PROGRESS REPORT

PROJECT NO.: 14799

TITLE: Retain and MCP on 'Bartlett' and 'd'Anjou' Pears

YEAR INITIATED 1998-99 **CURRENT YEAR** 2000-01 **TERMINATING** 2000-01

PERSONNEL: Dr. Eric A. Curry, Plant Physiologist, USDA-ARS, Wenatchee, WA

COOPERATOR: Dr. Don Elfving, WSU-TFREC, Wenatchee, WA

JUSTIFICATION:

Summer pears such as 'Bartlett', when mature, develop the capacity to autocatalytically enter a climacteric ripening phase, whereas winter pears like 'd'Anjou' are normally unable to autocatalize ethylene production without an inductive cold period of about 60 days. During 'Bartlett' maturation, ACC accumulates. ACC, formed by the enzyme ACC synthase, is then converted to ethylene by the enzyme ACC oxidase. Retain™ (AVG) inhibits ethylene by inhibiting ACC synthase. Thus, from the time it is applied until it is diluted, destroyed or metabolized, it inhibits the further formation of ACC. In 'd'Anjou pears, however, because ACC toes not accumulate at the same rate or magnitude, one would expect AVG to have a different effect on ripening. In apples, AVG has been shown to inhibit ethylene-induced abscission if applied before the onset of ethylene biosynthesis in the abscission zone. It also inhibits ripening of apples when applied as early as 4 weeks before harvest. AVG has also been shown to delay ripening of 'Bartlett' and 'd'Anjou' pears, however, results have been variable presumably because of extenuating environmental circumstances. 1-Methylcyclopropene (MCP) is a more recently developed compound that delays ripening through a different mechanism. Instead of inhibiting ethylene biosynthesis, it inhibits ethylene action. Presumably, this compound binds to ethylene receptors and prevents ethylene from autocatalysis. Preliminary data indicate it is effective in climacteric tree fruit. Because 'Bartlett' and 'd'Anjou pears could benefit from reduced drop as well as lengthened storage life. it would be useful to investigate the effects of such fruit ripening regulators on fruit quality during storage.

OBJECTIVES:

Determine maturity and ripening effects of preharvest applications of AVG on 'Bartlett' and d'Anjou pears.
Determine influence of postharvest applications of MCP to 'Bartlett' and 'd'Anjou' to pears in regular and CA storage.

PROGRESS:

RETAIN™ – BARTLETT Initial trials on 'Bartlett' were conducted in three Wenatchee-area orchards. The protocol was similar for both. Fruit were treated at 4 or 2 weeks before harvest with the maximum rate of AVG. At harvest, fruit were placed either in regular or CA storage. At 0, 5, 10, 15, 20 and 25 weeks after storage fruit were removed and assessed for quality. The following table highlights the data from this trial.

BARTLETT –1998, 50 gm AI Handgun Applied to Drench.

Storage (Wks)	Applied (WBH)*	Color (LH)	Color (AH)	Firm (LB)	SolSol (%)	Ethylene (ppm)	Scald (%)
0	--	62	-19.1	16.8	11.3	<0.01	--
0	2	61	-19.2	17.3	11.4	<0.01	--
0	4	62	-19.1	17.9	11.5	<0.01	--
10	--	75	-6.9	8.9	11.6	--	--
10	2	73	-7.9	9.0	11.9	--	--
10	4	73	-8.1	10.5	12.2	--	--
15	--	76	-3.2	10.3	11.0	91	18
15	2	75	-2.8	10.7	11.3	56	24
15	4	75	-3.9	11.3	11.6	19	23

*Weeks before Harvest

Another trial on 'Bartlett' in the Wenatchee area was conducted with Dr. Don Elfving. Data suggest when applied both 4 and 2 weeks before anticipated harvest, AVG at the maximum dosage promotes firmness retention in regular and CA storage at 5 and 10 weeks, but thereafter there was no benefit either in regular or CA storage. After 5 weeks storage. the increase was about 10% in regular storage and 20% in CA. At 10 weeks, the retention was about 7% in either storage.

Table 1. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on harvest quality of 'Bartlett' pears. (Monitor, 1998)

1. Fruit characteristics at harvest.

Growth Regulator[z,y]	Avg. fruit weight (g)	Firmness (N)	Total soluble solids (%)	Titratable acidity (%)	Hunter L	color a	factors b	Hue angle (°)
Control	210a	68.2a	12.4cd	0.50a	62.0a	-17.9a	40.3a	114.0a
AVG 50 gm/ac, 4 WBH	210a	65.7b	11.8d	0.48a	61.9a	-17.8a	40.5a	113.8a
AVG 25 gm/ac 4&2WBH	200a	66.5ab	12.8bc	0.53a	61.9a	-18.0a	41.2a	113.7a
NAA 25 gm/ac 8 DBH	200a	66.6ab	13.2ab	0.51a	62.2a	-17.9a	41.2a	113.5a
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac, 8 DBH	200a	68.3a	13.7a	0.52a	61.9a	-17.9a	41.8a	113.2a
Harvest Date[x]								
August 18	190b	67.0a	12.8a	0.52a	60.9b	- 18.3b	41.3a	113.9a
August 26	220a	67.1a	12.7a.	0.50a	63.1a	- 17.5 a	40.7a	113.3b

[z]Application of AVG by air-blast sprayer at 9351/ha (100 gallons/acre) on 14 July and 29 July 1998. Similar application of NAA-K+ salt 10 August 1998. WBH = weeks before anticipated harvest. DBH = days before harvest.

[y]Each value is the mean of 8 plot-mean values, each of which is the mean of 20 observations. Values followed by different letters are significantly different by the Waller-Duncan Bayesian k-ratio test ($p \leq .05$).

[x]Each value is the mean of 20 plot-mean values, each of which is the mean of 20 observations. Values followed by different letters are significantly different by single degree-of-freedom analysis of variance ($p \leq .05$).

Table 2. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'Bartlett' pears. (Monitor, 1998)

2. Fruit characteristics after 5 weeks of air storage.

Growth Regulator[z,y]	Firmness (N)	Total soluble solids (%)	Titratable acidity (%)	Hunter L	color a	factors b	Hue angle (°)
Control	55.6ab	13.4ab	0.45a	67.9a	-12.8a	44.2abc	106.3b
AVG 50 gm/ac, 4 WBH	52.6b	12.6b	0.44a	67.3a	-1 3.8b	43.7bc	107.6a
AVG 25 gm/ac 4&2WBH	53.0b	13.7a	0.46a	67.8a	-12.7a	45.2a	105.8b
NAA 25 gm/ac 8 DBH	59.3a	13.4ab	0.47a	66.6a	-14.0b	43.5c	107.9a
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac, 8 DBH	56.0ab	14.1 a	0.47a	68.0a	-12.5a	44.9ab	105.7b
Harvest Date[x]							
August 18	51.2a	13.6a	0.45a	68.9a	-12.0a	45.0a	105.0b
August 26	59.3a	13.3a	0.46a	66.1b	-14.4b	43.6b	108.3a

Table 3. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'Bartlett' pears. (Monitor, 1998)
3. Fruit characteristics after 5 weeks of CA storage.

Growth Regulator[z,y]	Firmness (N)	Total solids (%)	Titratable acidity (%)	Hunter L	color a	factors b	Hue angle (°)
Control	62.5a	13.9a	0.44b	67.7bc	-12.6ab	43.8a	106.1 bc
AVG 50 gm/ac, 4 WBH	66.0a	12.5b	0.44b	67.5bc	-13.0bc	44.0a	106.5b
AVG 25 gm/ac 4&2WBH	62.6a	14.0a	0.44b	69.1a	-12.0a	44.2a	105.2c
NAA 25 gm/ac 8 DBH	67.9a	13.6ab	0.46ab	67.0c	-13.6c	43.0b	107.6a
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac, 8 DBH	67.6a	14.4a	0.48a	68.2ab	-12.3a	44.3a	105.4c
Harvest Date[x]							
August 18	68.6a	13.8a	0.45a	68.4a	-12.1a	44.0a	105.4b
August 26	62.1b	13.6a	0.45a	67.4b	-13.3b	43.8a	107.0a

Table 4. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'Bartlett' pears. (Monitor, 1998)
4. Fruit characteristics after 10 weeks of air storage.

Growth Regulator[z,y]	Firmness (N)	Soluble solids (%)	Titratable acidity (%)	Hunter L	color a	factors b	Hue angle (°)
Control	38.3b	13.1a	0.38a	74.5a	-3.5bc	50.3ab	94.0ab
AVG 50 gm/ac, 4 WBH	38.0b	12.1b	0.40a	74.2a	-4.4c	49.9ab	95.1a
AVG 25 gm/ac 4&2WBH	37.1b	13.1a	0.40a	74.1a	-4.2c	49.6b	94.9a
NAA 25 gm/ac 8 DBH	38.8ab	13.4a	0.39a	74.4a	-2.7ab	50.3ab	93.1bc
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac, 8 DBH	41.1a	13.9a	0.39a	74.1a	-2.4a	50.7a	92.8c
Harvest Date[x]							
August 18	40.5a	13.2a	0.39a	74.1a	-3.7a	51.1a	94.2a
August 26	36.9b	13.0a	0.39a	74.4a	-3.2a	49.2b	93.8a

Table 5. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'Bartlett' pears. (Monitor, 1998)

5. Fruit characteristics after 10 weeks of CA storage.

Growth Regulator[z,y]	Firmness (N)	Soluble solids (%)	Titratable acidity (%)	Hunter color factors Hue angle L	a	b	(°)
Control	44.1 a	13.6ab	0.43bc	73.5a	-6.4a	47.4b	97.8b
AVG 50 gm/ac. 4 WBH	45.7a	12.7b	0.42c	72.1b	-8.5b	47.3b	100.3a
AVG 25 gm/ac 4&2WBH	47.8a	13.6ab	0.42c	71.8b	-8.8b	46.3c	100.9a
NAA 25 gm/ac 8 DBH	41.1a	14.0a	0.45a	73.3a	-6.2	48.3a	97.4b
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac. 8 DBH	43.6a	14.3a	0.44ab	73.3a	-6.2a	48.5a	97.3b
Harvest Date[x]							
August 18	45.4a	13.7a	0.44a	72.3b	-7.6a	47.6a	99.2a
August 26	43.5a	13.6a	0.43a	73.3a	-6.8a	47.5a	98.3a

Table 6. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'Bartlett' pears. (Monitor, 1998)

6. Fruit characteristics after 15 weeks of air storage.

Growth Regulator[z,y]	Firmness (N)	Soluble solids (%)	Titratable acidity (%)	Hunter color factors Hue angle L	a	b	(°)
Control	40.7a	12.5bc	0.30bc	72.9ab	-0.1 bc	48.0abc	90.1ab
AVG 50 gm/ac. 4 WBH	36.2b	11.8c	0.32ab	73.7a	-1.0c	49.1a	91.1a
AVG 25 gm/ac 4&2WBH	38.6ab	13.0ab	0.34a	73.4ab	-0.4c	48.9ab	90.5a
NAA 25 gm/ac 8 DBH	38.8ab	12.8ab	0.28c	71.8bc	0.7ab	47.2c	89.1bc
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac. 8 DBH	41.7a	13.5a	0.30bc	70.5c	1.2a	47.4bc	88.5c
Harvest Date[x]							
August 18	42.0a	12.8a	0.32a	72.6a	-0.1 a	48.9a	90.1 a
August 26	36.4b	12.6a	0.30b	72.3a	0.3a	47.3b	89.6a

Table 7. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'Bartlett' pears. (Monitor, 1998)

7. Fruit characteristics after 15 weeks of CA storage.

Growth Regulator[z,y]	Firmness (N)	Soluble solids (%)	Titratable acidity (%)	Hunter color L	a	b	Hue angle (°)
Control	40.9bc	13.6a	0.39a	74.0a	-3.2a	49.6a	93.7b
AVG 50 gm/ac, 4 WBH	43.5b	12.4b	0.40a	73.2ab	-5.5b	48.1b	96.6a
AVG 25 gm/ac 4&2WBH	48.6a	13.8a	0.41a	72.2b	-6.4b	47.5b	97.8a
NAA 25 gm/ac 8 DBH	38.8c	14.0a	0.40a	73.3ab	-3.1a	49.1a	93.6b
AVG 25 gm/ac 4 WBH + NAA 25 gm/ac. 8 DBH	40.9bc	14.5a	0.41a	73.5a	-3.2a	49.6a	93.7b
Harvest Date[x]							
August 18	45.1a	13.7a	0.40a	73.0a	-4.1a	49.2a	94.8a
August 26	39.9b	13.7a	0.40a	73.5a	-4.5a	48.4a	95.3a

RETAIN™ – D'ANJOU

Table 8. Effect of preharvest application of aminoethoxyvinylglycine (AVG) and naphthaleneacetic acid (NAA) on postharvest response of 'd'Anjou' pears. (Monitor, 1998)

WEEKS STOR.	HARV. DATE	TYPE STORAGE	TREATMENT	FIRM. LB	SOLSOL (%)	TITRAT. ACIDITY	MINOLTA COLOR LH	aH	bH
0	10-Sep	HARVEST	CONTROL	8.96	15.7	0.382	65.28	-16.82	37.66
0	10-Sep	HARVEST	RETAIN 4 WBH	11.87	15.0	0.374	65.03	-17.10	38.65
0	17-Sep	HARVEST	CONTROL	9.26	15.2	0.354	66.23	-16.60	38.61
0	17-Sep	HARVEST	RETAIN 4 WBH	9.57	15.3	0.328	65.94	-16.77	38.79
5	10-Sep	REGULAR	CONTROL	12.01	15.8	0.310	65.72	-15.80	38.19
5	10-Sep	REGULAR	RETAIN 4 WBH	12.68	16.0	0.285	66.32	-15.45	38.21
5	10-Sep	CA	CONTROL	12.69	16.1	0.299	65.60	-15.95	37.60
5	10-Sep	CA	RETAIN 4 WBH	12.67	16.0	0.291	65.43	-16.10	37.97
5	17-Sep	REGULAR	CONTROL	12.40	16.1	0.332	66.90	-15.45	38.44
5	17-Sep	REGULAR	RETAIN 4 WBH	11.86	16.2	0.340	67.28	-14.85	38.76
5	17-Sep	CA	CONTROL	12.26	16.5	0.283	66.09	-15.74	37.30
5	17-Sep	CA	RETAIN 4 WBH	12.10	16.0	0.289	64.90	-16.30	38.06
10	10-Sep	REGULAR	CONTROL	4.91	16.2	0.229	71.28	-12.87	43.07
10	10-Sep	REGULAR	RETAIN 4 WBH	4.90	15.8	0.223	70.81	-11.84	42.07
10	10-Sep	CA	CONTROL	4.94	16.3	0.228	69.76	-13.03	43.23
10	10-Sep	CA	RETAIN 4 WBH	6.02	15.9	0.236	68.24	-14.64	40.06

10	17-Sep	REGULAR	CONTROL	4.35	16.4	0.218	72.39	-10.65	42.50
10	17-Sep	REGULAR	RETAIN 4 WBH	4.69	16.7	0.233	70.89	-11.96	42.00
10	17-Sep	CA	CONTROL	5.99	17.1	0.240	69.95	-13.52	40.73
10	17-Sep	CA	RETAIN 4 WBH	5.76	16.3	0.259	67.83	-13.52	40.50
15	10-Sep	REGULAR	CONTROL	7.03	16.2	0.226	69.95	-11.50	41.68
15	10-Sep	REGULAR	RETAIN 4 WBH	6.56	15.6	0.219	69.42	-12.00	41.81
15	10-Sep	CA	CONTROL	10.70	16.4	0.268	64.80	-15.31	38.41
15	10-Sep	CA	RETAIN 4 WBH	12.14	16.0	0.272	66.14	-15.99	37.97
15	17-Sep	REGULAR	CONTROL	7.28	16.5	0.211	70.92	-10.34	40.75
15	17-Sep	REGULAR	RETAIN 4 WBH	6.93	16.1	0.206	71.93	-10.02	41.44
15	17-Sep	CA	CONTROL	11.05	16.2	0.263	67.16	-14.92	38.35
15	17-Sep	CA	RETAIN 4 WBH	11.18	16.7	0.259	65.41	-14.66	38.85
20	10-Sep	REGULAR	CONTROL	.	.	.	76.28	-5.66	41.99
20	10-Sep	REGULAR	RETAIN 4 WBH	.	.	.	75.68	-5.12	42.17
20	10-Sep	CA	CONTROL	.	.	.	68.17	-13.84	40.99
20	10-Sep	CA	RETAIN 4 WBH	5.93	15.4	0.233	68.11	-14.17	41.50
20	17-Sep	REGULAR	CONTROL	.	.	.	74.59	-5.23	42.37
20	17-Sep	REGULAR	RETAIN 4 WBH	.	.	.	76.59	-5.10	41.80
20	17-Sep	CA	CONTROL	6.44	16.0	0.234	69.16	-13.28	41.62
20	17-Sep	CA	RETAIN 4 WBH	6.83	16.2	0.226	68.57	-13.98	41.28

MCP – BARTLETT Initial studies on 'Bartlett' were conducted on fruit from a Wenatchee orchard. Treatments included: MCP at 0.1 and 1.0 PPM, treated for 1 hour either at harvest or at 10 weeks after storage, treated cold or allowed to warm to room temperature, and with or without an ethrel pretreatment. Fruit were stored for 20 weeks. The following table highlights the most significant data:

Table 9. BARTLETT –1998; quality after 15 wks. regular storage.

TRT	MCP (ppm)	MCP TRT (wks)	TRT TEMP	ETHREL (ppm)	FIRM (lb)	SSOL (%)	SCALD (%)
Har	--	--	--	--	15.0	12.1	--
1	0	0	Rm	0	9.4	12.8	68
2	0	0	Rm	600	12.2	12.6	20
3	0.1	0	Rm	0	13.9	12.3	0
4	1.0	0	Rm	0	14.1	13.0	5
5	1.0	10	Rm	0	9.7	13.1	88
6	2.0	10	Cold	0	6.3	13.0	98
7	2.0	10	Rm	0	9.6	13.0	78
8	1.0	10	Rm	600	6.0	12.5	95
9	2.0	10	Rm	600	5.8	13.0	88

Only pears treated at harvest showed significant effects on ripening. At 0.1 ppm treated for 1 hour, firmness was retained by 48%, at 1.0 ppm by 50%. These fruit exhibited typical ripening behavior specifically skin yellowing. Surprisingly, fruit treated with 600 ethrel also prolonged firmness by 30% above controls. In ethrel treated fruit, skin was yellowing and showed a 70% reduction in scald whereas both MCP treatments reduced scald by > 90%.

Table 10. BARTLETT –1999; Selected quality parameters after regular storage.

Weeks Storage	Treatment	Days Ripened	Firmness (Lb)	Sol. Solids (%)	CT (258)	Senescent Scald (%)	Rot (%)	Core Brkdn (%)
Harvest	Untreated	0	16.45	--	2.27	--	--	--
6	Untreated Check	3	8.02	12.40	10.08	0	0	--
6	Ethephon	3	8.41	12.47	10.03	0	0	--
6	MCP	3	17.17	12.37	2.27	0	0	--
6	MCP + Ethephon	3	17.01	12.47	3.24	0	0	--
12	Untreated Check	3	8.68	11.80	11.71	0	0	--
12	Ethephon	3	9.84	11.51	16.38	1.7	1.7	--
12	MCP	3	15.68	12.43	3.80	0	0	--
12	MCP + Ethephon	3	11.62	12.63	5.24	0	0	--
16	Untreated Check	3	9.78	11.39	11.84	13	45	100
16	Ethephon	3	11.18	11.05	13.00	43	5.0	93
16	MCP	3	10.09	12.25	5.90	0	0	3.3
16	MCP + Ethephon	3	8.46	11.93	9.38	0	1.7	24
20	Untreated Check	3	10.81	11.26	11.73	60	100	--
20	Ethephon	3	10.33	11.00	13.30	40	37	--
20	MCP	3	12.89	12.26	4.86	0	1.8	--
20	MCP + Ethephon	3	9.66	11.77	9.34	12	17	--

Table 11. D'ANJOU --1998; quality after 6 mo. regular storage.

TRT	MCP (ppm)	MCP TRT (wks)	TRT TEMP	ETHREL (ppm)	FIRM (LB)*	CT (258)*	SCALD (%)*
Har	--	--	--	--	14.3	--	--
1	0	0	Rm	0	5.9	6.8	100
2	0	0	Rm	600	6.4	8.9	80
3	0.1	0	Rm	0	7.6	3.0	0
4	1.0	0	Rm	0	10.6	3.1	0
5	1.0	10	Rm	0	6.3	6.9	10
6	2.0	10	Cold	0	7.7	4.6	60
7	2.0	10	Rm	0	5.3	5.6	15
8	1.0	10	Rm	600	3.8	6.1	40

*After 6 months regular storage plus 7 days ripening.

MCP – D'ANJOU Fruit were treated with either 0 or 1 ppm for 1 hour at harvest and placed in regular storage for 4 months, on CA storage for 4 or 8 months. Because this trial was partially completed at the time of this writing, some of the results will be shown at time of presentation.

Table 12. Firmness, and weight loss of d'Anjou pears treated with MCP at harvest and stored 4 months in RA or CA.

MCP (ppm)	Storage	Firmness (LB)	Storage Wt. Loss (%)	Ripened[z] Wt. Loss (%)
0	RA	5.6	2.9	4.7
1	RA	13.6*	5.7*	7.5*
0	CA	7.4	2.5	4.6
1	CA	14.2*	2.5	4.3

[z] Five days at 70F.

PROCEDURES:

This last year the study will concentrate on responses of 'Bartlett' and 'd'Anjou' to MCP with a more in depth look at the ripening behavior, moisture loss and effects of MCP on wax biosynthesis.

ANTICIPATED BENEFITS AND INFORMATION TRANSFER:

Results of this work will be published in peer reviewed journal articles, technical publications and presentations to the industry.

BUDGET:

1. Amount allocated by commission for FY 1999-00: $15,000

2. Request for FY 2000-2001:

Timeslip	9,500
Goods & Services[1]	2,500
Travel[2]	1,000
Employee Benefits	500
TOTAL	$13,500

[1]Lab supplies (syringes, vials, solvents); Gases for CA storage and calibration; presentation materials.
[2]General work travel; travel and presentation at WPCC, TFRC, WSHA and related meetings.

OTHER SUPPORT OF PROJECT: The WPCC and WTFRC are the sole sources of funding for my work on pears.