color and flesh firmness of 'Idared' apples. The effect of Alar in this regard is well known on many cultivars (3). In contrast, CCC did not affect these fruit characteristics despite higher levels of application.

These results indicate that CCC does not directly influence any fruit characteristics; its effects are confined to a retardation of vegetative growth and possibly a promotion of fruit bud formation (1,2,7). Further trials on these and other cultivars are necessary to confirm or contradict this trend.

*Table 3.* Effects of midsummer applications of CCC and Alar on the harvest and storage quality of 'Idared' apples.

| Treatment | Conc. (ppm) | Fruit count | Fruit weight (g per apple) | Flesh firmness (lbs) 11/4/67 | Flesh firmness (lbs) 3/21/68 | Soluble solids (%) 11/4/67 | Soluble solids (%) 3/21/68 |
|---|---|---|---|---|---|---|---|
| Control | | 134 | 201 | 16.1 | 12.1 | 13.8 | 13.3 |
| Alar | 1,000 | 151 | 182* | 17.3* | 11.9 | 14.1 | 13.5 |
| CCC | 1,000 | 139 | 195 | 15.9 | 12.2 | 13.5 | 13.0 |
| CCC | 5,000 | 176 | 195 | 16.1 | 11.4 | 13.7 | 12.9 |
| DSD 5% | | NS | 12 | 1.1 | NS | NS | NS |

*Significantly different from control by Dunnett's test.

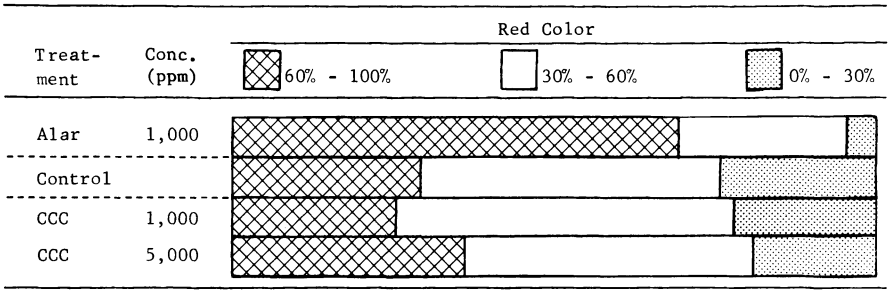


*Fig. 3.* Effects of midsummer applications of CCC and Alar on red color of 'Idared' apples.

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# Effects of Succinic Acid 2, 2-Dimethylhydrazide (Alar) on Bloom Delay and Fruit Development of Delicious Apples[1]


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*Abstract.* Alar applied at the rate of 4000 ppm to 'Delicious' apple trees in the fall delayed bloom the following spring four to five days and increased fruit set. At harvest, the fruits were smaller, less elongated, had more advanced ground color and expressible juice. Fruit diameter, over color, flesh color, soluble solids, and respiration rate were not affected.


In apple areas subject to late spring frosts, orchard heating is a necessary and expensive orchard practice. Limited reports indicate that succinic acid 2, 2-dimethylhydrazide (Alar) may be useful in retarding bloom (1, 5). Although only a few days' bloom delay has been reported, this may reduce the need for orchard heating. The purpose of this experiment was to determine bloom delay of 'Richared Delicious' apples and the subsequent development of fruits following fall application of Alar.

Eight 21-year-old 'Richared Delicious' trees at New Mexico State Agricultural Experiment Station were selected for treatment in the fall of 1967. Six branches in each tree were tagged and Alar was applied at the rate of 4000 ppm to three of the branches on September 18.

Bloom delay was determined by recording, on March 25, March 30, April 4, and April 9, the number of spurs in which the majority of buds were in the green tip, pink, full bloom, and petal fall stages. Each branch contained at least 150 flowering spurs with an average of 250. Fruit length and diameter and fruit set were determined on June 16. All trees had a very heavy set and were hand-thinned following fruit set counts.

On August 27, all of the apples from each branch were harvested and sized according to the following criteria: less than 2½", 2½" to 2¾", and greater than 2¾". Because of the small number of apples in the largest size group, fruit characteristics were determined on only the two smaller sizes.

The results indicate that Alar applied in the fall delayed bloom the following spring four to five days (Table 1). Between March 30 and April 9, buds on Alar-treated branches were in a more


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*Table 1.* Influence of September 1967 application of 4000 ppm of Alar on bloom of 'Delicious' apple trees in 1968.

| Date | Treatment | Distribution of spurs (%) | | | |
|---|---|---|---|---|---|
| | | Green tip | Pink | Full bloom | Petal fall |
| March 25 | Control | 38 | 48 | 14 | 0 |
| | Alar | 60 | 38 | 2 | 0 |
| March 30 | Control | 0 | 22 | 78 | 0 |
| | Alar | 8 | 74 | 18 | 0 |
| April 4 | Control | 0 | 0 | 26 | 74 |
| | Alar | 0 | 8 | 76 | 16 |
| April 9 | Control | 0 | 0 | 0 | 100 |
| | Alar | 0 | 0 | 17 | 83 |

retarded stage of development than the control branches. Although four or five days is a small delay, some frost protection could be expected because buds in the pink and green tip stages may survive temperatures of 5 to 9°F lower than flowers in full bloom.

Fall applications of Alar resulted in a higher percentage of fruit set, smaller, less elongated fruit in June of the following season (Table 2). The effect of Alar on fruit size and shape may be in part indirect, since it may be presumed that a greater percentage of Alar apples developed from late opening flowers. Late blooms tend to produce apples that are smaller and less elongated (4). Also, the significant increase in fruit set on Alar branches may be a contributing factor in reducing fruit size.

Apples from Alar-treated branches were less elongated at harvest as indicated by the length/diameter ratios (Table 3). This difference resulted from reduced lengths since diameter measurements were not significantly different. Interactions between treatment and fruit size were significant for optical density and length.

Post-bloom sprays of Alar are generally considered to delay fruit maturity. One might expect post-harvest applications to delay maturity, especially when combined with bloom delay. The lower percent expressible juice content determinations in Alar-treated fruit indicated this to be true. Expressible juice content has been shown to be inversely correlated with firmness (3). On the other hand, ground color development was advanced by Alar treatment, but flesh color, as indicated by optical density measurements, was not affected. Alar treatment did not significantly affect soluble solids, respiration rate, or surface color. Fisher and Looney (2) reported flesh color, soluble solids, and titratible acidity to be unaffected by Alar treatment. Williams, et al. (6) found less scald on treated fruits, a condition generally associated with insufficient harvest maturity. The effect of Alar in decreasing scald and increasing ground color may be associated since the increase of yellow ground color is generally accompanied by a decrease in the severity of scald.

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*Table 2.* Influence of September 1967 application of 4000 ppm Alar on 'Delicious' fruits in 1968

| Treatment | Fruit measurements and set June 16 | | | | Percent apples harvested August 27 | | |
|---|---|---|---|---|---|---|---|
| | Length (mm) | Dia. (mm) | L/D | % Fruit set | <2½" | 2½ - 2¾" | >2¾" |
| Control | 28.0 | 27.5 | 1.02 | 42.2 | 55 | 34 | 11 |
| Alar | 24.1** | 25.0** | 0.96** | 49.7** | 71 | 27 | 2* |

* Significant at the 5% level
** Significant at the 1% level

*Table 3.* Influence of September 1967 application of 4000 ppm Alar on fruit characteristics of medium and small 'Delicious' apples at harvest August 27, 1968.

| *Fruit size* and treatment | Ground color[a] | Surface color % | Optical density | Length (cm) | Dia. (cm) | L/D | Juice % | Soluble solids % | Resp. rate[b] |
|---|---|---|---|---|---|---|---|---|---|
| *Medium* | | | | | | | | | |
| Control | 2.5 | 58 | 1.99 | 5.5 | 6.0 | 0.91 | 60.1 | 11.3 | 16.1 |
| Alar | 3.0* | 69 | 2.04 | 5.0* | 6.0 | 0.83** | 56.6** | 11.1 | 16.3 |
| *Small* | | | | | | | | | |
| Control | 2.5 | 49 | 2.17 | 4.5 | 5.3 | 0.85 | 59.3 | 11.2 | 16.6 |
| Alar | 3.0* | 60 | 2.13 | 4.5 | 5.5 | 0.81** | 56.4** | 11.0 | 16.3 |
| *Mean* | | | | | | | | | |
| Control | 2.5 | 54 | 2.08 | 5.0 | 5.7 | 0.88 | 59.7 | 11.3 | 16.4 |
| Alar | 3.0* | 65 | 2.09 | 4.8** | 5.8 | 0.82** | 56.5** | 11.1 | 16.3 |

* Significant at the 5% level
** Significant at the 1% level

[a]Based on USDA Ground Color Chart ranging from one to four with one denoting deep green color.

[b]mg $CO_2$/kg /hr 24 hours after harvest.