EVALUATION OF INSECTICIDES FOR CODLING MOTH CONTROL IN WALNUTS - 2000

W. W. Coates, R. A. Van Steenwyk, and R. M. Nomoto

ABSTRACT

Several alternative insecticides to the standard organophosphate insecticides were found to be effective in reducing codling moth (CM) damage at harvest to commercially acceptable levels (below 5%) in an orchard that had 32.3% worm damage at harvest in an untreated control. The most effective treatment for the second year in a row was Baythroid followed by Decis with both having significantly better control than the grower standard of Lorsban/Imidan/Guthion or Guthion alone. Calypso also provided excellent control (<5% CM damage) at the 0.125 lb AI/acre rate as did Success combined with Dimilin, Confirm, and two rates of Intrepid although these were not significantly different than the grower standard. Materials providing good control that were not significantly different from the grower standard but above the 5% threshold included Avaunt with and without oil, Avaunt plus Dimilin and oil, Calypso at the lower rate (0.095 lb AI/acre), Assail, and Volck Supreme oil.

All insecticides tested reduced the drop of first flight-damaged nuts also. Baythroid again was the most effective. Other excellent control materials (less drop than the grower standard) included Decis, Calypso (O.125 lb AI/acre rate), Confirm and Intrepid (both rates).

OBJECTIVES

In the summer of 1996, the U. S. Congress passed and the President signed the Food Quality Protection Act. This piece of legislation will have a significant impact on all pesticides used in the United State and particularly those used on agricultural crops. Currently, the EPA is reviewing organophosphate insecticides, many of which will have increased restrictions on their use or their registrations may be terminated. Increased restrictions have already impacted uses of Guthion, Penncap M and Lorsban, at least for some crops. It is imperative that alternative codling moth control measures be found and tested to help maintain an economically viable walnut industry in California. This project was designed to evaluate some possible alternative chemical control measures in comparison to the existing organophosphate insecticides.

METHODS AND MATERIALS

This study was conducted in a commercial 'Payne' walnut orchard planted on a 24 X 24 foot spacing (75 trees/acre) northeast of Hollister, CA. Nineteen treatments were replicated four times in a randomized complete block design. Each replicate was an individual tree with a buffer tree in each direction. Foliar sprays were applied by a handgun operating at 250 psi with a finished spray volume of 250 gallons/acre (3.33 gal/tree).

Applications were scheduled based upon a single sine horizontal cutoff degree-day (DD) computer model with an upper threshold of 88°F and a lower threshold of 50°F. Maximum and minimum temperatures were obtained from the University of California IMPACT weather

station for Ausaymas located near Hollister, CA. CM flight activity was monitored with a pheromone trap placed high in the tree canopy on March 14 and checked weekly through September 12.

The target dates for various treatment materials were: Avaunt with and without oil as well as Confirm and Intrepid (two rates) at 200 and 600 DD after the first biofix and 200 DD after the second biofix; Avaunt or Success with oil at 200 DD followed by Avaunt or Success with oil and Dimilin at 600 DD after the first biofix and 200 DD after the second biofix; Baythroid (WP and EC), Decis, Volck oil, Guthion and Lorsban/Imidan/Guthion (grower standard) at 300 and 650 DD after the first biofix plus 200 DD after the second biofix; Calypso or Assail at 200 and 550 DD after the first biofix and 200 DD after the second biofix; Calypso at 100 DD after the first biofix and again at two and four weeks after the first treatment and at 100 DD after the second biofix; Calypso at 100 DD after the first biofix, two weeks later and 100 DD after the second biofix; and Lorsban and Dimilin at 650 DD after the first biofix and 300 DD after the second biofix.

Control of the first CM generation (over-wintering flight) was evaluated by inspecting all dropped nuts weekly for CM damage from June 9 through July 19. Control of the second generation (summer flight) was evaluated at commercial harvest on September 21 by inspecting 100 nuts per tree for codling moth and navel orangeworm (NOW) damage. Walnut aphids were evaluated on June 9 by inspecting 10 leaflets per tree.

RESULTS AND DISCUSSION

Trap Activity

The overwintering flight of CM began about March 28 based upon the pheromone trap catch (see figure 1). The first biofix was established on March 31 when the sunset temperature exceeded 62°F – the minimum temperature needed for CM mating (see appendix). The first peak of the overwintering flight normally occurs between 200 to 350 DD and the second peak occurs between 650 to 750 DD after the first biofix. In 2000, the actual dates for peak trap catches were from April 20 (236 DD) to May 2 (381 DD) for the first peak and May 30 (785 DD) to June 6 (889 DD) for the second peak. The second biofix was determined to be July 8 with the flight peak on July 18 (175 DD after the second biofix). The second flight began at 1418 DD after the first biofix, which is much later than normal.

Overwintering Flight Damage

All of the experimental treatments had significantly lower percentages of dropped nuts when compared to the untreated control (Table 1). Compared to the four-tree mean for the untreated controls of 61.3 dropped nuts, the four-tree means of the treatments ranged from zero (Baythroid 2EC) to 22.3 (Calypso 4SC – three applications at lower rate) dropped nuts. Volck Supreme oil (1%) averaged 7.0 dropped nuts per tree. Some variability in yield was noted between trees so direct comparisons between treatments based on dropped nuts may not be valid in all instances. The walnut aphid population began to increase on June 9 particularly in the Guthion treatment, but extremely high temperatures on June 13 and 14 caused the population to crash and it did not recover for the rest of the season. Mites were not observed to be a problem in any treatment.

Harvest Evaluation

While all of the treatments applied had a significantly lower percent total infestation at harvest than the untreated control, only the Baythroid and Decis treatments had a significantly lower percent infestation than the grower standard. NOW is normally not a major problem in the Central Coast and it did not contribute significantly to the total infestation. Calypso at the 0.125 lb AI/acre rate, Success combined with Dimilin, Lorsban combined with Dimilin, Confirm, Guthion and both Intrepid treatments also performed well with numerically lower damage totals than the grower standard. These treatments as well as the grower standard were also less than the 5% total damage considered acceptable by the industry particularly since the untreated control had 32.3% total damage. Treatments greater than 5% damage but not statistically different from the grower standard included Avaunt with and without oil, Avaunt plus oil and Dimilin, three or four applications of Calypso at the lower rate (.095 lb AI/acre), Assail and Volck Supreme oil.

CONCLUSIONS

This study was conducted in an orchard with an extremely high rate of CM infestation for walnuts – about 30% damage in the untreated control at harvest. Considering this high population of CM, Baythroid, Decis, Confirm and Intrepid provided excellent control as alternative control materials to the grower standard (Lorsban/Imidan/Guthion) as measured by percent infestation at harvest. The combination sprays of Success plus Dimilin and oil, as well as Lorsban plus Dimilin without oil also provided excellent control. The results obtained from Lorsban plus Dimilin was based upon two seasonal applications versus three or four for other treatments. Guthion and the grower standard both had about 4% damage. Materials that provided good control (considering the high population pressure) but still exceeded 5% CM damage include Avaunt, Avaunt plus oil, Avaunt plus Dimilin and oil, Calypso (0.095 lb AI/acre), Assail, and Volck Supreme oil. The fairly good performance of Volck Supreme oil alone when compared to the untreated control for the second year in a row is also encouraging and although damage was above acceptable commercial standards, it could be possibly be combined with other control measures to enhance efficacy.

Efficacy of the treatments for reducing nut drop from first flight CM damage varied a little from the harvest results. Baythroid was again the best treatment followed by Decis. Other treatments judged to be excellent included Calypso (high rate), Confirm and Intrepid (both rates). Control with Guthion was exactly the same as the grower standard of Lorsban/Imidan/Guthion. Other insecticides that provided good control include Avaunt, Avaunt plus oil, Avaunt plus Dimilin and oil, Success and Dimilin, Calypso (0.095 rate, 4 times), Assail, Lorsban plus Dimilin and Volck Supreme oil. Calypso at the 0.095 rate provided only fair control since it had significantly more drop than the grower standard but still significantly less than the untreated control.

Aphids were not a problem this year. The aphid population in the Guthion treatment began to rise in early June but hot weather in mid-June caused the population to crash. Mites were not noted as a problem in any treatment.

Table 1. Mean Total Number Codling Moth Infested Dropped Nuts per tree for First Generation and Mean Total Number of walnut aphids per leaf at Hollister, CA - 2000.

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Total No. Dropped Nuts/tree	Mean[a] No. aphids/leaflet
1) Avaunt 30WG[b]	0.11	3	13.5 bcde	0.3 a
2) Avaunt 30WG	0.11	3	7.8 abcd	0.1 a
3) Avaunt 30WG[b]	0.11	1	18.5 de	0.5 a
Avaunt 30WG[b]	0.11	2		
+ Dimilin 2L	0.25			
4) Success 2SC[b]	0.125	1	10.8 abcde	0.3 a
Success 2SC[b]	0.125	2		
+ Dimilin 2L	0.25			
5) Baythroid 2EC	0.022	3	0.0 a	0.0 a
6) Baythroid 20WP	0.022	3	1.8 abc	0.1 a
7) Decis 0.2EC	0.026	3	1.0 ab	0.0 a
8) Calypso 4SC	0.095	4	12.8 bcde	0.1 a
9) Calypso 4SC	0.095	3	22.3 e	0.2 a
10) Calypso 4SC	0.125	3	4.8 abc	0.0 a
11) Assail 70WP	0.15	3	8.0 abcd	0.0 a
12) Lorsban 4E	2.0	2	14.3 cde	0.3 a
+ Dimilin 2L	0.25			
13) Lorsban 4E	2.0	1	6.5 abcd	0.1 a
Imidan 70WP[c]	4.2	1		
Guthion 50WP	1.0	1		

Table 1. Continued

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Total No. Dropped Nuts	Mean[a] No. aphids/leaflet
14) Confirm 2F[d]	0.25	3	1.5 ab	0.0 a
15) Intrepid 2F[d]	0.125	3	2.5 abc	0.2 a
16) Intrepid 2F[d]	0.25	3	4.0 abc	0.3 a
17) Volck Supreme oil by volume	1.0%	3	7.0 abcd	0.1 a
18) Guthion 50WP	1.0	3	6.5 abcd	1.1 a
19) Untreated	—	0	61.3 f	0.3 b

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$).
[b]Treatments included 1% Volck Supreme oil by volume.
[c]pH adjusted to < 6 by Bu-pH-er.
[d]Treatments combined with 0.0625% Latron CS-7 by volume.

Table 2. Mean Percent Codling Moth and Navel Orangeworm Infestation at Harvest at Hollister, CA - 2000.

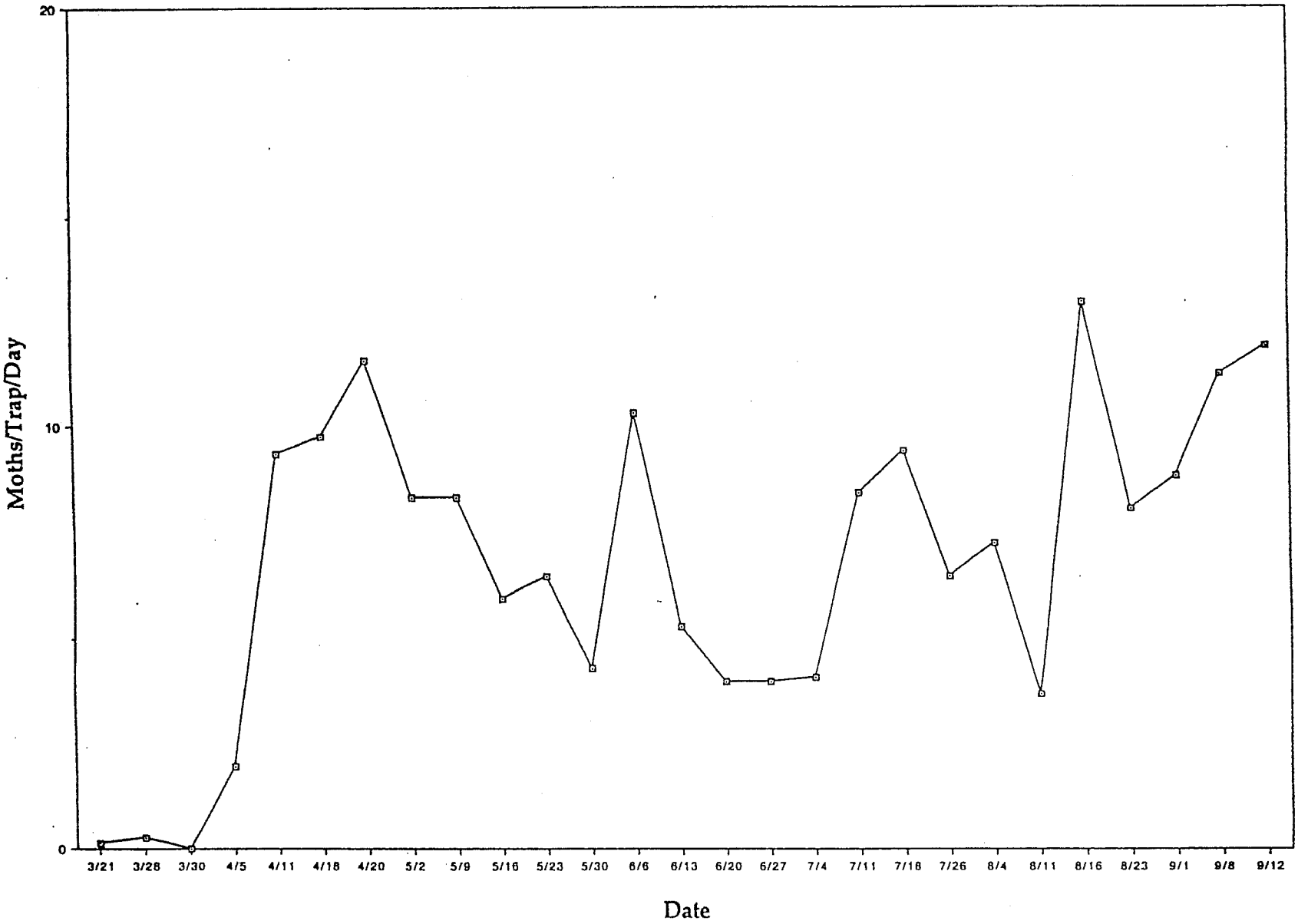
Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Percent Infested Nuts at harvest NOW	CM	Total
1) Avaunt 30WG[b]	0.11	3	0.3 a	6.2 cdef	6.5 efg
2) Avaunt 30WG	0.11	3	0.0 a	7.0 def	7.0 efg
3) Avaunt 30WG[b] Avaunt 30WG[b] + Dimilin 2L	0.11 0.11 0.25	1 2	0.0 a	5.5 cdef	5.5 defg
4) Success 2SC[b] Success 2SC[b] + Dimilin 2L	0.125 0.125 0.25	1 2	0.3 a	1.5 ab	1.7 abc
5) Baythroid 2EC	0.022	3	0.0 a	1.0 a	1.0 a
6) Baythroid 20WP	0.022	3	0.0 a	1.5 ab	1.5 ab
7) Decis 0.2EC	0.026	3	0.3 a	1.0 a	1.3 ab
8) Calypso 4SC	0.095	4	0.7 ab	8.5 ef	9.2 g
9) Calypso 4SC	0.095	3	0.3 a	8.3 ef	8.5 fg
10) Calypso 4SC	0.125	3	0.0 a	3.0 bcd	3.0 bcde
11) Assail 70WP	0.15	3	0.3 a	6.5 def	6.8 efg
12) Lorsban 4E + Dimilin 2L	2.0 0.25	2	0.0 a	1.8 ab	1.8 abc
13) Lorsban 4E Imidan 70WP[c] Guthion 50WP	2.0 4.2 1.0	1 1 1	0.5 a	3.7 bcde	4.2 cdefg

Table 2. Continued

Treatment	Rate lb (AI)/ac	No. Appl.	Mean[a] Percent Infested Nuts at harvest NOW	CM	Total
14) Confirm 2F[d]	0.25	3	0.0 a	2.2 abc	2.2 abcd
15) Intrepid 2F[d]	0.125	3	0.0 a	1.8 ab	1.8 abc
16) Intrepid 2F[d]	0.25	3	0.0 a	2.0 ab	2.0 abc
17) Volck Supreme oil by volume	1.0%	3	0.0 a	8.7 f	8.7 g
18) Guthion 50WP	1.0	3	0.0 a	4.0 bcde	4.0 bcdef
19) Untreated	—	0	3.0 b	29.3 g	32.3 h

[a]Means followed by the same letter within a column are not significantly different (Fisher's protected LSD, $P < 0.05$). Data analyzed using an arcsin transformation.
[b]Treatments included 1% Volck Supreme oil by volume.
[c]pH adjusted to < 6 by Bu-pH-er.
[d]Treatments combined with 0.0625% Latron CS-7 by volume.

Fig. 1 Seasonal Flight Activity of Codling Moths Captured in a Pheromone Trap at Hollister, CA - 2000



Appendix. Air Temperature and Degree-Day Accumulation for Codling Moth from the Ausaymas IMPACT Weather Station at Hollister, CA - 2000

DATE	AIR TEMP.(F) MIN.	MAX.	D.D.	ACCUM. D.D.
Mar 31 2000	38	83	13.21	13.21
Apr 01 2000	41	87	15.72	28.93
Apr 02 2000	44	90	17.75	46.69
Apr 03 2000	46	74	10.65	57.34
Apr 04 2000	51	73	12.00	69.34
Apr 05 2000	47	72	9.95	79.28
Apr 06 2000	42	75	10.22	89.50
Apr 07 2000	38	82	12.74	102.24
Apr 08 2000	45	69	7.99	110.23
Apr 09 2000	50	74	12.00	122.23
Apr 10 2000	38	77	10.42	132.65
Apr 11 2000	45	86	16.25	148.90
Apr 12 2000	51	79	15.00	163.90
Apr 13 2000	54	70	12.00	175.90
Apr 14 2000	50	69	9.50	185.40
Apr 15 2000	49	66	7.60	193.01
Apr 16 2000	51	63	7.00	200.01
Apr 17 2000	50	63	6.50	206.51
Apr 18 2000	40	70	7.54	214.05
Apr 19 2000	40	75	9.84	223.89
Apr 20 2000	43	79	12.34	236.23
Apr 21 2000	46	70	8.71	244.93
Apr 22 2000	48	69	8.76	253.70
Apr 23 2000	40	72	8.46	262.15
Apr 24 2000	40	80	12.18	274.33
Apr 25 2000	39	78	11.06	285.39
Apr 26 2000	47	89	18.28	303.66
Apr 27 2000	43	76	10.90	314.56
Apr 28 2000	46	68	7.74	322.30
Apr 29 2000	36	77	10.11	332.41
Apr 30 2000	44	90	17.75	350.16
May 01 2000	42	84	14.51	364.67
May 02 2000	52	82	17.00	381.67
May 03 2000	52	83	17.50	399.17
May 04 2000	55	80	17.50	416.67
May 05 2000	46	76	11.63	428.30
May 06 2000	42	70	7.87	436.18
May 07 2000	51	63	7.00	443.18
May 08 2000	57	72	14.50	457.68
May 09 2000	53	77	15.00	472.68
May 10 2000	49	66	7.60	480.28
May 11 2000	37	72	8.01	488.28
May 12 2000	39	76	10.13	498.41
May 13 2000	43	69	7.59	506.00

May 14 2000	40	72	8.46	514.46
May 15 2000	51	64	7.50	521.96
May 16 2000	47	61	4.60	526.56
May 17 2000	52	72	12.00	538.56
May 18 2000	45	85	15.76	554.32
May 19 2000	48	93	19.96	574.28
May 20 2000	54	97	23.71	598.00
May 21 2000	58	104	26.84	624.83
May 22 2000	60	104	27.74	652.57
May 23 2000	59	91	24.61	677.18
May 24 2000	57	72	14.50	691.68
May 25 2000	52	71	11.50	703.18
May 26 2000	46	82	14.57	717.75
May 27 2000	55	88	21.50	739.25
May 28 2000	50	91	20.15	759.40
May 29 2000	48	81	14.71	774.11
May 30 2000	42	77	11.16	785.28
May 31 2000	42	89	16.86	802.14
Jun 01 2000	47	90	18.65	820.79
Jun 02 2000	45	76	11.37	832.16
Jun 03 2000	45	82	14.29	846.45
Jun 04 2000	47	74	10.93	857.38
Jun 05 2000	52	81	16.50	873.88
Jun 06 2000	47	83	15.37	889.25
Jun 07 2000	53	73	13.00	902.25
Jun 08 2000	52	64	8.00	910.25
Jun 09 2000	50	73	11.50	921.75
Jun 10 2000	52	74	13.00	934.75
Jun 11 2000	42	84	14.51	949.26
Jun 12 2000	51	89	19.93	969.19
Jun 13 2000	54	102	24.69	993.88
Jun 14 2000	63	106	29.32	1023.20
Jun 15 2000	58	89	23.42	1046.62
Jun 16 2000	54	84	19.00	1065.62
Jun 17 2000	57	80	18.50	1084.12
Jun 18 2000	60	78	19.00	1103.12
Jun 19 2000	53	80	16.50	1119.62
Jun 20 2000	51	88	19.50	1139.12
Jun 21 2000	53	93	22.24	1161.36
Jun 22 2000	54	76	15.00	1176.36
Jun 23 2000	55	75	15.00	1191.36
Jun 24 2000	52	83	17.50	1208.86
Jun 25 2000	52	89	20.43	1229.29
Jun 26 2000	53	93	22.24	1251.53
Jun 27 2000	51	95	21.80	1273.33
Jun 28 2000	52	90	20.80	1294.13
Jun 29 2000	56	79	17.50	1311.63
Jun 30 2000	55	80	17.50	1329.13
Jul 01 2000	47	82	14.88	1344.01

Jul 02 2000	54	69	11.50	1355.51
Jul 03 2000	54	69	11.50	1367.01
Jul 04 2000	47	76	11.91	1378.92
Jul 05 2000	48	76	12.23	1391.15
Jul 06 2000	46	79	13.10	1404.25
Jul 07 2000	50	78	14.00	1418.25
Jul 08 2000	47	79	13.39	13.39
Jul 09 2000	49	81	15.08	28.47
Jul 10 2000	54	78	16.00	44.47
Jul 11 2000	54	77	15.50	59.97
Jul 12 2000	56	77	16.50	76.47
Jul 13 2000	47	77	12.41	88.88
Jul 14 2000	48	86	17.20	106.07
Jul 15 2000	50	80	15.00	121.07
Jul 16 2000	56	72	14.00	135.07
Jul 17 2000	58	83	20.50	155.57
Jul 18 2000	48	92	19.67	175.24
Jul 19 2000	50	91	20.15	195.39
Jul 20 2000	49	88	18.57	213.96
Jul 21 2000	50	84	17.00	230.96
Jul 22 2000	51	90	20.31	251.26
Jul 23 2000	50	99	22.23	273.50
Jul 24 2000	51	91	20.65	294.15
Jul 25 2000	49	88	18.57	312.72
Jul 26 2000	49	87	18.07	330.78
Jul 27 2000	46	88	17.53	348.31
Jul 28 2000	48	90	19.00	367.31
Jul 29 2000	50	90	19.81	387.12
Jul 30 2000	55	98	24.40	411.52
Jul 31 2000	54	94	23.00	434.52
Aug 01 2000	57	94	24.46	458.98
Aug 02 2000	58	90	23.79	482.77
Aug 03 2000	57	82	19.50	502.27
Aug 04 2000	58	90	23.79	526.05
Aug 05 2000	54	96	23.49	549.54
Aug 06 2000	51	88	19.50	569.04
Aug 07 2000	52	83	17.50	586.54
Aug 08 2000	56	84	20.00	606.54
Aug 09 2000	52	83	17.50	624.04
Aug 10 2000	52	89	20.43	644.47
Aug 11 2000	50	99	22.23	666.71
Aug 12 2000	52	95	22.28	688.99
Aug 13 2000	46	95	19.85	708.84
Aug 14 2000	48	95	20.51	729.35
Aug 15 2000	47	97	20.66	750.01
Aug 16 2000	47	100	21.32	771.33
Aug 17 2000	48	94	20.25	791.58

Aug 18 2000	44	90	17.75	809.33
Aug 19 2000	47	84	15.87	825.20
Aug 20 2000	43	84	14.75	839.95
Aug 21 2000	45	83	14.78	854.73
Aug 22 2000	56	76	16.00	870.73
Aug 23 2000	44	77	11.61	882.33
Aug 24 2000	50	93	20.77	903.10
Aug 25 2000	53	90	21.30	924.40
Aug 26 2000	51	83	17.00	941.40
Aug 27 2000	54	86	20.00	961.40
Aug 28 2000	54	80	17.00	978.40
Aug 29 2000	56	70	13.00	991.40
Aug 30 2000	57	79	18.00	1009.40
Aug 31 2000	60	73	16.50	1025.90
Sep 01 2000	57	69	13.00	1038.90