Albinism in Citrus Seedlings

nongenetic absence or deficiency of chlorophyll in seedlings prevented by treating freshly extracted seeds with fungicide

George F. Ryan

Part of the work described in the following progress report was conducted by Enrique Stein, Graduate Student in Subtropical Horticulture, University of California, Los Angeles, under the direction of Professor George F. Ryan.

Albino citrus seedlings completely lack chlorophyll and, therefore, do not survive after the stored food material in the embryo is used. Virescent seedlings have varying amounts of chlorophyll in their first leaves and—in most cases—will grow and gradually assume a normal green condition, but their growth is generally retarded by the deficiency of chlorphyll in the early stages.

The albinism in these studies was of a nongenetic character as indicated by its sporadic appearance in seedbeds of a wide variety of citrus and citrus rootstock species; nucellar seedlings as well as gametic seedlings are affected; virescence in seedlings which are partially green at germination does not continue beyond the young seedling stage, or reappear after a normal green condition is reached; and, removal of the seedcoats before planting prevents albinism, which is evidence that there is not a genetic factor for albinism in the embryos. This trouble is different from the genetic albinism and variegation appearing in seedlings of the variegated sour orange and in certain mandarin seedlings.

Workers in Palestine reported—in 1938—nearly complete prevention of albinism and virescence by treatment of seed with mercuric bichloride or commercial fungicides containing mercuric compounds. Salts of certain other heavy metals seemed to have a similar effect.

Recent studies at Los Angeles with Cleopatra mandarin seeds have indicated that treatment with various other fungicides—some of them containing no metals—also results in 100% normal green seedlings. Seeds were dusted with Fermate—76% ferric dimethyldithiocarbamate—or Phygon X.L.—50% 2,3-dichloro-1,4-naphthoquinone—or dipped for one minute in a 1% solution of 8-hydroxyquinoline — oxyquinoline — in 50% alcohol, or left untreated. Duplicate samples of 25 seeds were treated. After treatment, the seeds were placed in polyethylene bags and stored either at room temperature in the laboratory or at 39°F. Complete prevention of albinism was obtained by all three fungicide treatments.

In another experiment Cleopatra seeds were dipped for one minute in 1% aqueous 8-hydroxyquinoline sulfate or dusted with Arasan—50% tetramethylthiuram disulfide. Duplicate samples of 25 seeds were stored for various periods of time at 40°F in polyethylene bags or in sealed glass jars. The number of chlorophyll deficient seedlings appearing from untreated seed was much lower than in the previous experiment. It was clear, however, that both fungicides completely prevented albinism.

These and similar results from other experiments indicate that losses from albinism can be avoided by treating seed with a fungicide before planting or storing. All materials except 8-hydroxyquinoline or its sulfate are applied by shaking surface dried seed with an excess of powder.

If seeds are to be stored, treatment with 8-hydroxyquinoline sulfate may have a harmful effect on viability after the first month. Arasan, on the other hand, had a marked beneficial effect on viability during 12 months of storage, and other fungicides used in these experiments had a similar effect during a 3-month storage period.

The reason for the difference in response to 8-hydroxyquinoline and its sulfate in the two experiments is not known. The 8-hydroxyquinoline was used in alcoholic solution, because it is not readily soluble in water, and the sulfate was used in aqueous solution. Also, the two experiments were conducted at different times of year, with seeds from fruits differing considerably in stage of maturity.

Research workers in Florida have reported good retention of viability in 33 varieties of citrus seed stored at 35°F for eight months after treatment with 1% 8-hydroxyquinoline sulfate. In the Florida experiments the seeds were dipped momentarily, then surface dried, packed in moist sawdust or moss, and stored at 35°F. The treatment in the Los Angeles studies differed in several details, any of which might account for the different results. The seeds were dipped for one minute, placed in polyethylene bags without packing material, and stored at 39°F or 40°F.

The cause of albinism in citrus seedlings is not known, but it has been suggested that some conditions which affect the development or germination of the embryos may determine the presence or absence of chlorophyll in citrus seedlings. Also, that the possibility of toxic action by fungi or bacteria should be investigated. Several observations suggest a fungus is involved: *1*, Albinism occurs sporadically in seedbeds. Seeds obtained a few days apart from the same tree may produce a high percentage of albinos or none, which suggests a chance

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Effect of Fungicide Treatment on Albinism in Cleopatra Mandarin Seedlings 1953

Treatment before storage	Months stored at 39°F		
	1	2	3
	Germinated seeds producing only albinos %		
Untreated	52	44	52
Fermate	0	0	0
Phygon	0	0	0
8-hydroxyquinoline	0	0	0

Effects of Fungicides on Viability of Cleopatra Mandarin Seeds in Cold Storage

Treatment before storage	Months in storage (40°F)						
	0	1	2	3	4	8	12
	Germination %						
Seed extracted July 26, 1953							
Untreated	50	54	42	..	..	..	..
Fermate	88	92	90	..	..	..	..
Phygon	74	90	80	..	..	..	..
8-hydroxyquinoline	78	94	92	..	..	..	..
Seed extracted Feb. 11, 1955							
Untreated	86	80	54	..	56	76	8
8-hydroxyquinoline sulphate	88	76	22	..	12	16	6
Arasan	94	98	98	..	100	96	76

Effect of Fungicide Treatment on Albinism in Cleopatra Mandarin Seedlings 1955

Treatment before storage	Months in storage				
	0	1	2	4	6
	Chlorophyll deficient seedlings %				
Untreated	0	8	0	13	0
8-hydroxyquinoline sulphate	0	0	0	0	0
Arasan	0	0	0	0	0

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after, the percentages of chlorine in the dry matter of the peel greatly exceeded those of the pulp, both peel and pulp accumulating considerable chlorine.

Joseph N. Brusca is Principal Laboratory Technician, University of California, Riverside.

A. R. C. Haas is Plant Physiologist, Emeritus, University of California, Riverside.

MARKETING

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During the postwar years, retail grocery store sales have tended to trend up, but that trend has not been distributed evenly among all products. Some products and brands have gone ahead faster than others. Another fact in food distribution today pertains to the distinction between major advertised brands and minor brands. The major advertised brands not only account for the larger part of the total food market but the proportion has trended up slightly during the past half-dozen years. However, shifts occur within major brands, and those—like all other brands and products—have to struggle to hold their position. Of the top brands existing in 1948, more than one fourth had been introduced within the preceding six years. However, by 1954, 60% of the top brands in 1948 had been replaced by other brands. Not only is there a shifting among the major or top brands, but a competitive struggle is developing between nationally advertised and private label brands.

Shifting of positions among brands is not limited to the product or where the name of a brand is changed or even where a new brand is introduced. The shift is tied in with the development and introduction of new products. Between 1948 and 1955, the dollar sales of product classes without new or improved products increased 10%; but for product classes with new or improved products, the dollar sales in 1955 were 78% above 1948. As an indication of what is happening, one manufacturer merchandising through retail grocery stores reported that probably 70% of that company's volume comes from products that did not exist 10 years ago, which emphasizes the importance of research in foods and food products.

New product development and introduction has gone along with changes in promotional activities. During the past half-dozen years, remarkable changes have occurred in uses of advertising media. Since 1948, advertising—in newspapers, magazines, network radio, and network TV—as a whole has increased some 80%, but the proportion taken by newspapers and magazines has trended down. There has been a considerable downward shift in network radio, but a fantastic growth in the use of network TV. It is estimated that in 1957 some 45% of the total advertising funds expended is accounted for by network TV.

The competitive struggle by merchandisers for consumer attention has not been limited to printed matter and TV. In 1955, consumer promotions—excluding couponing and house-to-house samples—accounted for 11% of the total sales of seven major commodities; but in 1956, this type of consumer promotion accounted for 14.4% of total sales of those seven commodities. Whether merchandisers do or do not like to bother with promotional devices or whether consumers may be getting tired of them, they have been increasing in number and in dollar importance in the past several years.

Among the most notable changes in food distribution have been in the stores themselves. In 1942, clerk service occurred in about three fourths of the stores and self-service in the remaining one fourth. By 1955, the position was reversed with 75% of the stores classified as self-service and only 25% as clerk service. At the same time, the size of stores in terms of dollar volume has grown tremendously. In 1942, the average grocery store did about $78,200 worth of business a year. By 1955, the volume had grown to over $415,000, an increase of some 480%.

The growth of supermarkets—and in some cases giant supermarkets—has been one of the most significant developments in food distribution. As mass production has come to characterize American manufacturing industries, mass distribution is characterizing food marketing. However, supermarkets do not restrict themselves to food. They often carry hardware, clothing, notions, records, variety and drug items.

In some sense the old-time country general store with its many lines of products has returned in changed form. The medium-sized supermarket today carries 5,000 different items, all of which compete for shelf space and floor space. The food items are being crowded more and more as indicated by what is happening in frozen foods. The original cabinets were introduced primarily for frozen fruits and vegetables, but these items are being crowded for space by ice cream, popsicles, frozen pies, salads, and pizza as well as frozen TV dinners.

As food stores have grown in size and added new product lines, the market structure to which growers sell has changed. Mass buying by corporate chains is now an old story; but in recent years, privately owned or independent stores have been joining together in large-scale buying groups. The expansion of cooperative buying by independents has reinforced the changing market structure facing growers. These large-scale buyers of farm products—voluntary cooperatives as well as corporate chains—do not operate as did the independents acting singly. Product specifications, point of purchase, product mix, and trading terms may be affected. The balance of bargaining power between growers and those to whom they sell is changing.

It is within the current dynamic distribution system that orange marketing today must operate. The changing marketing patterns provide opportunities—and new problems—in the marketing of California oranges.

Sidney Hoos is Professor of Agricultural Economics, University of California, Berkeley.

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infection during the extraction and preparation for planting. *2*, Its appearance is prevented by treatment of fresh seed with a variety of fungicides. *3*, Treatment of seed with the same fungicides after storage does not always prevent albinism. If infection occurs at the time of planting, treatment at that time would be effective in preventing development of the fungus, thereby preventing albinism. However, if infection with the fungus has occurred before storage, a treatment after storage would not be expected to have the same preventive effect. If a microorganism is responsible for the chlorophyll deficiency, it must produce its effect through some action on the seed coats, because complete removal of the embryo from contact with the seed coats prevents the occurrence of albinism.

Attempts to demonstrate that a fungus is causing the albinism have given inconclusive results.

George F. Ryan is Assistant Professor of Subtropical Horticulture, University of California, Los Angeles.

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James F. L. Childs, Pathologist, and Gustave Hrnciar, Fruit and Vegetable Crops and Diseases, United States Department of Agriculture, conducted the studies in Florida mentioned in this report.

H. B. Frost, Associate Plant Breeder, Emeritus, University of California, Riverside, advanced the possibility that toxic action of fungi or bacteria might affect the presence or absence of chlorophyll in citrus seedlings.

J. M. Tager, Plant Physiologist, University of Pretoria, Pretoria, South Africa, and S. H. Cameron, Professor of Subtropical Horticulture, University of California, Los Angeles, determined that removal of the seed coat prevents albinism.