Research Reports

The Apple Fruitlet Thinning Response to Carbaryl is Unaffected by Russet

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Additional index words. fruit retention, Sevin, seed number, seed weight, fruit size

Summary. Russet is a disorder of apple (*Malus*×*domestica*) fruit where the formation of cork cells leads to a cosmetic blemish which is commercially undesirable. One of the many causes of russet is low temperature damage early in fruit development. Following frost damage to fruit, a study was initiated to determine whether carbaryl chemical thinner was more effective in thinning russeted fruit than nonrusseted fruit. With no chemical thinner application, russeted fruit abscised at a greater rate than nonrusseted fruit. Following the application of carbaryl to the fruit however, there was no difference in the retention of fruit among the treatments. Chemically thinning with carbaryl therefore is not a technique that growers could use to preferentially thin russeted fruit.

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Russet is a physiological disorder of apples characterized by cork formation over the epidermis following an environmental stress, such as frost. This undesirable characteristic usually results in fruit being culled or downgraded and can lead to significant economic losses to the fruit grower.

Early research (cited by Faust and Shear, 1972) found that cracking of the cuticle was the earliest step in the etiology of russet. Both cultural practices and environmental conditions can cause or exacerbate development of the disorder. Various pesticide applications can lead to the formation of russet (Creasy and Swartz, 1981) and high humidity and frequent rainfall are often associated with severe russeting (Creasy, 1980). Frost injury, particularly during bloom, frequently results in a band of russet around the equator of the fruit or patches of russet over the surface of the fruit (Simons, 1959). When such a frost event occurs, the fruit grower is usually faced with either hand thinning to eliminate damaged fruitlets or extensive sorting after harvest, both of which are labor intensive and expensive. Since russeted areas of fruit have a reduced amount of cuticular wax deposition above the epidermal cells (Vries, 1968), we hypothesized that this may allow increased absorption of chemical thinning materials, and thereby allow russeted fruit to be chemically thinned preferentially. This study was conducted to determine whether fruitlets russeted from frost damage were more responsive to chemical thinning applications than nonrusseted fruitlets, and therefore could be preferentially eliminated using a chemical thinning agent such as carbaryl.

Materials and methods

Studies were carried out on mature 'Empire' apple trees growing on Malling-Merton 111 (MM.111) rootstock near West Lafayette, Ind. Trees carried a light to moderate crop therefore no chemical thinners were applied to the orchard. A minimum temperature of 17 °F (–8 °C) was experienced for about 5 h duration just prior to bloom which resulted in a number of fruit exhibiting russet around the stem end of the fruit. Thirty days after full bloom, 50 russeted and 50 nonrusseted fruit were selected randomly down an orchard row and tagged. No attempt was made to select fruit from particular trees, and only spurs retaining a single fruit were selected. Twenty five fruit in each of these categories was treated with chemical thinner, while the other 25 received no treatment. Chemical thinner treatments consisted of two applications of Sevin XLR Plus (Rhone-Poulenc Ag Company, Research Triangle Park, N.C.) applied at a concentration of 1 qt/100 gal (1.0 $mL \cdot L^{-1}$ carbaryl) applied 30 and 47 d after full bloom directly to the fruit surface with a small brush. Direct application of carbaryl to young fruitlets has previously been shown to be highly effective in terms of thinning response (Knight, 1983; S.J. McArtney et al., unpublished data). At the first application date, the fruitlet diameters were 0.5 to 0.7 inches (14 to 18 mm), as determined by measuring the diameter of 50 randomly selected fruit. 'Empire' fruit are considered easy to thin, and carbaryl is active in thinning fruitlets up to 1 inch (25 mm) in diameter (Schwallier, 1996). Therefore the applications made in this experiment, both with regard to timing and rate, were within the range generally thought to cause thinning in this variety.

Tagged fruit were harvested during the commercial harvest period for this cultivar. Immediately following harvest, individual fruit were weighed, and the amount of russet on their surface estimated visually. The degree to which fruit were misshapen was estimated by placing the fruit, calyx end down, on a flat surface and measuring the deviation of the stem from a vertical orientation using a protractor. The number of seeds per fruit was counted and their fresh weight measured.

Table 1. The effect of russet and carbaryl on 'Empire' fruit characteristics at harvest.

Treatment	Fruit wt (g)[z]	Russet (% surface)	Misshapen[y]	No. seeds	Seed fresh wt/fruit (g)	Seed fresh wt/seed (g)
Control						
Check	106.9	0.2	5.0	5.4	0.337	0.064
Carbaryl	96.1	0	3.6	5.0	0.320	0.065
Russet						
Check	100.1	8.6	19.5	5.6	0.348	0.063
Carbaryl	89.7	10.9	28.1	4.1	0.251	0.059
P values						
Russet	0.091	<0.001	<0.001	0.579	0.384	0.057
Carbaryl	0.007	0.338	0.245	0.091	0.093	0.432
Russet × carbaryl	0.947	0.251	0.108	0.305	0.237	0.196

[z]1.0 g = 0.035 oz.
[y]Degrees deviation of longitudinal axis of fruit from vertical orientation.

Statistical analysis of fruitlet retention data were performed using analysis of variance using data transformed to the arcsin of the square root of the proportion fruit retained. Fruit characteristic analyses were performed using the GLM procedure of the Minitab statistical program (Minitab Inc., State College, Pa.).

Results and discussion

Fruit tagged as russeted at 30 d after bloom had about 10% of their surface area affected by russet at harvest (Table 1). This compares with only one fruit in those tagged as nonrusseted at 30 d after bloom affected by russet (5%) at harvest. Since the russet status of fruit did not appear to change over the course of the growing season, we can conclude that all russet was a result of events early in the growing season.

Fruit retention was significantly reduced by the chemical thinner carbaryl ($P < 0.01$, Fig. 1). Two applications of carbaryl reduced fruit retention from 100% in untreated, nonrusseted fruit compared to 75% in treated, nonrusseted fruitlets. In russeted fruitlets, the reduction caused by carbaryl was 11%, from 88% in non carbaryl treated fruit to 76% in fruitlets to which carbaryl was applied. After treatment with carbaryl, there was no difference in the proportion of fruit retained between russeted and nonrusseted fruit. The overall level of fruit thinning was mild compared with that commonly achieved commercially. This may have been due to the light crop load carried by these trees, or that most fruit on the tree, and all treated fruit, were borne singly on the spur. Carbaryl has been reported to be most effective at removing competing fruit within a spur (Way, 1967).

There was a trend for russeted fruit to abscise at a higher rate than nonrusseted fruit ($P = 0.10$). This provides some evidence that with no management intervention, the natural process of fruit drop would reduce the proportion of russeted fruit on the tree. According to Schwallier (1996), no more than half the spurs should be allowed to set fruit, to avoid biennial bearing. The level of natural fruit drop in this study, even with russeted fruit, was insufficient to provide such levels of fruit thinning. With higher crop loads, more naturally thinning (June drop) would be expected but it would still seem unlikely that this alone would reduce crops to an adequate level. There was no significant interaction between carbaryl and russet, although the trend was for russeted fruit to be less responsive to thinner applications ($P = 0.08$, Fig. 1).

The application of carbaryl reduced fruit size, both in russeted and nonrusseted fruit (Table 1). This reduction did not appear to be due to crop load effects, since the trees were carrying a light crop load and also carbaryl did not dramatically reduce fruit retention. It seems possible that the application of carbaryl may have stimulated the activity of competing sinks such as bourse shoots (as proposed by Knight, 1983) or by directly inhibiting fruit growth, which has not previously been reported. Alternatively, carbaryl may have inhibited photosynthesis in younger leaves, which is consistent with the results of Knight (1983) where application of carbaryl to bourse shoots resulted in abscission but application to spur leaves did not. Russet had no effect on fruit size and there was no interaction between carbaryl and russet.

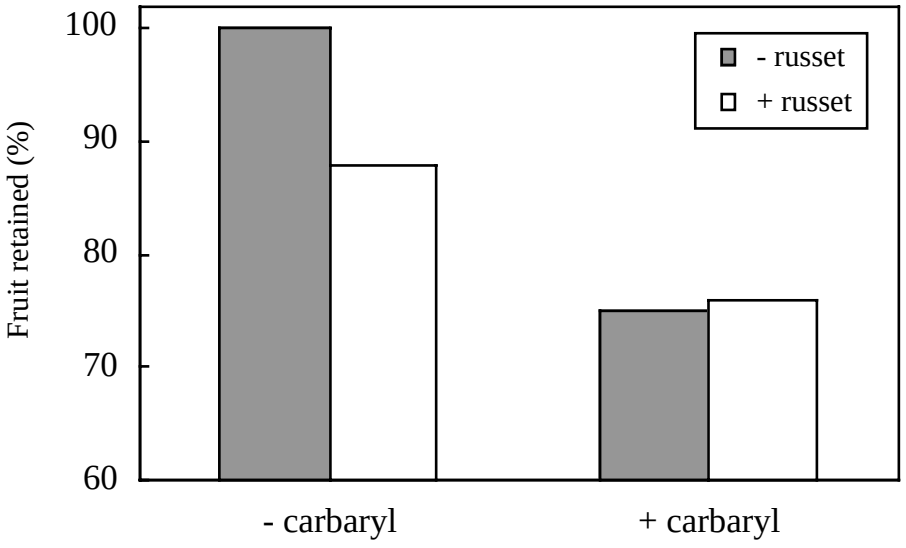

Fig. 1. The effect of two applications of carbaryl on retention of russeted (+ russet) and nonrusseted (– russet) 'Empire' fruitlets.

Fruit in the russet treatments had about 10% of their surface affected by russet at harvest, compared with practically no russet visible on fruit classed as nonrusseted. Russeted fruit were also markedly more misshapen than nonrusseted fruit (Table 1).

None of the treatments affected seed number per fruit or total seed fresh weight per fruit at harvest (Table 1). There was a trend for russeted fruit to have smaller seeds (in terms of fresh weight per seed) but this was not significant ($P = 0.057$). There were significant positive relationships between fruit weight and number of seeds per fruit ($r^2 = 0.16$, $P < 0.001$), total seed fresh weight per fruit ($r^2 = 0.22$, $P < 0.001$) and the fresh weight per seed ($r^2 = 0.15$, $P < 0.001$), however these relationships in all cases were weak.

In conclusion, russeted fruit were more misshapen than nonrusseted fruit, but neither russet nor carbaryl affected seed number nor seed weight per fruit. Chemically thinning with carbaryl did not preferentially thin russeted fruit and is therefore not a tool of use to growers to help eliminate fruit damaged by russet.

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The Green Brigade: The Educational Effects of a Community-based Horticultural Program on the Horticultural Knowledge and Environmental Attitude of Juvenile Offenders

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ADDITIONAL INDEX WORDS. extension programs, adolescents, probationary programming, vocational, education, at-risk youth, juvenile delinquent, gardening

SUMMARY. **The Green Brigade horticultural program is a community-based treatment and diversion program for juvenile offenders. The program is used for vocational training and rehabilitation. The objectives of this study were to determine if participation in the Green Brigade program improved the horticultural knowledge and the environmental attitudes of participating juvenile offenders. Participants of the Green Brigade program significantly improved their horticultural knowledge exam scores as a result of participating in the program. Participants also had significant improvements in their environmental attitude scores after completing the program. However, participants attending the Green Brigade program less than 60% of the time had significantly more negative environmental attitude scores than participants attending more frequently. Further analyses showed the program was equally effective at improving environmental attitude scores for all participants regardless of gender, ethnicity, age or grade in school.**

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The securing of job skills by underprivileged groups became the interest of both government and business leaders when President Clinton signed the Personal Responsibility and Welfare Reconciliation Act in 1996. At that time, the President challenged employers to hire more than 2 million people from public assistance into work situations by the year 2000. One of the elements that companies found was lacking in the nontraditional labor pool was job skills, in addition to transportation and childcare. Once companies initiated programs to teach basic job and social interaction skills, however, the retention and promotion rates of participants within the workplace were higher (Leonard, 1998). In addition, corporate youth training programs in some of the major metropolitan areas of the nation discovered that by investing in innercity youth, they helped build a future customer base while students gained lifelong job skills and pride in their communities (Greengard and Solomon, 1994).

In the criminal justice system, horticulture programs are commonly used in the vocational training and rehabilitation of adult offenders, and are becoming more common in juvenile probation programs. Horticulture programs that emphasize the acquisition of horticulture skills have helped enhance inmates' employment opportunities as well as their sense of community (Flagler, 1995; Migura et al., 1997; Rice and Remy, 1994). Questionnaires given to the participants of a program for juvenile offenders conducted by Rutgers University, found that 87% of respondents thought their quality of life was improved; 80% felt they had more job skills; and 75% believed they had obtained experience that might help them