EFFECT OF POST-HARVEST ETHEPHON ON CODLING MOTH SURVIVAL

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Methods and Materials: The trial was conducted in commercial 'Bartlett' pear orchard in the Courtland, California. Three treatments were replicated four times in a randomized complete block design. Each replicate was 8 trees long by 11 rows wide (0.5 ac). The trees were planted on a 11 ft. by 22 ft. square (180 trees/ac). The treatments were applied with a air-blast speed sprayer operating at 1.75 mph with a finished spray volume of 100 gal. per acre. The three treatments were: ethephon at 1200 and 1800 ppm (4 and 6 pt. Ethrel per 100 gal.) and an untreated control. The treatments were applied on 14 August.

The effect of ethephon on fruit drop was evaluated weekly from 21 August through 2 October. On the day preceding application, 25 rattail and 25 mature green fruit were flagged per replicate (100 of both fruit types per treatment). Percent fruit drop was based on the number of flagged fruit remaining on the trees at the weekly evaluations. The effect of ethephon on fruit maturity (fruit pressure and fruit color) was evaluated weekly from 14 August though 28 August for mature green fruit and 14 August through 11 September for rattail fruit. Fruit color and pressure were determined on 10 rattail and 10 mature green fruit per replicate (40 of both fruit types per treatment). Fruit color was determined using standardized peach maturity color chips which were provided by the California Tree Fruit Agreement. The chips were modified to more accurately reflect pear maturity. We assigned color A = 1, C = 2, D = 3, H = 4, I = 5, and J = 6. Fruit pressure was determined with a penetrometer taking three readings per fruit.

The effect of ethephon on CM survival was determined by infesting 10 rattail and 10 mature green uninfested fruit per replicate (40 of both fruit types per treatment) on 14 August and 5 rattail and 5 mature green uninfested fruit per replicate (20 of both fruit types per treatment) on 21 and 28 August. Fruit was infested by placing two recently hatched CM larvae on the calyx end of each fruit. A small plastic cup was placed over the larvae and sealed to the fruit to prevent predation or larvae falling off the fruit. The fruit was removed from the trees two weeks after infestation and placed individually in a large plastic container. The plastic container had a layer of single-sided corrugated cardboard above and below the infested fruit to serve as a site for pupation or diapause. The containers were inspected weekly for six weeks to determine if a larva had infested the fruit and had successfully completed development. In addition, 25 rattail and 25 mature green naturally infested fruit per treatment were removed from the trees on 21 August and placed in the large plastic containers.

Results and Discussion: Mean percent rattail and mature green fruit drop was accelerated with the application of ethephon as compared to the untreated control. Two weeks after application, 67% and 75% of the mature green fruit had dropped

at the 4 and 6 pt. Ethrel/ac, respectively, while only 36% of the fruit had dropped in the control. Five weeks after application, 25% and 26% of the rattail fruit had dropped at the 4 and 6 pt. Ethrel/ac, respectively, while only 6% of the fruit dropped in the control. The fruit drop was much greater in the ethephon treatments and untreated control than had been observed in previous years studies. The increased fruit drop was the result of the late application date (14 August) of ethephon. If we had applied ethephon in the first week of August, then we would have observed much lower fruit drop.

In addition to fruit drop, mean rattail and mature green fruit pressure was reduced with the application of ethephon as compared to the untreated control. One week after application, mean mature green fruit pressure was 8.5 and 7.4 kg/cm^2 at the 4 and 6 pt. Ethrel/ac, respectively, while the mean pressure in the control was 11.8 kg/cm^2. Two week after application, mean rattail fruit pressure was 6.4 and 5.4 kg/cm^2 at the 4 and 6 pt. Ethrel/ac, respectively, while the mean pressure in the control was 14.4 kg/cm^2. A corresponding pattern was also observed with fruit color. One week after application, mean green fruit color was 3.0 and 3.7 at the 4 and 6 pt. Ethrel/ac, respectively, while the mean color in the control was 2.6. Two weeks after application, mean rattail fruit color was 4.0 and 4.4 at the 4 and 6 pt. Ethrel/ac, respectively, while the mean color in the control was 2.4. Past research has shown that if pears reach a fruit color of 3 (D color) or greater and fruit pressure of 10 kg/cm^2 or less then the pears cannot support the complete larval development of CM. Since mature green fruit pressure reached these parameters by one week after application and rattail fruit reached these parameters by two weeks after application, few larvae should be able to complete their larval development within two weeks after application.

The percent of mature green or rattail fruit producing a CM larva was significantly reduced on the day of application with both 4 and 6 pt. Ethrel/ac (Tables 1 and 2). On the day of application, mean percent mature green fruit producing a larvae was 0.0% and 2.5% at the 4 and 6 pt. Ethrel/ac, respectively, while the mean percent in the control was 15.0%. The mean percent rattail fruit producing a larvae was 2.5% at both the 4 and 6 pt. Ethrel/ac, respectively, while the mean percent in the control was 35.0%. The total percent of mature green fruit produced a larva was 1.3 % and 2.5% when treated with 6 and 4 pt. Ethrel/ac, respectively, while 11.3% of the fruit produced a larva in the control. And total percent rattail fruit produced a larva was 3.8 % and 1.3% when treated with 6 and 4 pt. Ethrel/ac, respectively, while 27.5% of the fruit produced a larva in the control. The low number of mature green fruit producing a larva in the control was the result of the late application date (14 August) of ethephon. The untreated control fruit were rapidly ripening and dropping from the trees in late August. If we had applied Ethephon in the first week of August, we would have had much higher larval survival in the control. The low number of mature green fruit producing a larva at the day of application would indicate that ethephon will prevent complete larval development of previously infested fruit. This was also observed when we caged naturally infested mature green fruit that had been infested two or more weeks prior to the ethephon application but was not observed with rattail fruit (Table 3). It appears that the rapid ripening action of the ethephon on mature fruit was effective in preventing complete larval development. However, in rattail fruit that are less mature than green fruit, the

ethephon cannot act fast enough to prevent complete larval development of fruit infested before the ethephon application.

Conclusions: This was the first study that demonstrated that Ethrel applied at 4 and 6 pt/ac with a growers air-blast speed sprayer delivering 100 gal. per acre could significantly reduce the number of overwintering CM larvae through increased fruit drop and fruit maturity. In previous studies, we applied Ethrel with a handgun delivering 200 to 300 gal/ac to individual trees and it was uncertain whether the results from these handgun trials would be indicative of the results from a growers air-blast speed sprayer at the same ppm. Also in previous studies it was not possible to infest fruit with CM larvae because of the limited sample size (individual trees). These encouraging results will lead to further investigations, particularly looking at earlier applications and the reach back effect of ethephon.

Table 1. Mean Percent Mature Green Fruit Producing a CM Larva at Various Application Rates of Ethephon when Infested with Two First Instar Larvae, Courtland, CA - 1996.

	Mean* Percent Fruit Producing a Larva			
Treatment	8/14	8/21	8/28	Total
6 pt Ethrel/ac	0.0 a	0.0 a	5.0 a	1.3 a
4 pt Ethrel/ac	2.5 ab	0.0 a	5.0 a	2.5 a
Untreated Control	15.0 b	5.0 a	10.0 a	11.3 b

*Means followed by the same letter within a column were not significantly different (Fisher's Protected LSD, $P \leq 0.1$). Data analyzed using an arcsin transformation.

Table 2. Mean Percent Rattail Fruit Producing a CM Larva at Various Application Rates of Ethephon when Infested with Two First Instar Larvae, Courtland, CA - 1996.

	Mean* Percent Fruit Producing a Larva			
Treatment	8/14	8/21	8/28	Total
6 pt Ethrel/ac	2.5 a	10.0 a	0.0 a	3.8 a
4 pt Ethrel/ac	2.5 a	0.0 b	0.0 a	1.3 a
Untreated Control	35.0 b	30.0 c	10.0 b	27.5 b

*Means followed by the same letter within a column were not significantly different (Fisher's Protected LSD, $P \leq 0.1$). Data analyzed using an arcsin transformation.

Table 3. Mean Percent Rattail and Mature Green Fruit Producing a CM larva at Various Rates of Ethephon when Naturally Infested with CM Larvae, Courtland, CA - 1996.

	Mean Percent Fruit Producing a Larva	
Treatment	Mature green fruit	Rattail fruit
6 pt Ethrel/ac	8.0	32.0
4 pt Ethrel/ac	8.0	40.0
Untreated Control	20.0	36.0