

Thinning of 'Golden Delicious' apples with the combination of ethephon and CPPU

Redčenje plodičev jablane sorte Zlati delišes s kombinacijo etefona ter CPPU

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Abstract. A synthetic cytokinin forchlorfenuron (CPPU) 5 ppm was sprayed at the time of petal fall (PF) on eight years old 'Golden Delicious'/M.9 apple trees with the aim of enlarging the fruit growth. Since CPPU is not recognized as a thinning agent which increases the return bloom, a low dose of ethephon was sprayed on CPPU treated trees to enhance flower bud formation and increase flowering in the next season. Ethephon was applied in successive treatments (alone or in the combination with CPPU) 3 x 30 ppm or 5 x 50 ppm, starting at PF, and continued in week intervals.

The single application of CPPU 5 ppm or the combination of ethephon 3 x 30 ppm with CPPU 5 ppm decreased the fruit set and enhanced the fruit growth to reach the commercial demand. The combination spraying of ethephon 5 x 50 ppm + CPPU 2 x 5 ppm resulted in a too strong thinning response while the yield of bigger size fruit was not enhanced. The alone application of ethephon 3 x 30 ppm had no influence on the fruit thinning or fruit weight while the application of ethephon 5 x 50 ppm reduced the fruit set but, consequently, did not enhance the fruit growth. None of the treatments influenced the return bloom.

Key words: apple thinning, CPPU, ethephon, alternate bearing

Abbreviations: N-(2-chloro-4-pyridyl)-N'-phenylurea (CPPU), 2-chloroethylphosphonic acid (ethephon)

Izveček. Z namenom povečanja velikosti plodov, smo škropili osem let stare jablane 'Zlati delišes/M.9' s sintetičnim citokininom forklorfenuronom (CPPU), v koncentraciji 5 ppm ob koncu cvetenja (KC) dreves. Ker CPPU ne izboljšuje povratno cvetenje jablan, so CPPU tretiranim drevesom dodali še etefon, kateri naj bi spodbudil nastanek cvetnega brstja ter tako izboljšal cvetenje v naslednjem letu. Etefon je bil nanešen v več zaporednih nanosih (sam ali v kombinaciji s CPPU), v tedenskih intervalih z začetkom ob KC jablan in sicer 3x30 ppm ali 5x50 ppm.

Samostojni nanos CPPU 5 ppm ali pa kombinacija etefona 3x30 ppm s CPPU 5 ppm je zmanjšala rodni nastavek in povečala rast plodov kot zahteva komercial-

ni nivo pridelave. Kombinacija škropljenj etefona 5x50 ppm + CPPU 2x5 ppm je povzročila premočan osip plodičev, tako da se pridelek plodov večjega velikostnega razreda ni izboljšal. Samostojni nanos etefona 3x30 ppm ni imel vpliva niti na redčenje plodičev niti na težo plodov, medtem ko je etefon 5x50 ppm sicer zmanjšal rodni nastavek, kar pa posledično ni povzročilo povečanja teže plodov.

Ključne besede: redčenje plodičev jablane, CPPU, etefon, izmenična rodnost

Okrajšave: N-(2-chloro-4-pyridyl)-N'-phenylurea (CPPU),
2-chloroethylphosphonic acid (etefon)

Introduction

Forchlorfenuron (CPPU), a synthetic cytokinin, has a strong influence on apple fruit growth if applied at petal fall (PF) or a few days later at the concentration below 10 ppm (GREENE 1989, GREENE 2001). Undesirable side effect, a reduced return bloom, was observed on 'Delicious' and 'McIntosh' apple trees after CPPU 5 ppm applications (CURRY & GREENE 1993, GREENE 1989). By contrast, an old thinner, ethephon, is known to enhance the return bloom of apple trees because its post bloom application mostly results in good flower bud induction (KNIGHT & BROWNING 1986). The application of ethephon mostly thins apple fruitlets while the growth of the remaining fruit, frequently, does not respond with an enhanced growth rate (EBERT & BENDER 1986, LINK 2000, STOPAR 2000). In the experiment we tried to combine the positive effect of both growth regulators: application of ethephon a few times in a low concentration to enhance the return bloom and not to thin the fruitlets, and the use of CPPU for the enhancement of fruit growth on the high loaded trees.

Material and methods

Eight years old 'Golden Delicious'/M.9 apple trees were selected according to high bloom density and homogeneous growth vigor. In the field trial a standard randomized block design with six replications and a single tree per plot were used.

Successively, ethephon and CPPU were applied at weekly intervals and the first spraying of both agents started at petal fall (PF) time. The treatments were as follows:

- 1) Control – no thinning
- 2) Hand thin (done just after the June drop time)
- 3) CPPU 1x5 ppm = 5 ml Sitofex (SKW, Trostberk, Germany) / L water;
- 4) Ethephon 3x30 ppm = 0.06 ml Ethrel (Chromos, Zagreb, Croatia) / L water
- 5) Ethephon 5x50 ppm = 0.10 ml Ethrel / L water
- 6) Ethephon 3x30 ppm + CPPU 1x5 ppm;
- 7) Ethephon 5x50 ppm + CPPU 2x5 ppm;

The spraying was done with a hand sprayer to the point of drip. No surfactant was used. When ethephon was combined with CPPU spraying, first, ethephon was applied and an hour later, after the leaves were dry, CPPU was applied. At maturity time the fruit was harvested, counted, weighed and graded into two size classes, < 68 mm and > 68 mm fruit diameter. Phytotoxic effect on trees was estimated a month after spraying with a visual scale (1 = no effect observed, 5 = suppressed shoot growth, bigger and wrinkled leaves with yellow green spots, more transparent crown). The return



bloom was estimated visually next spring at bloom time using the scale 1-10 (1 = no flower clusters present on the trees; 10 = abundant flowering). During the experiment the trees received standard pest and disease management program. Data were subjected to statistical analysis using the statistical program Statgraphics 5.0 (STSC, Rockville, USA).

Results and discussion

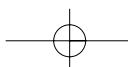
The single PF application of CPPU 5 ppm significantly reduced the final fruit set (Table 1) and increased the fruit growth to satisfy the commercial demand for 'Golden Delicious' apples (Table 2). When GREENE (2001) sprayed CPPU 8 ppm on 'McIntosh' at PF he got no thinning effect while a week later spraying thinned the trees appropriately. STOPAR (1999) did not observe an enhanced fruit drop of small fruited apple cultivars 'Jonathan', 'Elstar' and 'Gala' when CPPU 5 ppm was sprayed a week after PF. It looks that CPPU is not a thinner with a consistent fruitlet abscission response if sprayed either at PF or a week later. In this trial the return bloom after CPPU 5 ppm single spraying was not influenced too.

Table 1: The number of flower clusters at the start of the experiment, the final fruit number and the return bloom of 'Golden Delicious/M.9' apple trees after the application of thinning agents.

Treatment *	Flower clusters (No./tree)	Fruit (No./tree)	Fruit (No./100 clusters)	Return bloom (1-10)**
1) Control	191 a	142 cd	74 b	3,17 ab
2) Hand thin	219 a	101 bcd	47 a	1,83 a
3) CPPU 1x5 ppm	223 a	74 ab	33 a	4,0 ab
4) Ethephon 3x30 ppm	190 a	148 d	83 b	1,93 a
5) Ethephon 5x50 ppm	215 a	96 bc	44 a	4,38 ab
6) Ethephon 3x30 ppm + CPPU 1x5 ppm	221 a	76 ab	34 a	4,67 b
7) Ethephon 5x50 ppm + CPPU 2x5 ppm	196 a	42 a	22 a	4,00 ab

Table 2: Total yield, yield of commercial (> 68 mm) fruit, mean fruit weight and the effect on phytotoxicity after the application of thinning agents on 'Golden Delicious/M.9' apple trees.

Treatment *	Yield (Kg/tree)	Fruit > 68mm (Kg/tree)	Fruit weight (g)	Phytotoxicity (1-5)**
1) Control	16.0 b	5.5 ab	115 a	1,0 a
2) Hand thin	12.7 ab	8.4 ab	125 a	1,0 a
3) CPPU 1x5 ppm	10.9 ab	8.7 ab	161 b	2,2 b
4) Ethephon 3x30 ppm	15.5 b	4.5 a	106 a	1,0 a
5) Ethephon 5x50 ppm	10.8 ab	4.2 a	110 a	1,2 a
6) Ethephon 3x30 ppm + CPPU 1x5 ppm	12.7 ab	11.2 b	174 b	2,0 b
7) Ethephon 5x50 ppm + CPPU 2x5 ppm	7.2 a	6.8 ab	169 b	4,0 b



Application of ethephon 3x30 ppm did not affect the fruit set, yield or fruit growth of 'Golden Delicious', while spraying of ethephon 5x50 ppm reduced the fruit set but did not enhance the fruit growth (Table 1,2). None of the ethephon alone treatments affected the return bloom in this trial significantly. The combination spraying of ethephon 3x30 ppm + CPPU 5 ppm reduced the fruit set and enhanced the fruit growth while the return bloom was not increased, i. e. all similar effects as those which happened after a single CPPU 5 ppm spraying. A stronger combination of both regulators (ethephon 5x50 ppm + CPPU 2x5 ppm) induced the overthinning of 'Golden Delicious' trees. The fruit growth was enlarged but the yield of bigger size fruit was not increased because the fruit was not numerous. A very similar overthinning occurred when CPPU 5 ppm was combined with ethephon 3x70 ppm (PF + weekly intervals) on the cultivar 'Elstar' (STOPAR 1998). In spite of overthinning the return bloom was not increased. This can be speculated as a diminishing effect of CPPU on the return bloom observed by GREENE (1989) and CURRY & GREENE (1993).

A month after spraying the phytotoxic effect of treatments was estimated on trees. A week shoot growth, fewer but bigger leaves with green yellow spots and wrinkled surface were observed on CPPU treated crowns (Table 2). This phytotoxic effect was more pronounced on crowns on which CPPU was applied twice and the effect remaining on trees until harvest.

Spraying of 'Golden Delicious' with CPPU 5 ppm at PF thinned trees in our experiment, however, bearing in mind CPPU trials reported by others no consistent thinning response was observed. If a weak phytotoxic CPPU 5 ppm effect is taken into consideration, no recommendation should be given to apple growers for the use of CPPU. For a more complete understanding of CPPU action the concentration and time response studies should be done on different apple cultivars.

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