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Stimulation of Leaf Abscission of Tree Fruit Nursery Stock With Ethephon - Surfactant Mixtures[1]

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Abstract. Combinations of ethephon and D-WK (Dupont-WK) surfactant were effective in stimulating leaf abscission of 20 cultivars in 5 species of tree fruit nursery stock. Species and cultivars varied considerably in sensitivity to mixtures of these chemicals, but 1 to 3 applications at weekly intervals of 200 to 400 ppm ethephon + 1 to 2% D-WK were generally effective. These treatments caused little xylem, phloem, or bud damage except to 'Early Redhaven' peach and 'Early Italian' prune. 'Rome' apple was sensitive but was not damaged by concn of 200 ppm ethephon + 1% D-WK. D-WK stimulated leaf abscission when used alone at 1 to 2% but acted more slowly than when combined with ethephon. Ethephon alone at 200 to 400 ppm was usually relatively ineffective.

Interest in chemicals for nursery stock defoliation has been previously indicated (4, 8, 11, 12, 13). Ethephon [(2-chloroethyl)phosphonic acid] has been suggested for nursery stock defoliation (5, 7, 9). The role of ethylene in leaf abscission (1, 2, 3) and the ethylene-producing capacity of ethephon (14) has also been discussed. It has been reported that 2000 ppm ethephon + 2% mineral oil produced greater leaf abscission of nursery stock than 2000 ppm ethephon alone (6).

Other workers have suggested that 2000 ppm or more ethephon was necessary for defoliation of nursery stock (5, 6, 7). Previous trials by the writer showed that 1 to 3 applications of 500 to 2000 ppm of ethephon were necessary for nursery defoliation of several tree fruit cultivars (9), but such concn sometimes resulted in bark or bud damage (10). Further experimental work in 1970 and 1971 showed that these concn could be substantially reduced and more rapid defoliation could be obtained by combining 1 to 2% D-WK surfactant (Dupont-WK surfactant with the principal functioning agent being the dodecyl ether of polyethylene glycol) with the ethephon spray. We report the effectiveness of ethephon - D-WK mixtures for defoliation.

Materials and Methods

Ethephon (68-240 acid formulation) and D-WK surfactant were applied alone and in various combinations as sprays during October of 1970 and 1971 at commercial nurseries in central Washington (Hanford area, Quincy, Wenatchee, Brewster) and at the Washington State University Royal Slope Experimental Unit. Sprays were applied to runoff using hand operated trombone sprayers. In 1970, single, double, and triple applications were made at weekly intervals starting October 8 to duplicate plots of 3 or more plants each (0.6 to 1.0 m of row for stoolbeds or seedlings) on 8 apple, 1 pear, and 1 prune cultivar. Concentrations of 500 and 750 ppm ethephon + 2%

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D-WK were used. In 1971, similar applications were made, but at lower chemical concn than in 1970 (Table 1), to 8 apple, 1 peach, 1 prune, and 2 cherry cultivars and to domestic apple and pear seedlings.

The percentage leaf abscission was determined at weekly intervals following treatment until the plants were dug and stored by the nurserymen. Following winter storage, the plants were replanted at the Royal Slope Experimental Unit for observation. Plants originally treated at the latter location were over-wintered in the field. Limited commercial-size trials were made to provide further information.

For the sake of brevity, the 1970 data and part of the 1971 data are omitted.

Results and Discussion

Combinations of ethephon and D-WK surfactant produced faster, more complete leaf abscission than either material alone at the concn tested in 1970. Complete defoliation was achieved with most cultivars using no more than 500 ppm ethephon + 2% D-WK where 1000 to 2000 ppm ethephon had been required for similar effects when used alone in 3 previous years' work. However, it appeared that still lower concn of both chemicals would be effective on many cultivars.

The mixtures of reduced concn used in 1971 were effective, but ethephon used alone was usually nearly ineffective. D-WK used alone was effective but acted more slowly than in combination with ethephon (Table 1). While not all the data are shown, 3 applications of 200 ppm ethephon + 1% D-WK produced nearly 100% leaf abscission on 'Jonathan' apple and 'MM 106' apple stoolbed within 1 week of the last application. An additional week was required for similar effects on 'Bing' and 'Lambert' cherry, 'Early Italian' prune, 'MM 104' and 'MM 111' apple rootstock, 'Earlistripe Delicious', and 'Goldspur' apples. A total of 3 weeks beyond the last treatment was required for defoliation of 'Winesap' and 'Rome' apples. Domestic pear seedlings were nearly 100% defoliated after 3 weeks but required 200 ppm ethephon + 2% D-WK. Domestic apple seedlings were only 88% defoliated with 400 ppm

Table 1. Percent[z] leaf abscission promoted in the nursery by ethephon – Dupont-WK mixtures in relation to each chemical used alone on deciduous tree fruit nursery stock, 1971.

Cultivar, evaluation date	Oct. cation date	Ethephon (ppm) 0	200	400	0	0	0	200	200	200	400	400	400
		D – WK (%) 0	0	0	1.0	1.5	2.0	1.0	1.5	2.0	1.0	1.5	2.0
Jonathan apple (10/28/71)	7	0a	0a	0a	74b	96c	99c	98c	99c[y]	99c[y]	98c[y]	99c[y]	99c[y]
	7,14	0a	0a	0a	85b	98c	98c	99c[y]	99c[y]	98c[y]	99c[y]	99c[y]	99c[y]
	7,14,21	0a	0a	0a	87b	97c	96c	99c[y]	99c[y]	97c[y]	99c[y]	99c[y]	99c[y]
	14,21	0a	0a	0a	3a	10b	22d	18c	57f	28e	68g	78h	67g
	14	0a	0a	0a	0a	0a	10c	7b	10c	12c	12c	10c	15d
Earlistripe Del. apple (10/28/71)	7	0a	0a	0a	5ab	10bc	15c	55d	63e	68e	55d	63e	88f
	7,14	0a	0a	0a	10b	13b	23c	58d	70f	80g	65e	83g	97h
	7,14,21	0a	0a	5b	15c	25d	33e	63f	84g	90h	84g	92h	99i
	14,21	0a	0a	0a	5a	5a	5a	15b	30c	20b	30c	35c	20b
	14	0a	0a	0a	0a	0a	0a	0a	5a	3a	3a	5a	3a
Goldspur apple (10/28/71)	7	0a	0a	0a	5a	30b	68d	45c	85f	85f	78e	85f	99g
	7,14	0a	5ab	5ab	13b	43c	75e	58d	95f	99f	97f	97f	100f
	7,14,21	0a	10b	10b	23c	78d	93e	80d	98f	100f	98f	99f	100f
	14,21	0a	0a	5a	3a	15b	23c	33d	48e	63f	80g	85g	68f
	14	0a	0a	0a	0a	5b	8bc	8bc	10c	23d	10c	40e	23d
MM 106 apple stoolbed (10/28/71)	7	0a	0a	3a	15b	35c	89d	94e	94e	99f	95ef	97ef	98ef
	7,14	0a	7ab	10b	22c	58d	97e	96e	96e	99e	99e	99e	100e
	7,14,21	0a	7a	15b	25c	76d	98e	98e	99e	100e	99e	100e	100e
	14,21	0a	5ab	5ab	10b	21c	21c	68ef	67e	50d	73f	87g	83g
	14	0a	0a	0a	5b	13c	13c	33d	40e	32d	50f	58g	67h
MM 111 apple stoolbed (10/28/71)	7	0a	0a	0a	0a	0a	10b	10b	52d	73e	22c	57d	83f
	7,14	0a	5a	5a	5a	13b	20c	30d	83f	88f	55e	97g	99g
	7,14,21	0a	8a	8a	8a	20b	47c	55c	90de	98ef	82d	99f	99f
	14,21	0a	0a	0a	5a	8a	13b	40c	42c	81d	48c	73d	76d
	14	0a	0a	0a	0a	0a	5a	13b	20bc	23c	17bc	40d	47d
Domestic pear sdlg. (11/11/71)	7	5a	5a	5a	10b	12cd	12cd	10b	12cd	13d	10b	15e	15e
	7,14	5a	5a	7a	13b	20c	25d	17b	22c	25d	20c	22c	42e
	7,14,21	5a	7a	10a	18b	43e	58f	27c	65g	95h	35d	73g	97h[x]
	14,21	5a	5a	7a	12ab	23c	38d	18bc	25c	68e	18bc	42d	80f
	14	5a	5a	5a	10b	10b	12c	10b	10b	13c	10b	12c	18d
Bing cherry (10/28/71)	7	32a	50b	52bc	53bc	68cde	60bcd	68cde	87fg	90g	77def	87fg	90g
	7,14	32a	53b	58bc	63bcd	72cde	61bcd	78def	93fg	96g	82efg	97g	98g
	7,14,21	32a	65b	65b	68b	75bc	75bc	79bc	97d	97d	83c	97d	98d
	14,21	32a	43ab	57bc	47ab	52b	45ab	68cd	83de	83de	73cd	90e	82de
	14	32a	40ab	47abc	40ab	47abc	47abc	52bc	70de	75de	62cd	83e	77de
Early Italian prune[w] (10/28/71)	7	15a	38b	57c	50bc	57c	75d	84de	84de	91e	84de	92e	92e
	7,14	15a	52b	75d	55b	68c	83e	92f	93f	96f	93f	95f	98f
	7,14,21	15a	60b	82d	55b	73c	87d	94e	98e	99e	94e	98e	99e
	14,21	15a	20ab	20ab	28b	45c	45c	55cd	55cd	68ef	60de	78fg	82g
	14	15a	15a	15a	18a	37b	37b	50c	57cd	62de	50c	68e	68e

[z]Figures based on 3 plots of 3 or more plants each or 0.6 to 1.0 m of row for seedlings and stookbeds. Figures on a given line followed by the same letter are not significantly different at the 5% level.

[y]This level of defoliation was reached on e week earlier.

[x]About 1 inch damage to some seedlings.

[w]All treatments except single applications of 1% D-WK alone and 200 ppm ethephon + 1% D-WK applied on 10/14 appeared excessive on prune as evidenced by poor growth after replanting.

ethephon + 2% D-WK 3 weeks following a third application. 'Early Redhaven' peach was 98 to 100% defoliated within 1 week of a single treatment of any concn of D-WK alone or with ethephon. The apple and pear seedlings did not respond as readily as the other stock, presumably because they were growing in an area which had no frosts until the last week of October; in the other locations frosts occurred shortly after the first treatment (Oct. 7). Past experience has shown that the response to defoliants is more rapid after one or more light frosts. Faster abscission was usually produced by mixtures of 400 ppm ethephon + 1.5 to 2.0% D-WK than at lower concn (Table 1). In some cases, 1 or 2 applications of these concn would be sufficient.

Discolored xylem tissue extending as far as 5 cm from the tip of the main terminal shoot was noted before digging on some trees of 'Rome' apple and 'Early Redhaven' peach treated with the higher concn. Further damage on these cultivars was noted after storage and replanting as evidenced by partial main terminal and lateral shoot tip dieback on some trees. With few exceptions, peach was damaged by the treatments used, but much lower concn might be effective in stimulating abscission, hopefully without damage. Mixtures with concn higher than 200 ppm ethephon + 1% D-WK caused excessive shoot damage on 'Rome' apple, and mixtures with 400 ppm ethephon caused excessive shoot damage on 'Winesap' apple. Considerable main terminal shoot damage was noted on 'Early Italian' prune after replanting as evidenced by shoot dieback. Mixtures of 200 ppm ethephon + 1% D-WK applied on 10/14 or single applications of D-WK alone caused no damage to this cultivar. Slight main terminal shoot damage occurred on some pear seedlings with 3 applications of 400 ppm ethephon + 2% D-WK.

D-WK rapidly penetrates the leaf causing a translucent appearance of some tissue. A 3% concn sometimes causes patches of necrotic tissue or entire leaf necrosis. In a few days, depending on the treatment, patches of yellow pigment appear and the leaves usually have a mottled yellow-green appearance by the time they fall. In addition to leaf injury caused by D-WK which stimulates the abscission process, it probably aides penetration of ethephon, producing greater abscission from a given ethephon concn than would otherwise be possible.

Past experience indicates that commercial sprays applied with a tractor-mounted boom will cause less damage than in experimental plots, since application rates can be adjusted to cover the leaves sufficiently without completely saturating buds and stems.

While caution must be exercised to select optimum rates for each cultivar, our evidence indicates that a combination of ethephon and D-WK surfactant can be used effectively on many cultivars. This conclusion was substantiated by limited commercial trials. Variation in results will occur from year to year as a result of environmental conditions (i.e., temp, soil moisture, precipitation) and condition of the stock (i.e., nutrition, presence or absence of buds at shoot tips, lignification).

If the ethephon concn used here in combination with D-WK can be used commercially as suggested, the costs will be more reasonable than for the ethephon concn previously proposed (5, 7, 9), and the danger of adverse carryover effects may be less. D-WK could be used alone for defoliation of many cultivars if a response less rapid than that obtainable from an ethephon-D-WK mixture is acceptable. Our work suggests that careful consideration must be given to the kind and amount of adjuvant used with nursery defoliants.

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