at five stages in 1995.