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A REPORT FOR APRC (PROJECT SP104)

ADAS ⊕

Presentation of historical data

**THE RELATIONSHIP BETWEEN
HARVEST MATURITY PARAMETERS
AND THE STORAGE QUALITY
OF COX APPLES**

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INTRODUCTION

The main report for project SP 104 concerned with the development of models for the prediction of harvest date was submitted to APRC in October 1996. This brief report is concerned only with historical data, ie. fruit maturity measurements carried out on Cox apples by ADAS over the period 1983 to 1993. These data cannot contribute to the formulation of picking date guidelines for Cox apples as there were no storage samples put aside to test whether advice given in each of those years was correct. However, these data provide indications of how Cox apples 'matured' in each of those years and these will be useful in analysing any temporal trends in the ripening characteristics of Cox. These data also provide the means of determining the extent of any correlation between the various indicators of maturity over the 11-year period.

EXPERIMENTAL

Fruit samples were collected twice-weekly from up to 6 'marker' orchard sin Kent commencing in late August or early September and in most years monitoring continued until late September. Measurements were made of fruit firmness (hand-held penetrometer), starch (iodine test) and internal ethylene concentration (IEC). The latter was determined by extracting a sample of gas from the core cavity of apples using a modified syringe needle and injecting 0.5 ml into a gas chromatograph fitted with an alumina column and a flame ionisation detector. The mean data calculated over orchards are presented in the attached graphs. Within each year correlation coefficients were calculated for firmness against starch and IEC, and for starch against IEC. Sample means for individual orchards were used for these calculations and the (pooled) within site correlations are presented in Table 1. The correlation coeffecient (r) is a measure of the linear relationship between two variables. The value of r is always between -1 and +1. A value of -1 indicates a perfect linear relationship with the value of the 'y' variable decreasing as the value of 'x' increases. A value of +1 indicates a perfect linear relationship between the sample values but one in which the value of 'y' increases as 'x' increases. If there is no linear relationship between the sample values then r will have a value near zero.

RESULTS

The graphs indicate the change in the maturity status of Cox apples in the period 1983 to 1993. The ethylene data represents the percentage of apples in the harvested samples which contained more than 0.1 ppm ethylene. This ethylene threshold was chosen on the basis of previous research where ripening had generally been triggered in fruits achieving an IEC in excess of 0.1 ppm. Based on IEC the optimum stage for long-term storage is generally considered to be when 20% of fruits have an IEC greater than 0.1 ppm. Traditionally the potential harvesting period for long-term storage was defined as the number of days required for starch to fall from 90% to 80% of the maximum coverage. During this period of monitoring less emphasis was given to the fruit firmness measurements made at harvest as a means of predicting optimum harvest data (OHD). However, in years when firmness at harvest was low, earlier harvesting was encouraged irrespective of starch and IEC. It is clear from the maturity programme carried out in the last two years that harvest firmness is the major criterion for judging harvest dates for long-term storage of Cox apples (see the first part of this report by Ridout & Johnson).

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TABLE 1

Correlation coefficients for firmness, starch and internal ethylene concentrations for Cox apples over the period 1983 to 1993. These are the (pooled) within orchard correlations in each year. Figures in brackets are degrees of freedom.

Year	Firmness Ethylene		Firmness Starch		Ethylene Starch	
1983	-0.31	(54)	0.79	(54)	-0.52	(54)
1984	-0.15	(45)	0.75	(45)	-0.43	(45)
1985	-0.58	(55)	0.87	(61)	-0.64	(55)
1986	-0.45	(48)	0.69	(48)	-0.67	(48)
1987	-0.46	(52)	0.73	(52)	-0.61	(52)
1988	-0.29	(35)	0.52	(35)	-0.73	(35)
1989	-0.18	(55)	0.46	(55)	-0.58	(55)
1990	-0.62	(27)	0.69	(27)	-0.73	(27)
1991	-0.72	(39)	0.76	(39)	-0.59	(43)
1992	-		0.77	(47)	-	
1993	-0.49	(45)	0.80	(45)	-0.66	(45)

The correlation coefficients presented in Table 1 indicate the degree of association between the three measures of maturity over an eleven year period. Not surprisingly there was generally a good relationship between variables so that samples higher in starch were firmer and contained less ethylene. It is not surprising that a perfect linear relationship was not achieved since ethylene production is not linear with time, increasing logarithmically once triggered. The degree of association between firmness and IEC was particularly variable and, in some years, e.g. 1984, 1988 and 1989, the correlation coefficients were not statistically significant. This lack of relationship serves to remind us that the many changes taking place as fruits mature on the tree are under the control of different genes and that there is not one picking date which optimises all aspects of fruit quality.

CONCLUSIONS

Historical Cox maturity data has now been entered onto computer disk for safe storage. Whilst the main use of these data was to guide growers towards the correct time of harvest in the years 1983 to 1993 the graphs that have been generated will serve as convenient aids for discussing past seasons and trying to characterise behaviour in future years.
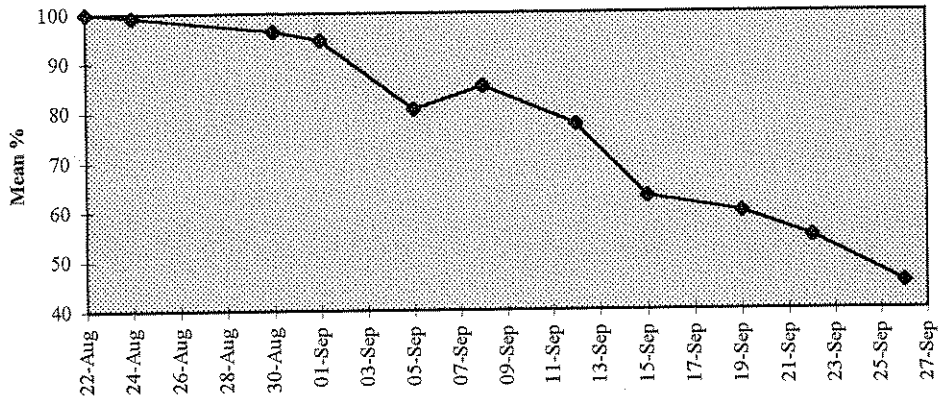
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Cox Data - 1983

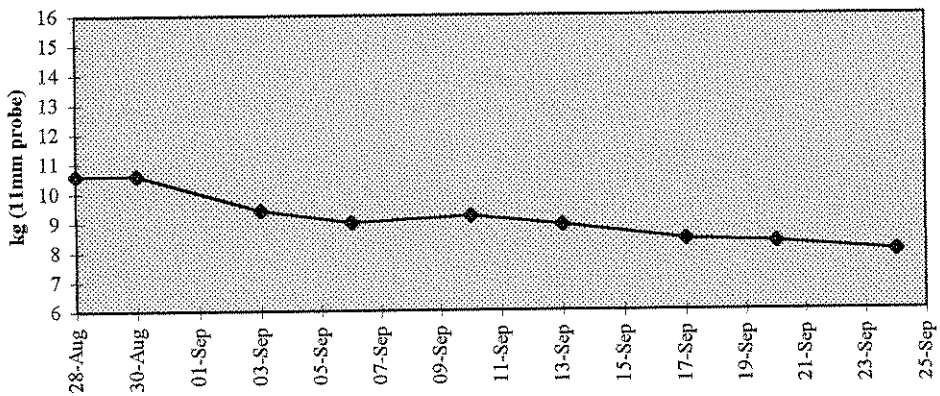|	Ethylene	Starch	Firmness
22-Aug	15	100	16
24-Aug	0	99.2	14.75
30-Aug	0	96.4	13.64
01-Sep	4	94.6	10.13
05-Sep	0	80.6	9.37
08-Sep	6.7	85.2	9.88
12-Sep	5	77.4	7.8
15-Sep	20	62.8	8.2
19-Sep	9.2	59.7	7.98
22-Sep	34	54.7	5.85
26-Sep	90	45.5	8

Cox Ethylene - 1983
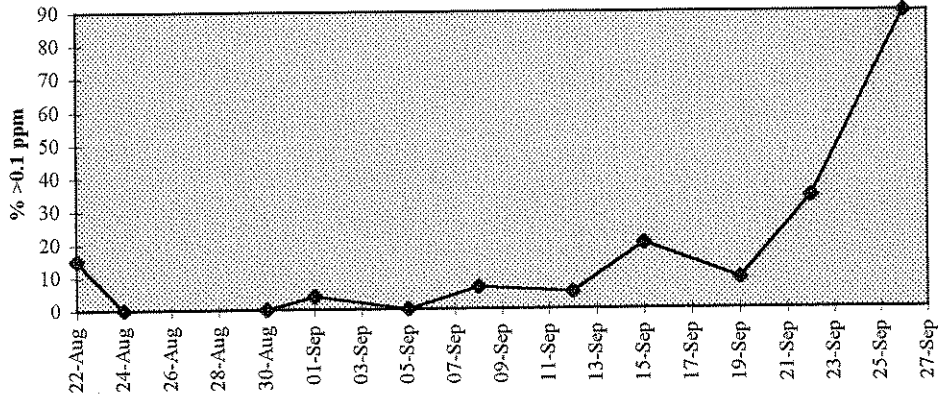
Cox Starch - 1983

Cox Firmness - 1983

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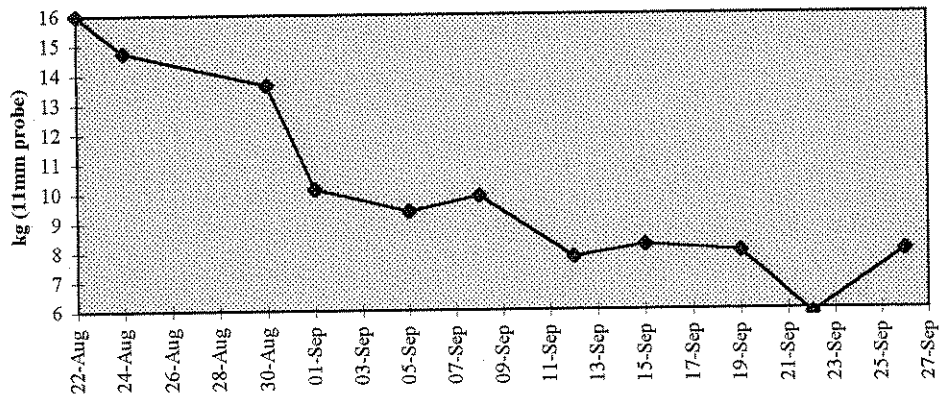
Cox Data - 1984

	Ethylene	Starch	Firmness
28-Aug	0	99.5	10.6
30-Aug	12	99.2	10.6
03-Sep	0	97	9.4
06-Sep	0	96.2	9
10-Sep	0	89.3	9.2
13-Sep	0	86.8	8.9
17-Sep	1.2	73.7	8.4
20-Sep	4.3	70	8.3
24-Sep	24.7	64.8	8

Cox Ethylene - 1984
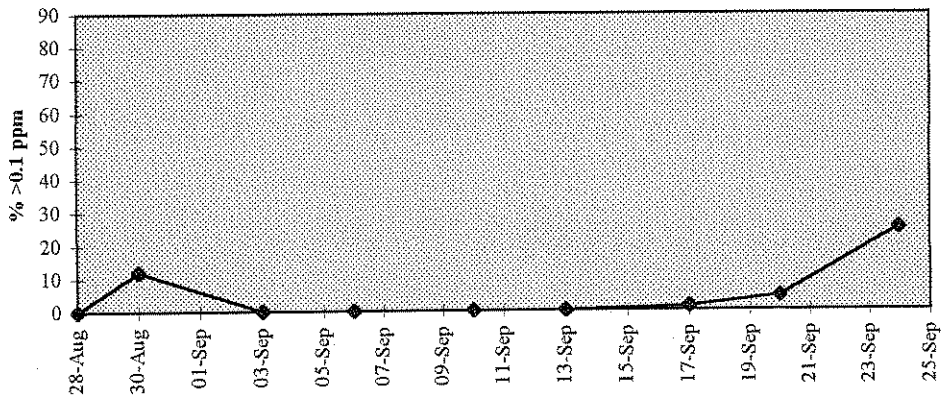
Cox Starch - 1984

Cox Firmness - 1984

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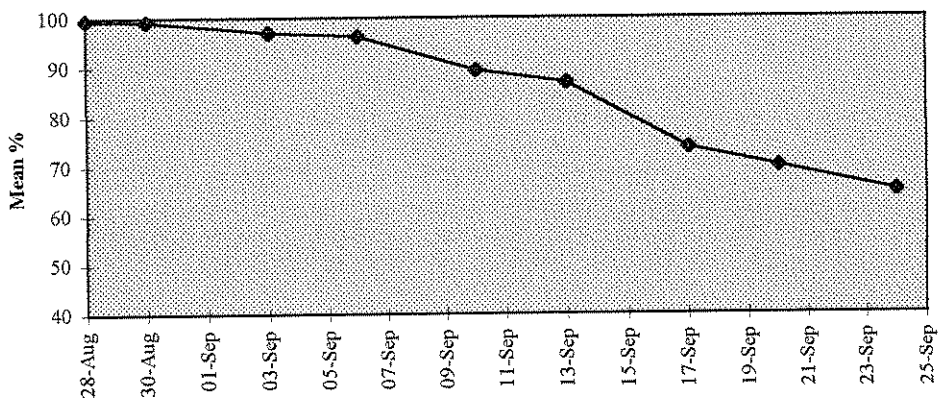
Cox Data - 1985

	Ethylene	Starch	Firmness
19-Aug	0	97.4	12.7
22-Aug	0	99	12.8
27-Aug	1.3	98	12.1
29-Aug	4.7	97	11.8
02-Sep	3.5	95.5	11.3
05-Sep	8.7	92.8	10.86
09-Sep	0.7	90.5	10.45
12-Sep	4	87.5	10.48
16-Sep	1.2	78.8	10.1
19-Sep	25.5	79	9.8
23-Sep	28	76.3	9.6
26-Sep	43.8	72	9.31

Cox Ethylene - 1985

Cox Starch - 1985

Cox Firmness - 1985

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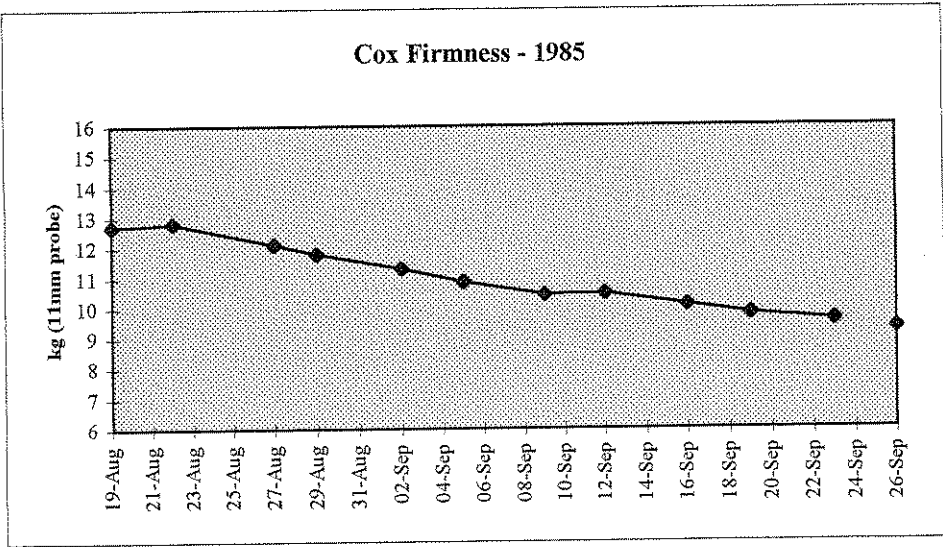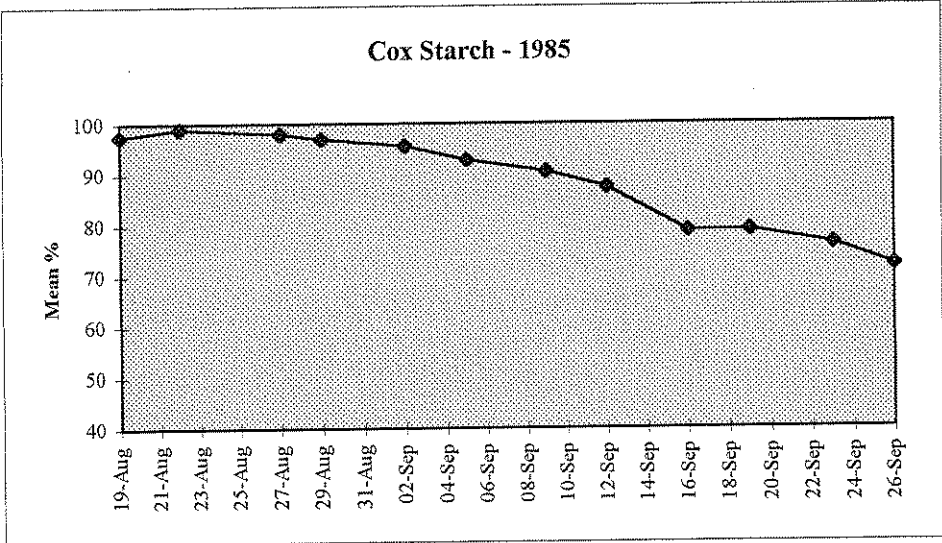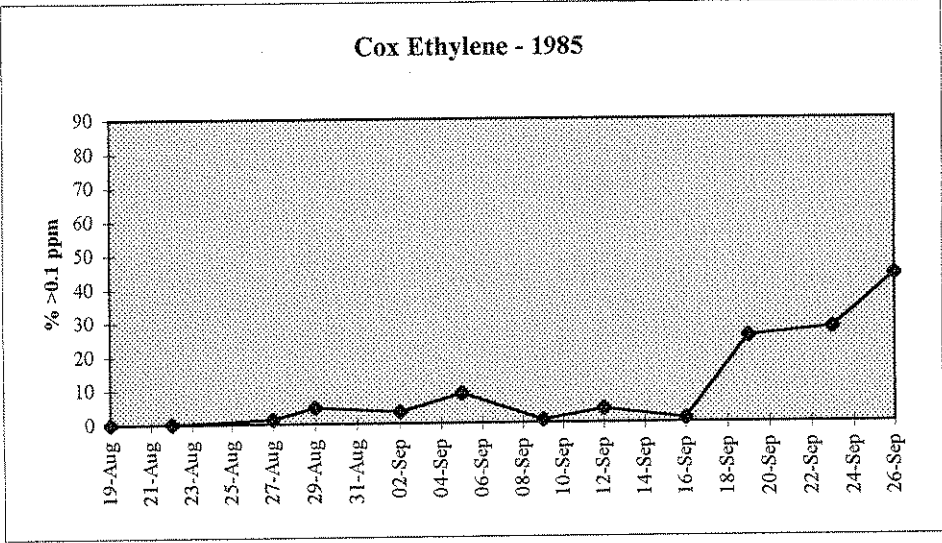
Cox Data - 1986

	Ethylene	Starch	Firmness	
26-Aug	0	100	9.6	
28-Aug	0	99	9.6	
01-Sep	0	98.5	9.2	
04-Sep	0	96.2	10.3	
08-Sep	0	94	8.36	
11-Sep	1.7	92	8	
15-Sep	2.5	86	7.8	
18-Sep	13.3	82.7	7.9	
22-Sep	28	77.4	7.7	
25-Sep	25	68.3	7.7	

Cox Ethylene - 1986
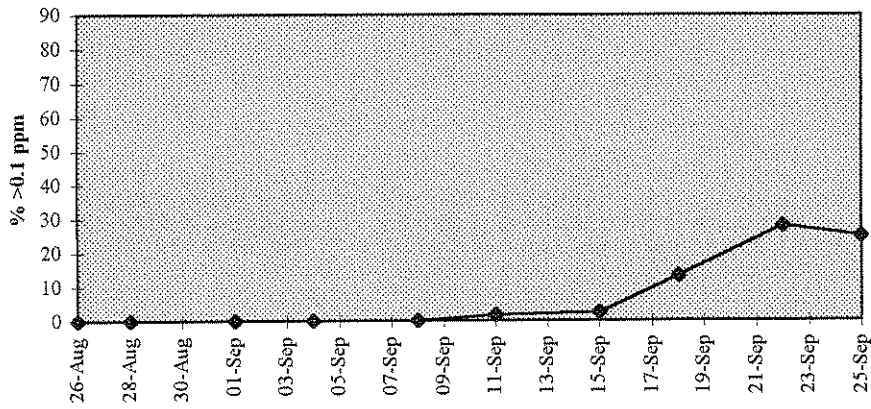
Cox Starch - 1986

Cox Firmness - 1986

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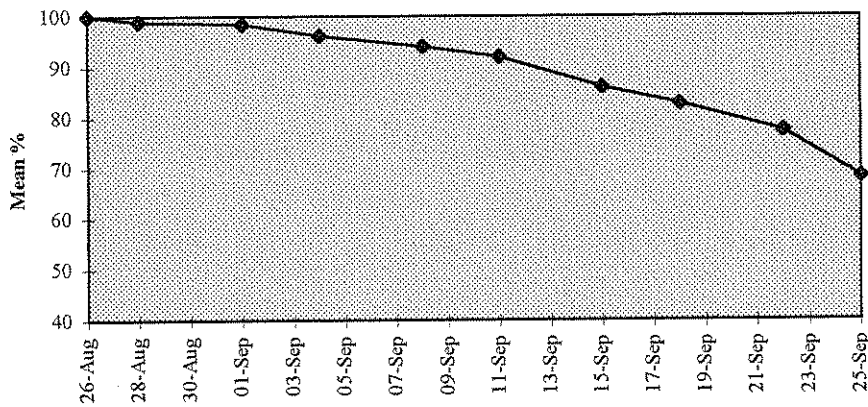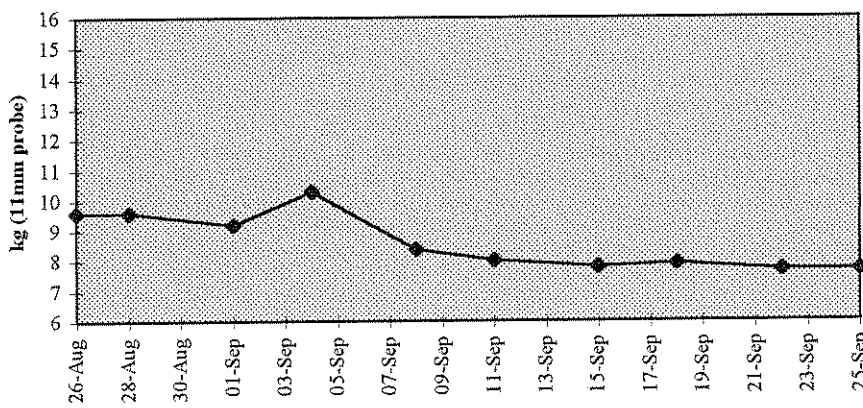
Cox Data - 1987

	Ethylene	Starch	Firmness
01-Sep	1.25	95.5	9.4
03-Sep	0.6	94.7	8.8
07-Sep	1.25	88.4	8.4
10-Sep	0	89.5	8
14-Sep	1.25	90	8.2
17-Sep	0.7	73.25	7.8
21-Sep	5.4	76.6	7.3
24-Sep	10.25	75.3	7.1
28-Sep	21	63.4	6.7

Cox Ethylene - 1987
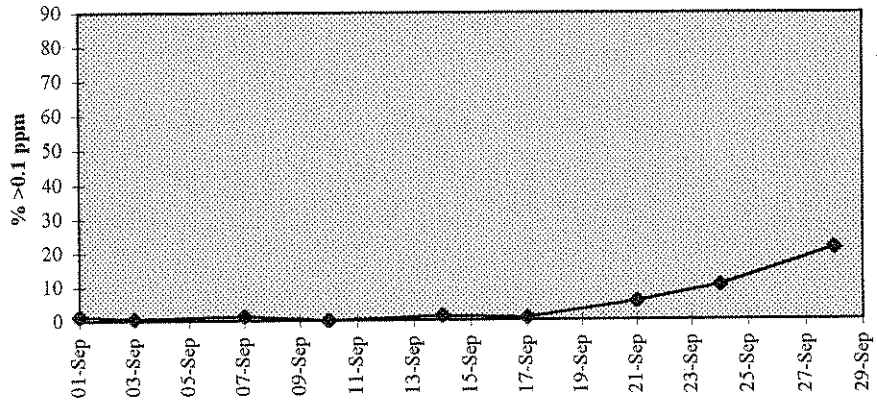
Cox Starch - 1987

Cox Firmness - 1987

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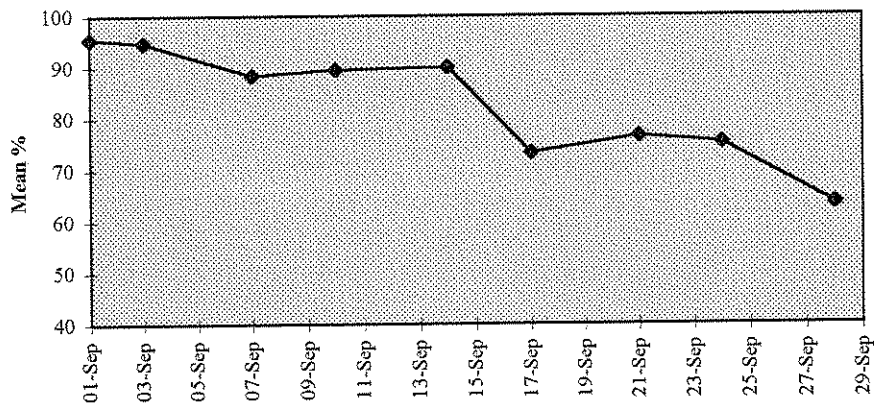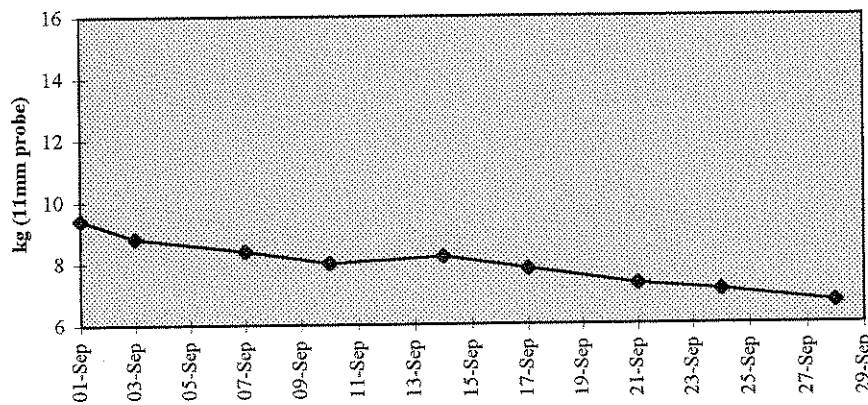
Cox Data - 1988

	Ethylene	Starch	Firmness
01-Sep	1.25	98.3	11.5
05-Sep	1	93	9
08-Sep	2.5	88	8.7
12-Sep	2.5	86.4	8.4
15-Sep	9.3	82	8
19-Sep	27.6	78.6	7.8
22-Sep	48.3	72.7	8.2

Cox Ethylene - 1988
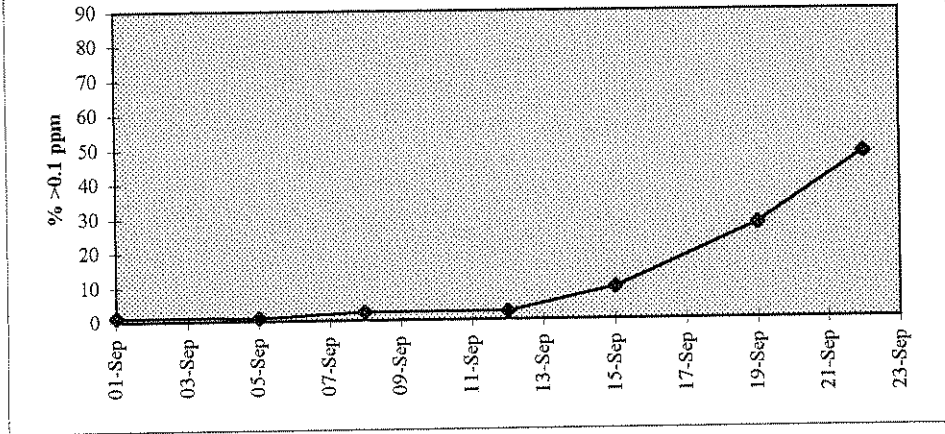
Cox Starch - 1988

Cox Firmness - 1988

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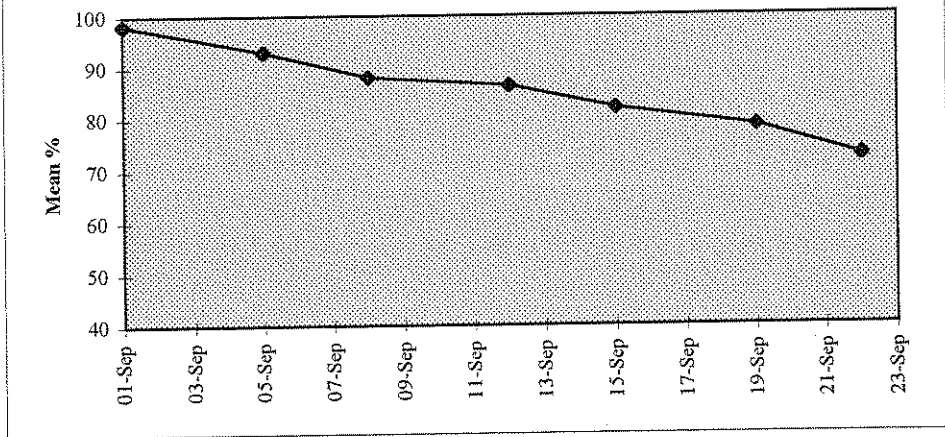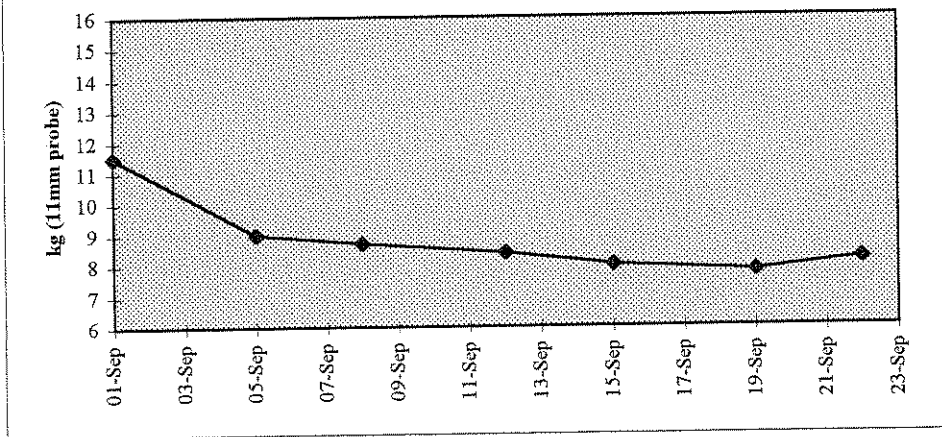
Cox Data - 1989

	Ethylene	Starch	Firmness
24-Aug	3.4	95.4	9.4
29-Aug	4.4	90	9
31-Aug	2.8	91	8.6
04-Sep	0.6	87.6	7.7
07-Sep	11.25	88	8
11-Sep	16.9	89	7.1
14-Sep	24	89	8.5
18-Sep	50	80	7.1

Cox Ethylene - 1989
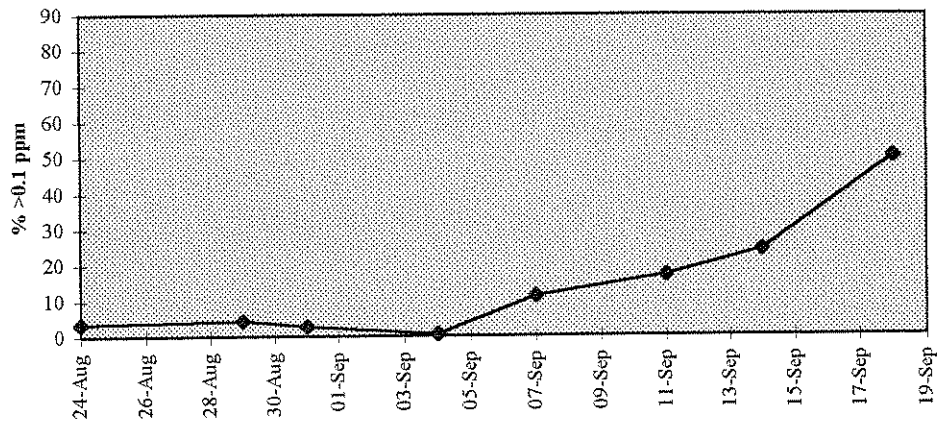
Cox Starch - 1989

Cox Firmness - 1989

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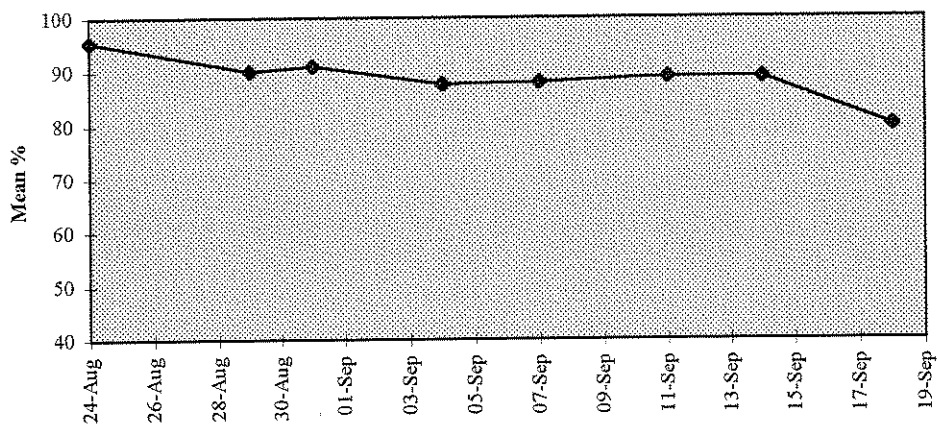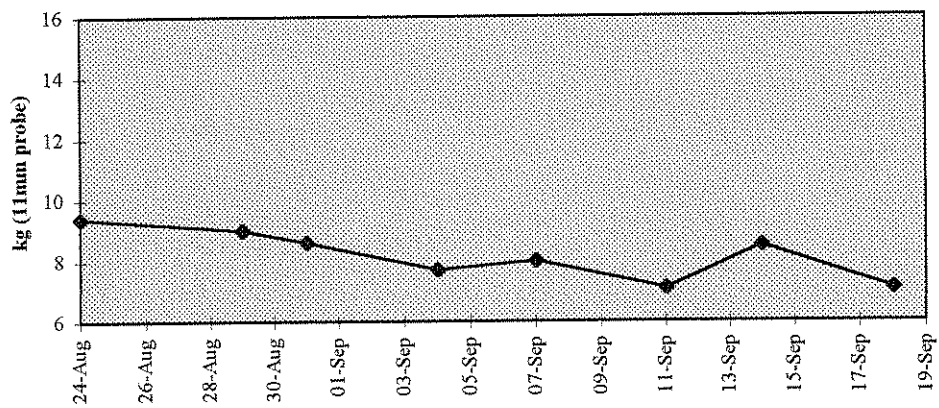
Cox Data - 1990

	Ethylene	Starch	Firmness
16-Aug	3.3	100	10.7
20-Aug	0.6	98	9.4
23-Aug	15.6	97	9.3
28-Aug	34	92	9
30-Aug	33	83	8.7
03-Sep	55	64	8

Cox Ethylene - 1990
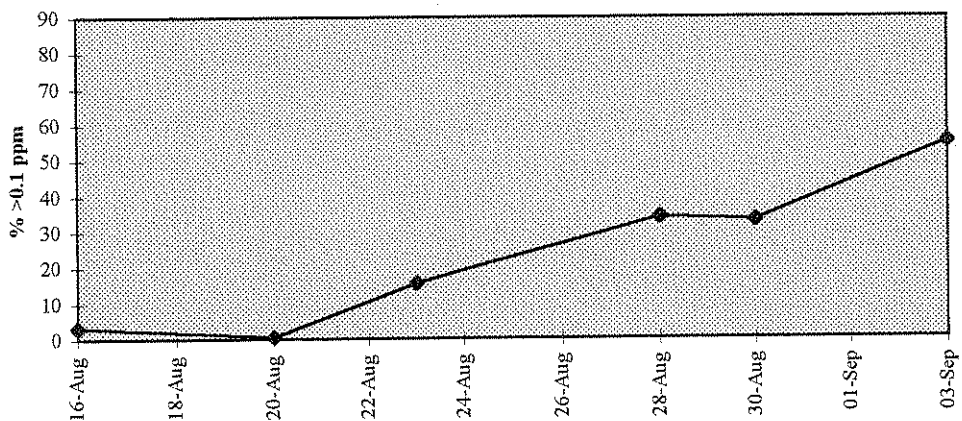
Cox Starch - 1990

Cox Firmness - 1990

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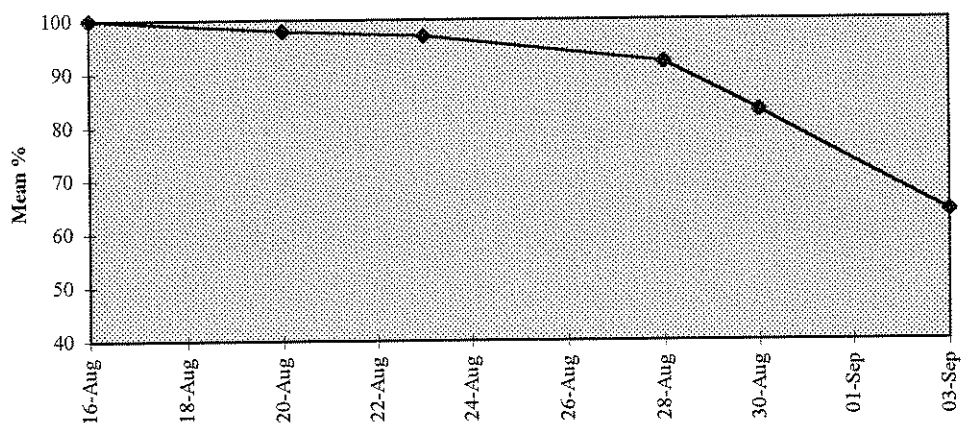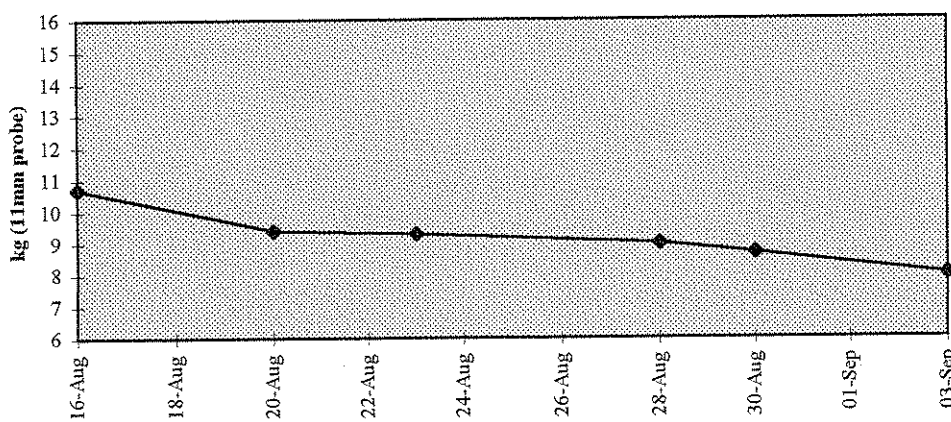
Cox Data - 1991

	Ethylene	Starch	Firmness
02-Sep	5.2	90	11
05-Sep	0	93	10.6
09-Sep	6.8	92.8	10.2
12-Sep	11.9	78	9.9
16-Sep	27.5	74	9.5
19-Sep	10	67	9.4
23-Sep	62	71	8.6
26-Sep	68	59	8.6

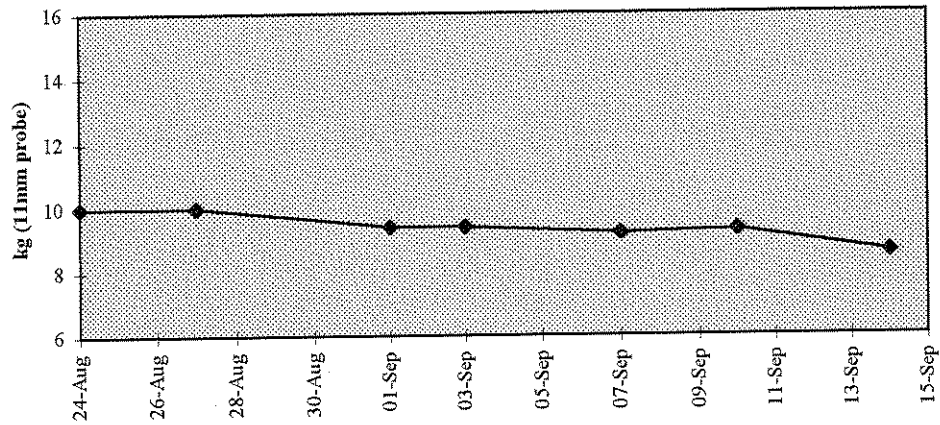Cox Ethylene - 1991
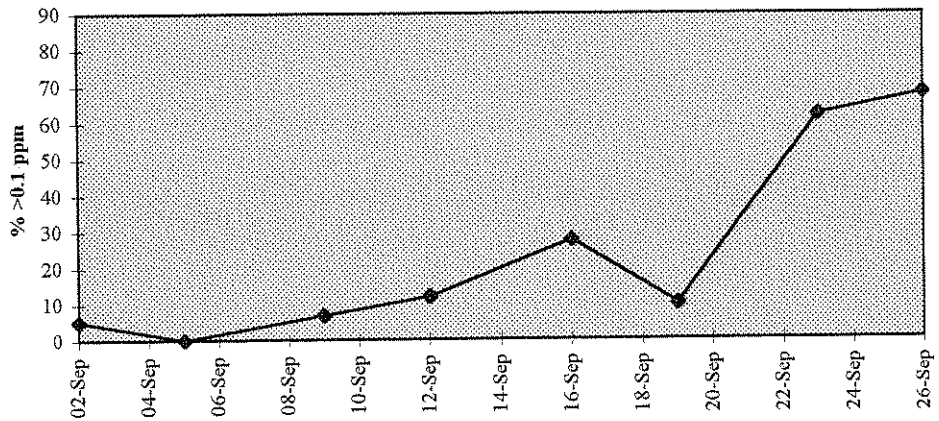
Cox Starch - 1991

Cox Firmness - 1991

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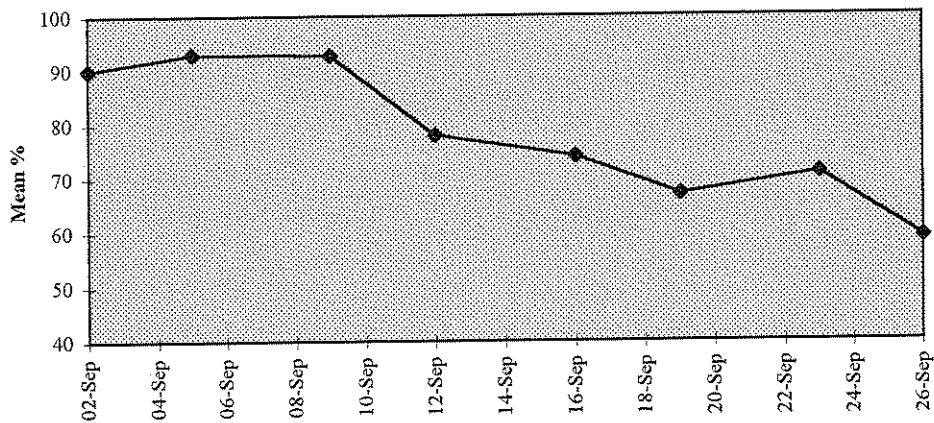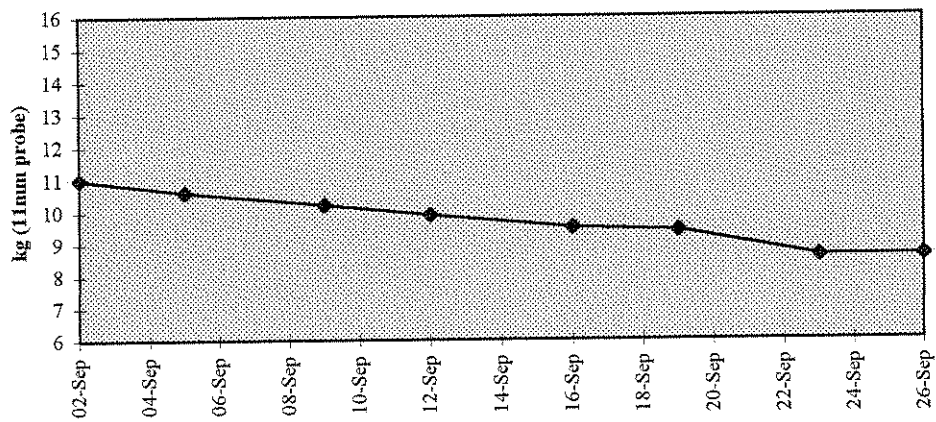
Cox Data - 1992

	Starch	Firmness
24-Aug	97	10
27-Aug	90	10
01-Sep	90.5	9.4
03-Sep	86	9.4
07-Sep	73.5	9.2
10-Sep	71	9.3
14-Sep	60	8.6
No data for ethylene		

Cox Starch - 1992
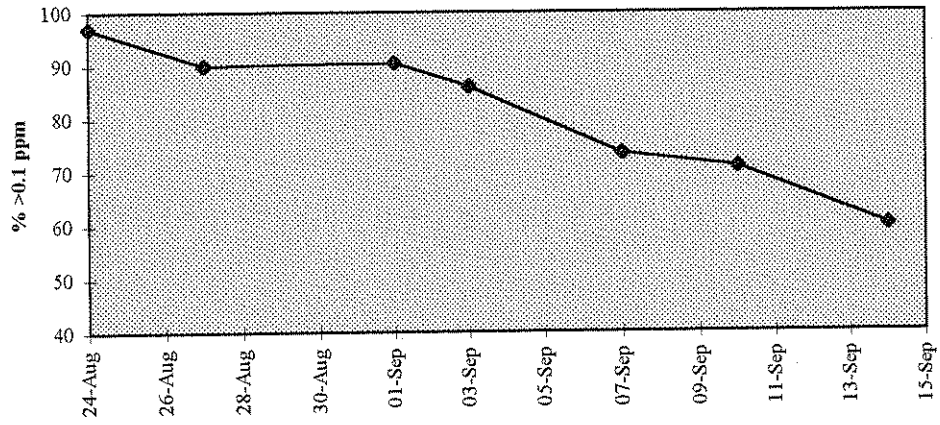
Cox Firmness - 1992

NO DATA FOR ETHYLENE

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Cox Data - 1993

	Starch	Firmness
19-Aug	94.6	10.7
23-Aug	90.3	10.4
26-Aug	83	10
31-Aug	67	10
02-Sep	65	9.8
06-Sep	53.8	9.7
09-Sep	59	9.5

Cox Starch - 1993

Cox Firmness - 1993

NO DATA FOR ETHYLENE

ADAS