

Testing CPPU for crop load management and improved fruit quality in ‘Bartlett’ pear, 2007

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Summary, 2006: CPPU (2-chloro-4-pyridyl)-N=-phenylurea) applied at petal fall + 2 weeks doubled the percentage of the crop that was #1 fruit, significantly increased weight of both #1 and #2 fruit, and advanced maturity based on firmness. Effects appear to be due to a direct effect on size increase during Stage I growth; fruit set on individual limbs was increased, but number of fruit per half tree was decreased.

Summary, 2007: CPPU was applied to an experimental orchard of ‘Bartlett’/’Pyrodwarf’, planted at 3 different spacings (3’ x 14’, 6’ x 14’ and 7’ x 14’). The orchard was not maintained by commercial practices and was used so as to avoid crop destruct costs, therefore, results were not expected to be similar to those from a commercially-farmed orchard, such as that used in 2006. Crop destruct would have been an added cost until an EUP is obtained again for this material. Thus, results have been considered for trend purposes only.

All treatments, all spacings: Planting density is highly influential on crop load and fruit size, therefore results of these analyses are limited. In 2007 fruit per tree was reduced by treatment of 5 ppm CPPU applied at petal fall and at petal fall + 2 weeks (April 2 and April 16, respectively); with the later timing resulting in a substantial reduction in set, regardless of planting density considerations. A trend toward improved percentage of the crop that was #1 fruit was found with both CPPU treatments; size of #1 fruit tended to be improved with CPPU applied at petal fall. Maturity (as measured by firmness) was delayed by later CPPU treatment, which could have also had an effect on fruit size in that fruit harvested at the same time as that of the other treatments was smaller. It is possible that CPPU in a later timing could be a management tool for spreading out harvest maturity to optimize limited labor resources. No visible defects were observed.

Firmness after storage: Firmness was reduced in fruit treated with CPPU after 5.5 weeks storage at ~40°F without controlled atmosphere conditions. Loss in firmness for both treatments averaged ~3 lb while ~0.6 lb firmness reduction was found in untreated fruit.

Problem and Its Significance:

‘Bartlett’ pear in the leading European pear variety grown in California. ‘Bartlett’ pears are grown for both fresh and processing markets. A premium price can be obtained for large sizes in most years and if the majority of the crop is above minimum size at an early harvest timing, multiple harvests might be reduced or eliminated, thereby reducing hand labor costs and enabling rapid harvest over the large acreages that are typical for California’s growers. CPPU is labeled for improved fruit size in kiwifruit and grapes in California, under the ‘Prestige’ label (Valent BioSciences). CPPU is a synthetic cytokinin that is not metabolized by the plant, and is, therefore, active in very low concentrations (~100x stronger than 6-benzyladenine). As a cytokinin, it can be expected to have some similar effects, and potentially different effects, than other cytokinins used as plant growth regulators, and may have complementary potential in combinations. Late applications, or applications at high concentration (15-20 ppm) has been shown to delay fruit maturity (development of color, soluble solids and flesh softening). Thus, concentration and application timing is critical to desired results.

Plans and Procedures: 2007.

The experimental site was near Courtland and consisted of approximately 40-year old >Bartlett=/'PyroDwarf= trees planted at three high-density spacings and microsprinkler-irrigated. Spacings were 3' x 14', 6' x 14' and 7' by 14'. Trees were not managed commercially. Three treatments were compared using 2 rows of trees; the untreated control trees were 6 single trees split between 2 rows at the 7' x 14' density. CPPU-treatments were applied to the rest of the 2 tree rows, with a single timing in each row and all spacings represented among these treatments. CPPU was applied at 5 ppm (+0.1% Regulaid) at 100 gallons per acre, at petal fall (April 2) and petal fall + 2 weeks (April 16) by Aerofan type orchard sprayer. All treated trees were harvested on a single day (July 20). Fruit were counted and randomly sampled for size; #1 fruit (≥ 2.5 " diameter) were subsampled for equatorial diameter and firmness (10 fruit-sample per tree). Firmness was measured by UC pressure tester on a single cheek after removal of peel. Fruit were examined for evidence of shape abnormalities (knobbing at calyx end).

A subsample of five #1 fruit per tree (or fewer in cases of too few fruit) were stored for approximately 5.5 weeks at ~40 °F, then re-evaluated for firmness.

Statistical analyses:

Analyses of variance were performed with Proc GLM in SAS (SAS Institute Inc., Cary, NC) and mean separations tested by Duncan=s Multiple Range Test, $P = 0.05$. All data was normal and did not require transformation (Adler and Roessler, 1964).

Results and Discussion:

A pilot study in 2006 was conducted in a commercial 'Bartlett' orchard that tested two treatment timings of 10 ppm CPPU applied at approximately 200 gallons per acre using a Stihl mistblower; applications were made at petal fall + 2 weeks (11 May) when small fruit were just starting to drop, and at petal fall + 4 weeks (25 May). Bloom was very late in 2006 due to cool spring temperatures and crop load was light due to early warming at the end of the dormant season, followed by a freeze.

The trial was very small and results were taken as indicators only, however, it appeared that CPPU applied at petal fall + 2 weeks increased the percentage of the crop that was #1 fruit, increased weight of both #1 and #2 fruit, and advanced maturity based on firmness. Effects appeared to be due to a direct effect on size increase during Stage I growth; fruit set on individual limbs was increased, but number of fruit per half tree was decreased. No apparent benefit of the later treatment was found, nor detrimental effects.

2007: CPPU was applied to an experimental orchard of 'Bartlett'/'Pyrodwarf', planted at 3 different spacings (3' x 14', 6' x 14' and 7' x 14'). All untreated trees were in the 7' x 14' spacing; CPPU treatments were in all spacings. As these trees are not very productive and of poor vigor, the widest spacing only was selected for the untreated control and all treatments are compared both on the basis of a similar spacing to the untreated control, and in analyses where all trees are compared without respect to spacing. The orchard is not maintained by commercial practices and was used so as to avoid crop destruct costs, therefore, results are not expected to be similar to those from a commercially-farmed orchard, such as that used in 2006. Crop destruct would have been an added cost until an EUP is obtained again for this material. Thus, results are considered for trend purposes only.

All treatments, all spacings: Planting density is highly influential on crop load and fruit size, therefore results of these analyses are limited. CPPU treatments in 2006 clearly reduced fruit set. In 2007 fruit per tree was reduced by treatment of 5 ppm CPPU applied at petal fall and at petal fall + 2 weeks (April 2 and

April 16, respectively). The first timing reduced fruit set by 35% and the second timing reduced fruit set by 64%. The percentage of all fruit harvested from trees that was #1 fruit was not significantly different among treatments, but a trend toward improvement due to CPPU treatment and timing is suggested by the data: CPPU at petal fall + 2 weeks (68% #1 fruit) > CPPU at petal fall (65%) > untreated control (62%). A trend toward improved fruit diameter (of #1 fruit) was observed: CPPU at petal fall (73.6 cm) > CPPU at petal fall + 2 weeks, untreated control (71 cm, 72 cm, respectively). This size improvement may have been due to both direct and indirect effects in that CPPU is a synthetic cytokinin that should enhance cell division in the rapid growth phase just after bloom (direct effect) and has an indirect effect through reducing fruit set. Firmness was slightly increased by the later CPPU treatment (17.9 lb) vs CPPU at petal fall and the untreated control (17.2, 17.4 lb, respectively).

Treatments compared in the 7' x 14' spacing only: As in 2006 when CPPU applied at petal fall + 2 weeks, and as in the 2007 results for all trees, CPPU applied at petal fall + 2 weeks greatly reduced fruit set (52% reduction) compared to CPPU applied at petal fall (8% reduction). Percentage of all fruit on the tree that were #1 fruit was also improved by CPPU treatment, with a tendency for earlier application to enhance this effect; CPPU at petal fall (80%) > CPPU at petal fall + 2 weeks (72%) > untreated control (65%). Weight of #1 fruit was improved by early CPPU treatment (7.5 oz) > untreated control and CPPU at petal fall + 2 weeks (7.3, 6.6 oz, respectively). Fruit diameter showed the same trend: early CPPU treatment (2.9", 75 cm) > untreated control (2.8", 72 cm) and CPPU at petal fall + 2 weeks (2.8", 71 cm). Maturity, as measured by firmness, was slightly delayed by the later CPPU treatment (18.4 lb) vs CPPU at petal fall (16.8 lb) and the untreated control (17.4 lb).

Storage effects on firmness by treatment: Firmness was reduced in CPPU-treated fruit after storage, compared to untreated fruit (Table 1). Firmness in untreated fruit did not change appreciably (less than 1 lb average change), however, both CPPU treatments resulted in at least 3 pounds change in firmness on average. Storage conditions were not as similar to those used commercially as in 2006; storage temperature was higher and no atmosphere control conditions were imposed. These results indicate that storage for CPPU-treated fruit must be better evaluated when trials can be conducted in commercially-managed orchards.

The potential for CPPU to reduce fruit set and increase fruit size needs to be substantiated in a full-scale trial in a well-managed, commercial orchard, as growers seek to reduce labor costs and increase profitability. A chemical thinner for pears has been sought for decades; in 1995 and 1996, Southwick and Glozer evaluated Accel[®] (Abbott Laboratories—now replaced by MaxCel[®], Valent BioSciences), containing a cytokinin (6-benzyladenine) and 2 gibberellins (GA₄ and GA₇), purported to be an effective thinner and fruit sizing agent for several apple varieties. In those studies, we did not obtain a thinning effect at either petal fall or small fruit stages of application timing. Fruit set was increased by 15 g a.i. Accel[®] applied at petal fall, compared to the untreated control for both 'Bartlett' and 'Red Sensation' varieties. Application at 11 mm diameter fruit size did not affect fruit set. The increase in fruit set has been explained as Accel[®] (benzyladanine and gibberellins A₄A₇) applied at petal fall enhancing by parthenocarpic set.

Effects on maturity timing, similarly, need to be clarified. In 2006 on a limited number of trees with a light crop load there may have been an advance in maturity (by firmness, not by soluble solids) with CPPU (10 ppm, petal fall + 2 weeks). The 2007 trial did not obtain similar results, but the orchard conditions make these conclusions indecisive. Furthermore, CPPU concentration (10 ppm in 2006, 5 ppm in 2007) may have changed results with respect to fruit size and maturity, independently of application timing. A delay in maturity may account for decreased fruit size in the later treatment in 2007; with a dramatic reduction in fruit set, the crop should show larger fruit size as a result, however if maturity is delayed, the fruit could be expected to take longer to gain an equivalent size. If this is true, and desired fruit size is gained with a later maturity, it is possible that CPPU in a later timing could be a management

tool for spreading out harvest maturity to optimize limited labor resources. However, early fruit size optimization for a single, early harvest of larger fruit is the industry goal at this time, to command higher prices and reduce number of harvests in each orchard.

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Table 1. Effects of 5 ppm CPPU applied at petal fall (PF) or PF + 2 weeks (2 and 16 April, respectively) on firmness of 'Bartlett' pear before and after storage at ~40 °F for 5.5 weeks in 2007.			
Treatment (applied at 100 gallons per acre; 0.1% Regulaid as adjuvant)	Firmness (lb)		
	At harvest	After storage	Change
Control	17.4 ab ^x	16.8 a	0.6
CPPU 2 April	17.2 b	14.0 b	3.2
CPPU 16 April	17.9 a	14.1 b	3.8

^xMean separation within columns by Duncan's Multiple Range Test, *P* = 0.05.

