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Chemical Stimulation of Branching in Deciduous Tree Fruit Nursery Stock with Ethyl 5-(4-chlorophenyl)-2H-tetrazole-2-acetate[1]

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Additional index words. apical dominance, *Malus domestica, Pyrus communis, Prunus avium,* apple, pear, sweet cherry

Abstract. **Ethyl 5-(4-chlorophenyl)-2H-tetrazole-2-acetate (PP528) applied in early summer to apple (*Malus domestica* Borkh.) and pear (*Pyrus communis* L.) trees stimulated lateral branching the first year in the nursery. Concentrations of 25 to 50 ppm were effective, while 100 ppm or more sometimes killed shoot terminals and stopped or retarded further vertical growth for the season. Branch angles were not measured, but when terminal meristems were not killed, branch angles were wide. If terminal meristems were killed, the uppermost branch angles were narrow. Double applications 2 weeks apart of 25 or 50 ppm were sometimes more effective than single applications. Timing, uniformity of growth, and application during active growth were important to produce maximum branching effect and branching in suitable locations. PP528 caused more branching in 2 non-spurred 'Delicious' apple cultivars (up to 9 times control values) than in 'Oregon Spur Delicious' (up to 3 times the control). Treatments with up to 200 ppm were largely ineffective on sweet cherry (*Prunus avium* L.). Use of 100 or 250 ppm GA was of little benefit in overcoming the stunting effect of high concentrations of PP528.**

In today's intensively managed orchards, early yields are highly desirable. One reported method to secure early production is the use of well-feathered (branched) maiden trees which not only provide a sound framework of branches but also flower and fruit sooner than unfeathered trees (11, 17).

Nursery trees vary in natural branching tendency. Many produce few or no branches, while others produce well-branched trees the first year in the nursery. Branching varies with species, cultivar, rootstock, climate, cultural practices, and propagation techniques (1). Chip-budded trees branch more than T-budded trees (5). Peaches and apricots usually branch readily, while many apple cultivars do not. Conditions that produce vigorous growth promote branching.

Some branching can be stimulated by manual removal of the shoot tips during the growing season; however, this usually stimulates formation of only 2 to 3 narrow-angled branches near the point of decapitation (Fig. 1a).

Chemical pruning agents offer a potentially less expensive and more effective alternative to hand pruning for the production of branched nursery trees. Cytokinins overcome apical dominance (14, 15) and other chemicals specifically stimulate lateral bud growth (2, 6, 8, 10, 18). A few chemicals stimulate branching of fruit trees in the nursery and in the early years in the orchard (1, 3, 4, 7, 9, 12, 13, 16, 18).

This paper reports the results of the use of an experimental chemical, PP528, for stimulating branching of apple, pear, and sweet cherry trees during the first year in the nursery.

Materials and Methods

In 1976 and 1977, the top 25 to 30 cm of the scion shoots of first-year apple, pear and cherry trees growing on seedling roots in commercial nurseries in Yakima and Wenatchee, Washington were sprayed to runoff when the scions were 45 to 60 cm high; some plots were resprayed 2 weeks later. X-77 (principal functional agents: alkylarylpolyethylene glycols, free fatty acids, isopropanol) at 0.1% was used as a surfactant. Treatment dates were June 24 and July 7, 1976 and June 15 and 30, 1977. On the last treatment date in 1977, some plots were also sprayed with 100 or 250 ppm GA_3 to see if GA would reduce the stunting noted from some levels of PP528 in 1976. PP528 was used between 50 and 200 ppm in 1976. These concentrations appeared excessive and were lowered to 25, 50, or 100 ppm in 1977. Plots included 3 to 5 trees with 3 replications of each treatment. Just before digging in November, the trees were measured and lateral branches 3 cm or longer were counted. Trees with normal nursery growth were planted in commercial orchards and developed normally. Those stunted in the nursery were discarded.

Results and Discussions

For brevity, only data from 1977 are included (Table 1). In 1976, 'Anjou' and 'Bartlett' pear and 'Wellspur Delicious,' 'Oregon Spur Delicious,' and 'Winter Banana' apple trees

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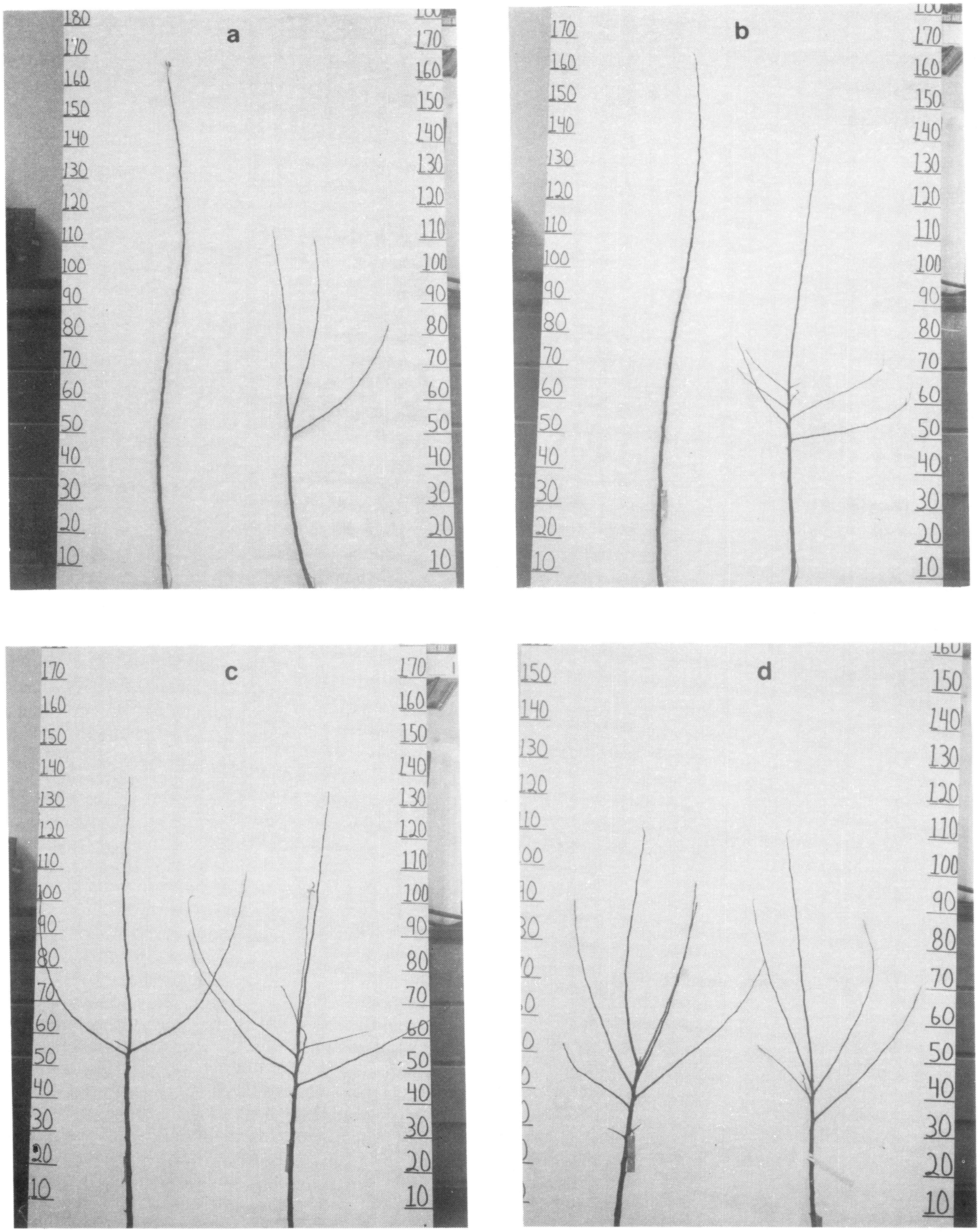

Fig. 1. Effects of PP528 sprays on first-year nursery trees of 'Real McCoy Delicious' Photographed November, 1977. a) Left: control; right: hand tipped June 15, 1977. b) Left: sprayed with 25 ppm June 15, 1977; right: sprayed with 25 ppm June 15 and 30, 1977. c) Left: sprayed with 50 ppm June 15, 1977; right: sprayed with 50 ppm June 15 and 30, 1977. d) Left: sprayed with 100 ppm June 15, 1977; right: sprayed with 100 ppm June 15 and 30, 1977. Terminal meristems killed in both treatments. Note more narrow branch angles than with lower concentrations (b, c) where terminal meristems were not killed.

responded with significant wide-angled branching compared to untreated or hand-tipped trees. However, terminal meristems were killed on 'Oregon Spur Delicious' and 'Winter Banana' trees sprayed with more than 50 ppm PP528, and the trees were severely stunted. Following treatments of 100 to 200 ppm, 'Rome Beauty' apple trees branched significantly more than the control; two applications of 100 ppm produced 12 branches, compared to 6 for the control. Terminal meristems were not killed on 'Rome Beauty,' and tree height was unaffected. 'Van' cherry did not respond to any treatment.

Table 1. Effects of PP528 on branching and on increase of tree height in first-year nursery trees of apple and pear. Sprays applied June 15 and 30, effects evaluated November 1977.[z]

Species and cultivar	Strain	Hand[y]	PP528 0 ppm	50 ppm 1 trt	50 ppm 2 trt	100 ppm 1 trt	100 ppm 2 trt
			No. branches per tree				
Apple, Delicious	Real McCoy	3.3bc	0.1a	3.1b	5.6bc	7.8c	5.8bc
	Early Red One	1.8ab	0.1a	6.3bc	8.2c	3.0ab	4.3bc
	Oregon Spur	1.7ab	0.0a	2.1ab	2.9b	2.3ab	2.2ab
Red Rome	Barkley	5.1a	9.4a	11.0ab	15.8b	10.0a	11.9ab
Golden Delicious	---	3.1a	1.9a	2.2a	7.1b	6.8b	8.1b
Pear, Bartlett	---	3.7a	3.0a	4.3a	5.6a	6.0a	7.1a
			Increase in tree height (cm)				
Apple, Delicious	Real McCoy	84bc	111d	93cd	70abc	64ab	57a
	Early Red One	77bc	92c	66bc	56ab	61ab	37a
	Oregon Spur	30ab	51b	34ab	36ab	29ab	16a
Red Rome	Barkley	94a	103ab	108b	108b	91a	103ab
Golden Delicious	---	49a	82bc	92c	89c	73abc	54ab
Pear, Bartlett	---	70b	109a	87ab	93ab	87ab	82ab

[z]Mean separation within cultivars and responses by Duncan's multiple range test, 5% level.

[y]Branches resulting from hand tipping had narrow angles.

In 1977, 'Bartlett' pear and 'Golden Delicious,' 'Early Red One Delicious,' 'Real McCoy Delicious' (Fig. 1), 'Oregon Spur Delicious' and 'Rome Beauty' apple trees all responded with significant wide-angled branching following 1 or more treatments. 'Rainier' cherry did not respond at all. The most effective treatment on 'Oregon Spur Delicious,' 'Early Red One Delicious' and 'Rome Beauty' apples was 2 applications of 50 ppm PP528. While not the most effective on 'Real McCoy Delicious' and 'Golden Delicious' this treatment did significantly stimulate branching. With 'Bartlett' pear, the increase was not significant.

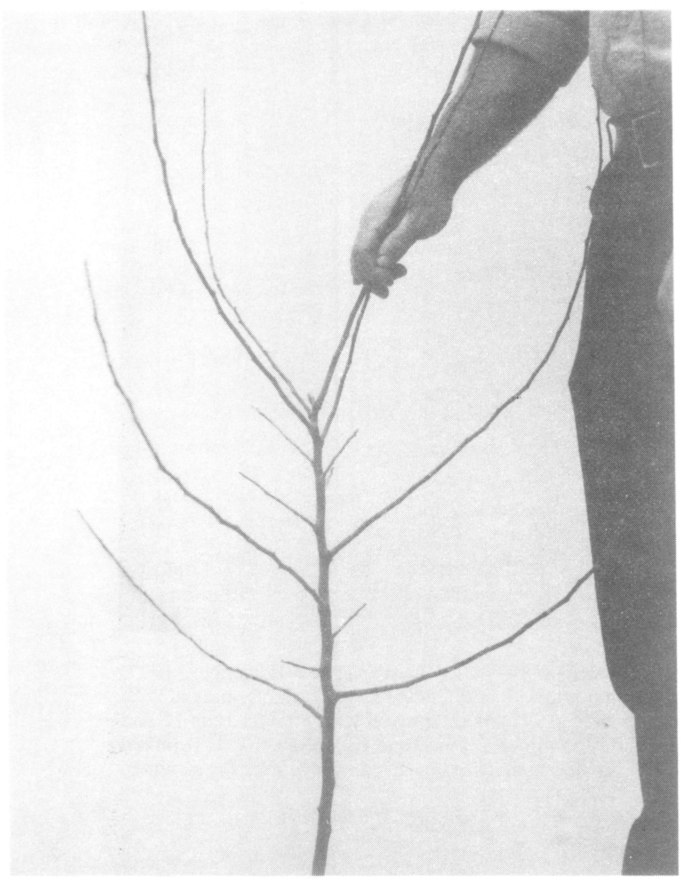

Fig. 2. Good branching on a 1-year nursery tree of 'Early Red One Delicious' sprayed June 15 with 50 ppm PP528. Note presence of killed terminal meristem in center of tree without stunted tree growth. Also, note more narrow angles on upper branches as compared to others. Photograph taken November, 1977.

Terminal meristems were killed on 'Early Red One Delicious' apple with concentration of 50 to 100 ppm (Fig. 2), on 'Real McCoy Delicious' apple at 100 ppm (Fig. 1d) and on 'Oregon Spur Delicious' apple with more than one application of 25 ppm. Death of the terminal meristems did not necessarily cause stunting (Figs. 1 and 2). Where trees branched and continued growth without stunting, even though terminal meristems were killed, stem caliper was not reduced. If terminal meristems were killed and branches subsequently developed, the angles of the uppermost branches were more narrow than desired (Fig. 1d). Tree height was usually somewhat reduced (except with 'Rome Beauty' apple) in response to branching, as might be expected, since growth was directed into several growing points rather than one. Double applications of PP528 at 2-week intervals were sometimes more effective than a single treatment (Fig. 1).

While some *Prunus* spp. branch readily without mechanical or chemical treatment, 2 sweet cherry cultivars treated with PP528 did not respond to the concentration used. Sweet cherry, however, did not respond to even a 10% concentration of Off-Shoot-0 (10).

Cultivars such as 'Rome Beauty' apple, which usually branch readily without treatment, may or may not respond to PP528 as demonstrated here (response in 1976, but little in 1977), probably depending on factors already mentioned. Terminal meristems were not killed on 'Rome Beauty', even at PP528 concentration 4 times those needed to kill terminals on other apple cultivars, and tree height was not reduced even when significant branching increases were produced. Marked variability in cultivar response to PP528 has been noted by others (4, 7, 16).

Variability in plant size and vigor at treatment time was a factor in this experiment, for large differences in mean number of branches were sometimes not statistically significant. The most vigorous trees were most responsive. This can be related to weather and cultural practices which affect vigor, and is complicated by the inherent vigor of the cultivar and rootstock.

Spurred types of 'Delicious' apple did not respond as readily as standard types. Spurred types produced no branches on controls, 1 or 2 on hand-tipped trees and up to 5 branches with some PP528 treatments. In 1977, where both spurred and standard types were compared, the standard types ('Real McCoy' and 'Early Red One') produced 2 or 3 times as many branches as 'Oregon Spur'. This is apparently related to the inherent vigor of these types, because spur and standard types manifest size and vigor differences even in the nursery.

Trees should be sprayed when they reach the approximate height where the lowest branches are desired; if terminal meristems are not killed, most branching occurs above the height of the main shoot terminal at the time of treatment. If spraying is delayed, branches will be too high.

This experiment shows that PP528 may be used to produce one-year-old branched nursery trees. However, optimum concentration and timing vary with each cultivar and rootstock. Some cultivars may not respond favorably to any treatment. The results will also vary with the stage of growth, plant uniformity and vigor and with weather and cultural practices which affect vigor.

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Preharvest Foliar Desiccation and Onion Storage Quality[1]

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Additional index words. Allium cepa, phenolic compounds, neck moisture, storage rots, sprouting, paraquat, endothall, ethephon, stoddard solvent

Abstract. **Several compounds were used to desiccate tops of onion (*Allium cepa* L.) prior to harvest. Most chemicals at various rates and timings caused an increase in postharvest disease and sprouting. Endothall at 1.1 kg active ingredient/ha had storage losses comparable to the control. Paraquat substantially elevated storage decay at all rates, but there was less increase from Ethephon and Stoddard Solvent. Disease in storage was not correlated with neck moisture as affected by spray treatments. Phenolic concentration in neck tissue studied for several treatments was weakly and negatively correlated with subsequent disease in storage.**

Postharvest losses are common in stored onions (7, 17). Preharvest foliar desiccation theoretically could reduce disease in storage by reducing field curing time and exposure to rains. Also, the migration of pathogens into the bulb might be stopped by rapidly reducing foliage and neck moistures. In practice, desiccation treatments have often increased storage losses due to disease. Isenberg and Abdel-Rahman (6), Pendergrass, et al. (11), and Richardson et al. (12) found that desiccation produced drier necks and foliage in a shorter period of time than conventional field curing. However, in all these cases, there were higher storage losses in the desiccant treatments. Böttcher et al. (3), Rickard and Wickens (13), and Zschau and Böttcher (18) all found a similar increase in disease loss with the use of desiccants; whereas Stow's (14) results were inconclusive. Böttcher et al. (3) noted a great increase in disease from desiccants if the onions received rain prior to storage. Root and shoot sprouting were increased in storage in several desiccant experiments (2, 14).

Top desiccation, however, offers some important cultural benefits. Maturity may be manipulated with desiccants to allow more efficient harvest scheduling (3). Desiccation reduces the volume and moisture content of field debris for better operation of harvest machinery (6, 13) and a reduction in the amount of debris moved into storage (13). Thus, the field advantages have encouraged additional research on compounds

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