X-ray Induced Bud Sports in Apples

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Scientists who are interested in apple breeding have searched for years to find rare bud sports which would be of commercial value through an improvement in appearance or some other characteristic of the fruit. Through the years, a great many of these have been discovered, the most extensive published list being that of Shamel and Pomeroy (1936). Many of these natural sports have now become established as improved varieties in our present day apple orchards. These include the red color strains of such varieties as Delicious, Rome Beauty, Northern Spy, Gravenstein, McIntosh, Melba, and many others.

In all these cases, improvement of the variety has been the result of an increase in the color of the apple, with other characteristics generally unaffected. The relative merits of the flavor and quality of the red color strains and their parent varieties have frequently been debated both by plant breeders and the consuming public. In certain varieties, there seems to be little doubt that flavor has been adversely affected, and that the quality of the original strain is superior to its "red sports". In some cases, the difference between the sports and the true variety may be due to the fact that the new strains are actually seedlings rather than bud sports.

Because of the potential economic value of true bud sports, scientists have hoped to discover an artificial process which could be used to increase the rate of sporting and thus improve the chances of obtaining a worthwhile sport. On the basis of other biological experiments with various plant and animal material, the most promising agent for doing this would seem to be some type of ionizing radiation.

This idea was originally expressed in the literature by Stadler (1930) who suggested the use of a portable X-ray machine in the apple orchard as a means of mass production of such sports. However, little was known of the dosages of X-rays required to produce such changes, and as a result, the few experiments tried at that time resulted in a complete failure to induce any bud sports. From recent work, it is now clear that the dosages which were used were much too small to cause the expected results.

As a consequence of the failure of the few original attempts, little further investigation was carried out, and the possibilities of this method have been generally neglected. It was probably reasoned that, since the apple was propagated by vegetative means, any X-ray-induced changes would be recessive and would not be expressed in the resulting vegetative growth. Because the apple is genetically very heterozygous, it was not practical to isolate mutations by inbreeding, if, indeed, they could be distinguished from the many undesirable alleles already present.

With the increased recognition of the effectiveness of X-rays in producing gene mutations, particularly in naturally self-pollinated and genetically relatively pure species like cereal crops, the use of X-rays in plant breeding has become more extensive. Certain mutant types in some crops have been found to be of agricultural value and have led to the introduction of new varieties or have resulted in strains of value in plant breeding programs.

New attempts to use X-rays in apple breeding were initiated independently in Sweden and Nova Scotia, and both projects have now been carried to the point of successfully inducing gene changes through the use of this artificial radiation. The first report of this new work was that published by Granhall *et al* in 1949, and this has been followed by a further account of the changes found in the fruit. (Granhall, 1953.) These changes have included "an increase in the red blush" of the fruit and also russeted forms.

The work in Nova Scotia (Bishop, 1954) was begun in the Spring of 1948 with the use of X-ray equipment purchased by the Nova Scotia Research Foundation and housed at Acadia University, Wolfville, N. S. Dormant apple scions were X-rayed with dosages from 2,000 to 40,000 roentgens and grafted by the "framework" method (Hilton, 1946) into grown apple trees, inserting from 100 to 300 scions per tree. Subsequent work has shown that the optimum dosage is 4,000 to 5,000 roentgens.

One of the major difficulties encountered in previous X-ray experiments with apple trees was the difficulty in propagating the X-rayed scions in the desired numbers, and the time required to grow the resulting plants to maturity to determine whether any change in the fruit had been induced. The use of framework-grafting effectively eliminates this difficulty, and not only allows large numbers of treated scions to be handled, but requires relatively little orchard space for conducting the work.

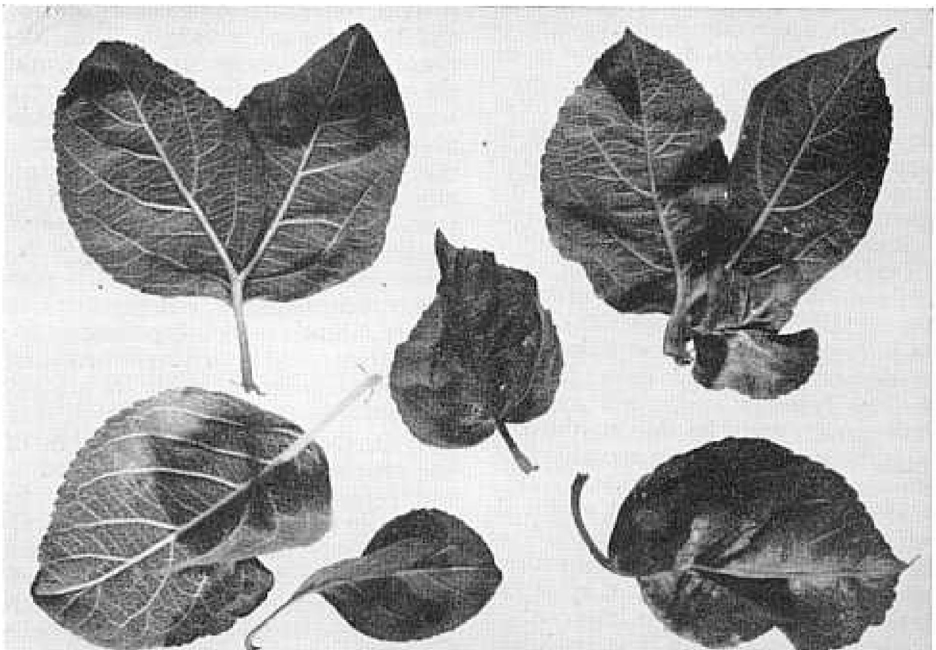

FIG. 1. Abnormal apple leaves taken from scions that had been exposed to X-rays while dormant and before grafting.

In the period since 1948, X-ray treatments have been carried out on nearly 10,000 scions of the varieties Yellow Bellflower, Cortland, Sandow (open pollinated seedling of Northern Spy), and Golden Russet. These have been grafted in the orchards at the Experimental Station, Kentville, N. S., and three years' apple crops have been observed for color changes in the fruit.

During the early growth the first season after grafting, morphological abnormalities were seen that were typical of those observed in many plants that have been exposed to artificial radiation. These included abnormally shaped leaves (Fig. 1) as well as shoot bifurcations in the growth from the scions. The latter were not confined to the early growth and frequently developed after several inches of shoot growth, apparently as the result of the lethal expression of some radiation-induced damage in the cells of the apical meristem.

One interesting morphological effect observed in some scions of the Cortland and Golden Russet varieties was the formation of short thick shoots in the first year's growth with precocious flower bud development. In the Cortland variety particularly, a considerable proportion of the scions produced flowers the first year after grafting.

The first crop of fruit was produced in 1951 and included 150 picked Cortland apples as well as a number which dropped on the ground. One striking characteristic of most of these first fruits was their giant size and irregular shape. Whether this was an X-ray effect or was caused by the relatively few apples in newly grafted trees could not be determined. If it was an X-ray effect, it did not persist in the fruit produced the next year.

All of the 150 apples in the first crop were examined carefully for color changes, particularly sectors of the skin that were a darker or lighter red color than the remainder of the apple. Nine apples were discovered that showed distinct sectorial color changes, some in the direction of more color and some with less color. Several of these included sectors that were 1 to 3 cm. wide. In all cases, they were single apples produced on fruit spurs developing from an irradiated scion.

The second year's crop of about 2500 Cortlands was disappointing in that only two of the apples showed minor sectorial changes. A few apples were produced on the scions from the other varieties, but none showed any difference from normal apples of untreated trees. The most logical explanation for this difference in the results of the two years seems to be that the first crop of fruit was borne mainly from scions that were strongly affected by the X-rays and showed a short shoot growth and early formation of flower buds. The second crop was mainly from less affected scions that made strong vegetative growth the first year, while the shorter shoots that bore fruit the first year in the second became vegetative and grew vigorously. The fruit spurs producing the larger sectorial changes in the first crop were marked, but none produced any fruits the second year.

In 1953, some 60 bushels of fruit were harvested, including mostly apples of the variety Cortland, but also some of each of the other three varieties, Yellow Bellflower, Sandow, and Golden Russet. Although the great majority of the apples were apparently normal, 74 scions were marked which produced fruit that differed from the normal type. A few showed size changes, and these will be examined to determine whether or not they are genetic in nature, but most were sectorial color changes. Several instances were found where a scion produced partly sectored apples, partly normal, and partly what appeared to be complete color changes to a darker red color.

The actual occurrence of these X-ray-induced bud sports, and the fact that in some cases, sections of the shoot growth developed from a mutated sector of the apical meristem in such a way that complete sports were produced, are results that are of real value to the apple breeder. Very frequently seedling apples are found which produce top quality fruits that are highly desirable as new commercial varieties except for the fact that they lack color and attractiveness. Now, it may be possible through the use of artificial radiation to obtain color sports without having to wait for one to occur naturally—something which may not be discovered until a variety has been propagated in large numbers.

It should also be possible to reduce the color of some of the darker colored varieties, thus making them brighter in appearance and more acceptable to the consumer. In a similar way, it is theoretically possible to reduce or increase the amount of russeting of the skin, though no definite indications have yet been obtained on this point in the work at Kentville. The increasing popularity of the Russet Bartlett pear would suggest the practical importance of this character in that tree fruit.

Furthermore, it is quite possible that other less obvious characters such as the waxiness of the skin, the acidity of the fruit, season of ripening, disease resistance, self-sterility, and fruit size may be altered as a result of the X-ray treatment. No careful study of these characters in apples from the irradiated scions has yet been made.

Increasing attention is now being given by plant breeders to the possibilities offered by this technique, and the future years may prove it to be of considerable practical importance and a means of shaping new fruits to fit our increasingly exacting specifications.

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Sweet Cherries in Canada

On the basis of performance at the Summerland Experimental Station, British Columbia, Canada, the Schmidt sweet cherry has been found to be inferior in size and quality to Bing, Star and Van.

Comparing Van with Schmidt, the fruit of these two varieties are similar in firmness. Schmidt is about a week earlier. Van is somewhat superior in size, much superior in quality, and is more resistant to cracking.

Vernon has proved too soft, and very susceptible to cracking. Its quality and firmness has varied from year to year. It also tends to drop some of its fruit prematurely, sometimes reducing the crop materially.—A. J. MANN, *Experimental Station, Summerland, B. C., Canada*

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