vessel to absorb O_2, the changes over the same period of time varied around zero. The results of one such experiment are shown in Fig. 1.

It is tempting to speculate that the water-soluble, heat-stable factor mentioned by French in his review of photosynthesis (*4*) is carbon dioxide or some substance readily produced from carbon dioxide by plant cells or cell constituents. If such a situation is subsequently found to be of general occurrence in plant materials, it would provide a link between photosynthesis and the type of organic acid metabolism recently reviewed and studied by Bonner and Bonner (*3*).

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The Organic Acid Content of Various Samples of Raw Cotton Fiber in Relation to Ash Alkalinity and Leaching by Rain

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Raw cotton fiber contains *l*-malic acid, citric acid, and unidentified organic acids (*3*). A number of samples of raw cotton fiber of different varieties and grown in different places were analyzed in order to obtain information on variation in organic acid content.

Citric acid, *l*-malic acid, and total organic acids, exclusive of pectic acid, were determined by the methods of Pucher, Wakeman, and Vickery (*4*) after fuming the samples with hydrochloric acid and extracting with ethyl ether (*2*). Pectic acid was determined by the method of Whistler, Martin, and Harris (*5*), the values being calculated in milliequivalents, directly from the carbon dioxide values. The methods of Fargher and Probert (*2*) were used to determine ash and ash alkalinity. Moisture values, for calculating to the dry-weight basis, were found by drying in a forced draft oven for 5 hrs at 105° C. The pH of the water extracts was determined by adding 5 ml of hot water to 0.5 gm of ground cotton fiber in a test tube, mixing with a rod to wet the cotton, heating

TABLE 1

Organic Acids, Ash, and Ash Alkalinity of a Number of Samples of Raw Cotton Fiber

No.	Kind or variety	Place grown	Year	Milliequivalents/100 gm of dry cotton				Ash % M.F.B.	pH of water extract
				l-Malic acid	Citric acid	Total* organic acid	Ash alkalinity		
1	Bobshaw 1	Stoneville, Miss.	1945	2.8	0.7	9.5	14.2	0.97	7.5
2	Coker 100-9	" "	"	2.8	0.6	7.6	15.1	0.97	7.7
3	Delfos 531-C	" "	"	3.1	0.7	8.0	14.4	0.97	7.5
4	Deltapine 14-060	" "	"	3.4	0.7	7.8	13.1	0.89	7.3
5	Stoneville 2B	" "	"	3.2	0.7	7.9	14.8	1.00	7.5
6	Wilds 17	" "	"	2.8	0.8	7.8	15.6	1.06	7.8
7	Wilds	" "	1943	8.5	1.5	13.7	20.5	1.31	6.2
8	Stoneville 2B	" "	"	6.9	1.1	12.1	17.0	1.07	6.4
9	SXP	Sacaton, Ariz.	1942	4.7	0.8	11.6	16.7	1.06	6.5
10	Empire	Experiment, Ga.	1944	2.8	0.7	8.2	14.0	0.86	7.2
11	Unknown	Big Springs, Tex.	1941	7.2	0.9	12.8	16.5	1.16	6.5
12	Immature	....	..	6.1	1.5	14.6	21.8	1.32	5.8
13	Mature	....	..	1.7	0.6	5.7	11.7	0.79	7.6
14	Deltapine 14-060	Greenville, Tex.	1945†	7.1	0.8	11.5	15.4	1.02	6.3
15	" " "	" "	1945‡	9.5	1.0	14.0	17.0	1.07	6.2
16	Ark. Green Lint	Stoneville, Miss.	1942	2.5	1.1	10.7	15.4	1.07	6.5
17	Empire	State College, N. M.	1945	5.6	1.2	12.2	17.1	1.15	6.5
18	"	" " " "	"	6.9	1.0	11.6	16.5	1.12	6.4
19	Deltapine 14	" " " "	"	10.3	0.7	16.1	20.2	1.32	6.4
20	" "	Rocky Mt., N. C.	"	3.7	0.7	9.4	13.2	0.90	6.8
21	Stoneville 2B	" " " "	"	4.1	0.8	9.5	14.7	1.01	7.0
22	Coker 100-8	" " " "	"	4.9	0.9	10.5	15.7	1.00	6.9

* Not including pectic acid.
† Early-opening bolls.
‡ Late-opening bolls.

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in a water bath for 1 hr, cooling, and measuring the pH of the supernatant liquid with a glass electrode.

The data in Table 1 show that raw cotton fiber varies greatly in organic acid content. The greatest variation is shown by *l*-malic acid, while citric acid and the unidentified portion of the organic acids, which may be obtained by difference, show less variation. The first 6 samples listed, all of which were grown in the same place and at the same time, show little variation, although they are of different varieties. Some of the same varieties, grown at different times or in different places, showed large differences in organic acid content. It appears that some environmental factor was more important than variety in controlling the organic acid content. The data also show a rough correlation between the content of organic acids and the ash and ash alkalinity. This is not surprising, since the organic acids occur in the fiber as salts.

TABLE 2

Relationship Between Ash Alkalinity of Raw Cotton and the Sum of the Pectic and Other Organic Acids

Sample No.	Milliequivalents/100 gm of dry cotton				pH of water extract
	Pectic acid A	Other organic acids B	Sum A + B	Ash alkalinity	
5	4.8	7.9	12.7	14.8	7.5
6	4.9	7.8	12.7	15.6	7.8
7	6.9	13.7	20.6	20.5	6.2
8	4.9	12.1	17.0	17.0	6.4
10	5.6	8.2	13.8	14.0	7.2
11	4.7	12.8	17.5	16.5	6.5
12	7.0	14.6	21.6	21.8	5.8
13	3.2	5.7	8.9	11.7	7.6
17	5.5	12.2	17.7	17.1	6.5
20	4.3	9.4	13.7	13.2	6.8

It seemed likely that better correlation between organic acid content and ash alkalinity would be obtained by taking pectic acid into consideration. Pectic acid was therefore determined on 10 selected samples. From the results given in Table 2 it will be seen that the agreement between the total organic acids, including pectic acid, and the ash alkalinity is rather good. Where the ash alkalinity exceeds the sum of the acids, the pH of the water extract is high. The quantity of acid necessary to change 100 gm of raw cotton fiber from pH 7.5 to pH 6.5 was found to be about 1.3 milliequivalents. If this value is used to correct to the same pH, the agreement is even better.

Since the potassium and sodium salts of *l*-malic and citric acids are water soluble, it seemed probable that leaching of the fiber by rain would have a large effect on the organic acid content. Samples were collected from tagged bolls before and after rain by R. H. Tilley, of the Bureau of Plant Industry, Soils, and Agricultural Engineering at Statesville, North Carolina. Cracked bolls were tagged on September 26 and a sample dried in a greenhouse. The second sample, collected from the field on October 2, was definitely dry and untouched by rain. From October 7 to 10 there was a 4-day rain. The third sample was collected on October 13, and the last sample on October 20, some rain having fallen in the interim. Because of the small size of these samples, pectic acid was determined by an unpublished colorimetric method based on a reaction described by Dische (*1*). The data given in Table 3 show that rain and other weathering factors have a profound effect on the organic acid content of raw cotton fiber, especially on the *l*-malic acid content. The high pH of the fiber exposed to rain is of interest. Microorganisms in the wet cotton and surviving metabolic processes as well as leaching may be factors in the action of rain on the organic acids.

TABLE 3

Organic Acid Content of Raw Cotton Fiber in Relation to Rain

No.	Description	Milliequivalents per 100 gm dry cotton						Ash % M.F.B.	pH of water extract
		l-Malic acid	Citric acid	Total * organic acids A	Pectic † acid B	Sum A + B	Ash alkalinity		
23	Dried in greenhouse, no rain	15.4	1.1	20.3	5.1	25.4	23.2	1.50	6.2
24	Remained in field, no rain	12.2	1.2	15.9	5.0	20.9	19.4	1.22	6.4
25	Same after 1 heavy rain (2.6 in)	3.7	0.5	7.4	3.9	11.3	15.2	0.98	8.6
26	Same after 3 more rains (0.6 in)	2.3	0.3	6.3	3.5	9.8	14.3	0.94	9.0

* Not including pectic acid.

† Determined by a colorimetric method based on a reaction described by Dische (*1*).

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