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Red Color Changes Following Irradiation of 'Royal Gala' Apple Scions

A. G. WHITE,[1] P. A. ALSPACH,[2] R. A. NORTON[3] AND H. I. SELBY[1]

Abstract

A study was made on the variation in fruit red color in a population of 'Royal Gala' apple developed from buds irradiated with gamma rays. A wide range of coloration was observed between the clones, however except for one clone the range of variation within clones was small.

Introduction

'Royal Gala' apple is the result of a spontaneous mutation of 'Gala' apple for more red pigmentation in the hypodermis (LII derived) layer of the fruit skin (3).

Plantings of 'Royal Gala' exhibit considerable variability in the amount of red color coverage on the fruit. A survey of several large orchards in Canterbury, New Zealand (Alan Robson, Pers. Comm.), 11% of 'Royal Gala' trees were considered to have suffi-

[1]HortResearch, Havelock North, New Zealand.
[2]HortResearch, Riwaka, New Zealand.
[3]Washington State University, Mount Vernon, Washington State, U.S.A.

ciently poor fruit color to warrant the trees being replaced. The trees did not however segregate distinctly into high color and low color groups. Rather a range of color from high to low occurred.

This variability could result from 'Royal Gala' being a sectorial or mericlinal chimera (6), or from mutation of the buds from which the trees were propagated.

A population of 'Royal Gala' trees was developed from buds irradiated with gamma rays for selection of clones with improved fruit color and color stability. Irradiation has been shown to cause cell death in the apical meristem, particularly in the LII region, creating the chance to reduce or eliminate the cells from which the poor colored sector is derived (5).

Materials and Methods

Dormant scionwood from a tree of 'Royal Gala' growing on a commercial orchard in Hastings, New Zealand was harvested in the winter July of 1985 and irradiated with gamma rays from a Cobalt 60 source at a rate of 1.3 Kilorads per hour to a total dose of 6 Kilorads (2). The irradiated scionwood was grafted onto 4 year old trees. The following summer (February 1986) a complete whorl of 5 buds, from bud 7 on the shoot upwards to bud 11, was taken from the first vegetative shoots after irradiation (V1 generation) and budded onto MM.106 rootstocks to form the second vegetative generation (V2) (4). Buds from 29 V1 shoots were propagated giving 29 sets of 4-5 V2 trees (bud failure reduced some sets to 4 trees). Three sets of control trees were propagated from three non-irradiated scions sourced from the same trees as the irradiated scions were.

The trees were planted out in a commercial orchard in 1987. Each set was regarded as a clone and planted in sequence down the rows. The controls (Clones 7, 14 and 32) were planted randomly throughout the trial block in their sets. Flooding in the first year reduced tree numbers in Clone 1 to 3, Clone 2 to 1, Clone 3 to 2 and Clone 4 to 0.

Ten fruit were randomly sampled from each tree of each clone on the first day of commercial harvesting in their 4th year in the orchard. The fruits were evaluated using the measurement algorithm developed to work with the PCVISION plus Frame Grabber hardware installed in a IBM compatible personal computer (PC) and linked to a Burle TC600X Charge Couple Device (CCD) video camera (7, 8). The color response of the CCD detector element determines that a yellow pixel will appear brighter than a red pixel. The PC host performed operations such as the numeric computation of data. Each apple was rotated 360° on a turntable as 256 single pixel width samples were taken along the longitudinal axis of the fruit. The video camera and turntable speed were synchronised so that the samples did not overlap. A near replica image of the fruit was then constructed by stacking the samples side by side to build up a mosaic of the apple surface.

The red color content was determined by counting the number of dark pixels in the black and white mosaic image and returning this as a percentage of the total mosaic area. Color area figures tend to be lower than for subjective methods of estimation where coverage refers to area of striping and includes both red and yellow stripes.

The data (Fig. 1) was transformed (arcsin [$\sqrt{p}$]) prior to analysis. For each tree, the mean fruit value and associated standard deviation was calculated for this variate.

The mean standard deviation for each clone was plotted against its corresponding mean to investigate if a relationship existed between the level of red color and its within-clone variation (Fig. 2).

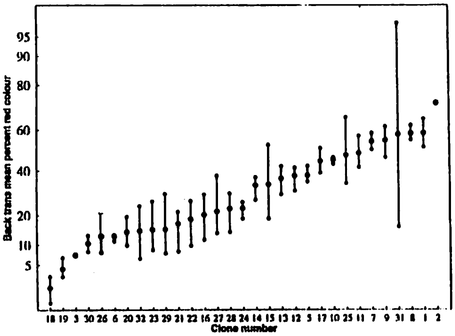

Figure 1. Mean and range of red colour area on the fruit of 'Royal Gala' and 28 clones of irradiated 'Royal Gala.'

Results and Discussion

In general, intra clone fruit color variation increased with the mean of the proportion colored (r = 0.621, Fig. 2). However this was not consistent. For example Clone 8 was well colored (ranked 3rd) yet had relatively small variation (Fig. 1). If 'Royal Gala' is a mericlinal chimera a higher level of variation than that observed within clones, including controls, would have been expected. It is possible that a larger number of buds than five may be required to expose the chimeral sectors (2, 4).

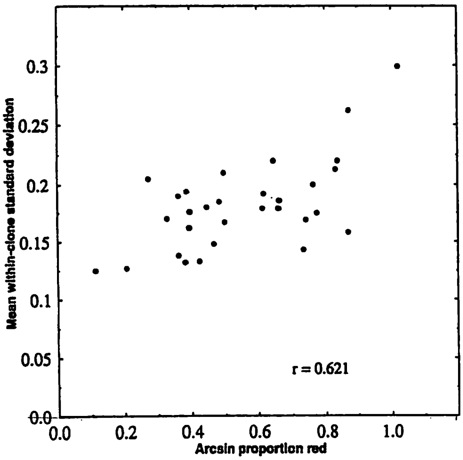

Figure 2. Relationship between the level of red colour and it's within clone variation.

Only Clone 31 showed marked intra clone variation (Fig. 1). Three of the trees of this clone had a similar striped color pattern and coverage to 'Royal Gala,' whereas two were dark red and block patterned. The behaviour of Clone 31 can be explained by suggesting the formation of a mericlinal chimera where the dark block red fruited trees growing from buds taken from a mutated sector and the trees with the 'Royal Gala' color pattern growing from buds from the region which did not mutate.

Red color coverage between clones was evenly distributed, with a near linear progression from a back-transformed average of 1.3% red surface area in Clone 18 to 72.6% in Clone 2 (Fig. 1). This range was wider than that of the controls, which had values of 14.3% (Clone 32), 33.1% (Clone 14) and 54.5% (Clone 7) respectively. A similar pattern has been found in naturally occurring mutants of 'Gala' (7). These results are consistent with the hypothesis that the level of red color expression is controlled by a multiple allelic series which exists at the loci governing red colour (1). The decreasing level of red color observed in most of the clones in this study could then be explained by the deactivation by irradiation of alleles augmenting pigmentation. Higher levels of red color observed in some of the clones could be the result of deactivation of alleles inhibiting pigmentation.

Naturally occurring mutation to a multiple allelic series governing red color is also a possible reason for the red color variability in the controls and in orchard plantings of 'Royal Gala.' The high level of variability would result if the mechanism controlling red color were highly susceptible to mutation.

Several clones with high color and low within clone variability have been propagated to form a V3 population to further evaluate their stability and suitability for commercial use.

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Mr. Alan Robson of Canterbury Orchard Services for the information on reversion in commercial orchards of 'Royal Gala.'

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Variation in Local Apricots Growing in District Kinnaur of Himachal Pradesh (India)

S. D. SHARMA[1]

Abstract

The variation on 700 apricot (*Prunus armenica* L.) seedling trees in respect of physico-chemical characters, leaf area and yield were studied. The population had distinct variation for these characters. The fruit weight ranged between 4.0-29.3 g, fruit length 1.9-3.6 cm, fruit diameter 1.9-3.5 cm, fruit volume from 2.1-27.5 cm^3. The stone weight varied from 0.5-2.9 g, kernel weight 0.2-0.7 g, flesh weight 3.5-21.6 g and flesh/stone ratio from 2.7-15.5. The total soluble solids ranged between 6.5 to 18.0%, acidity from 0.4 to 3.4% and oil content from 25.0 to 60.2 per cent. The leaf area varied from 8.2-39.9 cm^2 and yield per tree from 10.0 to 175.0 kg.

Introduction

Wild apricot (*Prunus armeniaca* L). trees are found in large number in district Kinnaur of Himachal Pradesh. These trees are scattered around the villages. The villages where these studies were undertaken had elevation between 1600 to 3050 m above mean sea level. The Kinnaur region (Fig. 1) of Himachal Pradesh in India extends from longitude 77°45′ to 79°00′, 35E and latitude 31°05′ to 32°05′, 15N. The rainfall decreases rapidly from south east to north eastern regions bordering Tibet are almost semi arid. Average rainfall of the whole district is about 450mm. The temperature goes up to 35°C in summer and minimum up to -25°C in winters. There are practically no rains from June to October when fruit development and ripening takes place. Some of these seedlings produce fruits comparable to those of commercial cultivars and are even superior in some aspects. The fruits are mainly used for table purposes, extraction of liquor, extraction of oil from kernels, fed to animals and preparation of chutney, jam, juice, etc.

[1]Dr. Y. S. Parmar University of Horticulture and Forestry, Regional Horticultural Research Sttation, Sharbo 172107 District Kinnaur (H.P.)—India. Present address: Associate Director (Res.) UHF, nauni-Solan (HP) 173230.