

Temperate Fruit Breeding in Brazil

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Brazil consumes over 500,000 tons of temperate fruits each year. The most used temperate fruit is the apple, of which about 240,000 tons are consumed annually, followed by the peach with 100,000 tons. The other species of major importance are pear (80,000 tons), fig (45,000 tons), plums (25,000 tons), and nuts (12,000 tons). The majority of these fruits are imported and in 1979 about US \$200 million was expended for their purchase. Apples alone cost US \$100 million.

Even though Brazil is large in surface area (3,294,600 square miles) and extends about 2,700 miles from north to south, there are not many parts of the country adapted to temperate fruit production. In fact, suitable climate with proper winter cold to satisfy rest requirements is found only in the southern region of Brazil. In the South, there are areas where good ecologic conditions exist for the economic exploration of temperate fruit production.

The total area planted to temperate fruit species at present is slightly more than 60,000 hectares located primarily in 7 southern states: 20,000 ha. in Rio Grande do Sul, 13,000 in Santa Catarina, 12,000 in Sao Paulo, 9,000 in Parana, 6,000 in Mirias Gerais, and lesser amounts in Goias and Espirito Santo.

In general, fruit cultivars introduced from abroad have not shown good adaptation to Brazil's climate. None of the introduced apple and pear cultivars are adapted and only a few plum and table peach introductions show good adaptation. Therefore, the temperate fruit industry in Brazil depends on locally bred cultivars.

PEACH

History: The peach has been grown as a backyard fruit in Brazil for over

100 years. By 1940, some small commercial orchards had been established in Rio Grande do Sul (RS) and Sao Paulo (SP) states. However, until the late 1960's most of the peaches consumed both fresh and canned were imported from Argentina and Uruguay. The industry has grown rapidly, however, and during the past three years (1978-80), the production in RS and SP has been sufficient for the national demand and it is expected that within a few years there will be a surplus for exportation.

Peach breeding in Brazil was started in 1950 by Orlando Rigitano at Instituto Agronomico de Campinas in Sao Paulo state. Rigitano developed cultivars adapted to very mild winter regions accumulating only 50 to 150 hours of chilling (temperatures $\leq 7.5^{\circ}$ C). Basically he used germ plasm introduced from Florida such as Jewel, Suber, Hall's Yellow, and Angel which he crossed with seedlings brought by Portuguese immigrants early in the 20th Century.

In 1953, Sergio Sachs initiated a peach breeding program at Estacao Experimental Fitotecnica de Taquari, Taquari, RS, to develop cultivars adapted to regions with 200 to 650 hours of chilling. In 1963 this program was transferred to UEPAE de Cascata, Pelotas, RS. At that time, only two cultivars were grown in RS: Aldrighi, a seed propagated processing type and Delicioso a fresh market cultivar. The peach harvesting period was only about 15 days in duration.

In 1957, thousands of open-pollinated and hybrid seeds were collected in Florida, Georgia, North Carolina, Maryland, California, and particularly New Jersey. A few hundred clones were selected in the peach area of

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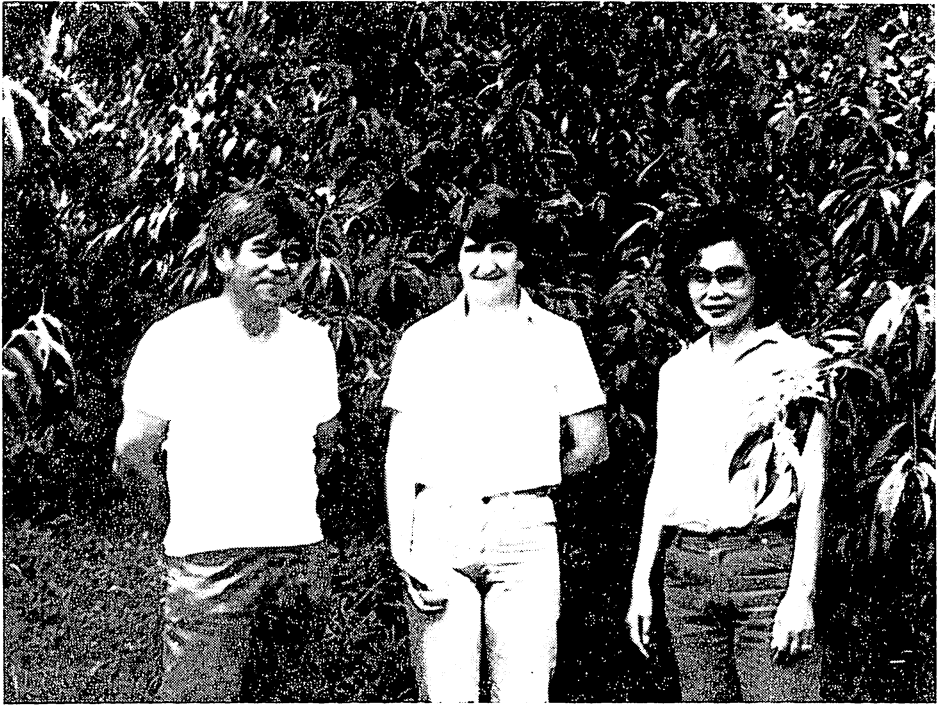


Figure 1. Temperate fruit breeding team at UEPAE de Cascata. Left: Dr. Bonifacio Nakasu. Center: Mario do Carmo Bassols. Right: Dr. Ascunia Feliciano.

Pelotas and about 200 cultivars and selections were introduced from all over the world. In spite of many deficiencies which exclude this introduced germ plasm from commercial production, it has contributed the basic genetic material for the breeding program.

Today, UEPAE de Cascata has the largest peach breeding program in Brazil and in the next three years will evaluate over 20,000 seedlings each year.

With the release of new cultivars in the late 1960's and the decade of the 1970's, the ripening period of table peaches has been extended to 70 days.

Present Industry: There are 18,000 hectares (44460 A.) of peach orchards in Brazil of which 12,000 ha (29640 A.) are in the southern part of RS state.

The great increase in the peach industry of RS in the last decade occurred primarily to meet the need of an expanding processing industry. Presently, RS accounts for 85% of the total canned peaches in Brazil. Sao Paulo, Parana and Santa Catarina states produce more table peaches and some nectarines. Altogether they produce about 4,000 hectares. The majority of the table cultivars are white fleshed with sweet taste.

Cultivars: Despite the fact that peach breeding in Brazil began only 30 years ago, the majority of the commercial cultivars are locally developed. Foreign cultivars propagated to some extent are the table peaches Flordasun, Fla. 13-72, Peach 16-33, and the nectarine Sunred, all developed in Florida by Ralph H. Sharpe.

In the warmer areas such as Sao Paulo, the most used cultivars are the ones developed at the Instituto Agromomico de Campinas. Popular table cultivars are Talisma, Tutu, Cristal, Reliquia, Alo Docura, Colibri, Natal and Nectar. Processing cvs. are Rei da Conserva, Real and Biuti. All these cultivars require less than 150 hours of chilling for breaking of dormancy. The preferred table cultivar in Sao Paulo is Talisma which is white fleshed and sweet. The most grown nectarine is Sunred.

All the cultivars used commercially in the states of Parana, Santa Catarina and Rio Grande do Sul are releases from UEPAE de Cascata. The most popular are:

Fresh Market Cultivars:

Premier. Released in 1968. Vigorous, productive, early ripening; fruit round-conic, medium size, skin 30% red with yellow-green ground color. Fruit is semi-freestone, medium firm, white flesh, melting texture, sweet good flavor. Requires 150 hr. of chilling.

BR-3. Released in 1979. Vigorous, productive, early-ripening tree. Fruit medium size, attractive, round with slight suture, 90% red overcolor with cream ground color, flesh white, medium firm, melting, freestone. Flavor sweet with slight astringency. Requires 250 hr. chilling.

Princesa. Released in 1966. Tree of good vigor, highly productive, but susceptible to bacterial spot. Fruit round, large, 90% dull-red with yellow ground color. Flesh yellow, melting, firm, semi-free. Quality is good with well balanced sweet-acid taste when fully ripe. Requires 250 hr. chilling.

Coral. Released in 1966. Mid-to-late ripening. Vigorous and highly productive but susceptible to bacterial spot and brown rot. Fruit is medium to large, conic with slight tip, of attractive color, 50% bright red with cream ground color. Flesh white,

melting, medium firm, freestone with good quality, sweet and juicy. Requires 350 hr. chilling.

BR-1. Released in 1979. Tree semi-vigorous, late blooming, mid-season to late ripening and productive. Fruit is medium size, round-ovate with skin 50% red and attractive. Flesh is white, melting, but the firmest of the table cultivars, and is clingstone. Quality is good, sweet with slight acidity. Requires 300 hr. of chilling.

Vila Novo. Released in 1968. Tree is vigorous and productive, late ripening, and susceptible to bacterial leaf spot. Fruit is large, ovate, of good appearance with 50% red skin and yellow ground color. Flesh is yellow, melting, firm, freestone, and of good quality. Requires 400 hr. of chilling.

Chiripa. Released in 1975. Tree vigorous, productive, and latest ripening of fresh market cultivars. Fruit is medium to large, ovate with prominent suture. Flesh is white, melting, firm and freestone. The skin is 15% covered with red with creamy ground color. Quality is good. Requires 500 hr. of chilling.

Processing Cultivars:

Diamante. Released in 1973. Tree vigorous, productive, moderately resistant to bacterial spot but susceptible to brown rot. Ripens early. Fruit is medium to large, uniform round shape without tip. Flesh yellow, non-melting, firm. Canned fruit is attractive with good consistency and good quality. Requires less than 200 hr. of chilling.

BR-4. Released in 1980. Tree semi-vigorous, productive, and ripens early midseason. Fruit is medium to large, round-ovate. Flesh is yellow-orange, non-melting and firm. Processed quality is good. Requires 250-300 hrs. chilling.

Cerrito. Released in 1969. Tree is vigorous, medium productive, and moderately susceptible to bacterial spot. Ripens midseason. Fruit is large,

round-conic, uniform with small tip. Flesh is yellow, non-melting, firm, and is moderately susceptible to browning. Requires 200 hr. of chilling.

BR-2. Released in 1979. Tree of medium vigor and productivity. Ripens midseason. Fruit medium to large. Flesh is non-melting, yellow-orange with traces of red at the pit. Quality for canning is good. Requires 300 hr. of chilling.

Convenio. Released in 1966. Tree is vigorous with medium productivity. The major weakness of this cultivar is high susceptibility to sun scald on the trunk and branches. Fruit is large and uniformly round without tip. Flesh is golden yellow, non-melting and firm. After canning, the flesh becomes very firm and has the highest quality of the processing cvs. Requires 350-400 hrs. of chilling.

Aldrighi. This cultivar originated in the orchard of a grower named Aldrighi in the 1940's. Trees are medium vigor, productive, but susceptible to rust and gummosis and moderately susceptible to brown rot. The fruit is medium to large in size, of irregular shape with a pronounced suture and tip. Flesh is yellow, firm, and non-melting. Quality of the canned product is only fair. Requires 350 hrs. of chilling.

Capdeboscq. Released in 1966. Trees are vigorous and very productive but highly susceptible to brown rot. Ripens in late midseason. Fruit is of medium size, and round-conic with a small tip. Flesh is yellow, non-melting and firm. Canned fruit is of good quality, but is susceptible to browning. Requires 300 hr. of chilling.

Magno. Released in 1977. Semi-vigorous and productive, but susceptible to bacterial leaf spot and brown rot. Ripens in late season. Fruit is large, round without tip and uniform. Flesh is yellow, non-melting, firm, with traces of red at the pit. Canned

fruit has good quality. Requires about 450 hr. of chilling.

BR-6. Released in 1980. Vigorous and very productive, late ripening trees. Fruit is large, round, but with slightly prominent suture. Flesh is yellow, firm, non-melting and of good processed quality. Requires 350 hrs. of chilling.

Major Production Problems:

In the southern states of Brazil, where peaches are grown, accumulated chilling hours range from 50 to 650 hr. The winter season is very variable. Spring frost is quite common in some areas as well as rain during bloom and ripening which results in very high humidity and disease problems.

For most cultivars, major problems are lack of fruit firmness, occurrence of such diseases as brown rot, botrytis, bacterial spot, rust and leaf curl, and insects such as oriental fruit moth and fruit fly.

The average production of peach orchards in Brazil is about 8 tons/ha (3.2 tons/A) although a few well cared for orchards produce 30 tons/ha. Processing pack recovery (% of fruit weight that is usable) is around 50%, but should be at least 70%. Due to cultivar deficiencies, an appreciable percentage of fruit is discarded because of small size, disease and insect damage, and lack of uniformity of maturity.

Objectives of the Breeding Program:

Major objectives of the program are: 1) To develop table peaches and nectarines with firm fruit, late bloom, good shelf life, and with ability to be transported to distant markets. 2) To develop processing cultivars which bloom late and produce large fruits with yellow flesh which is resistant to browning. 3) To extend the season of peach maturity to 120 days with both earlier and later ripening cultivars. 4) To develop cultivars which

have adaptation to regions of 200 to 650 hrs. of chilling and which have resistance to late frosts, diseases, and highly fluctuating winter temperature.

APPLE

History: The apple industry in Brazil has become commercially important only in the last decade. However, small plantings have existed in the north part of Rio Grande do Sul since the 1940's, and a group from Algeria planted apples in Santa Catarina state in 1960.

At present, more than 15,000 hectares are planted to apples in Brazil with 3,000 ha. in Rio Grande do Sul, 7,000 ha. in Santa Catarina, 2,000 ha. in Parana and lesser amounts in Minas Gerais and Espirito Santo. Almost all apple plantations are at high elevations in mountain regions on land previously not used or used only for cattle or wheat.

The apple industry has stimulated economic development in a large area and has given Brazilians a seasonal fruit at lower prices and better quality than imported cold-storage apples. The 1980 production was over 50,000 tons, resulting in the increasing participation of a national fruit in the Brazilian market.

Cultivars: The major cultivars being planted in the southernmost states of Rio Grande do Sul, Santa Catarina and Parana are Golden Delicious, Gala, and to a lesser extent, Fuji. There are also plantings of Belgolden, BR-1, Willie Sharp, Melrose, and others. Several years ago, Starkrimson was a leading cultivar, but due to its low quality and low productivity is not popular at present.

In Sao Paulo and other subtropical areas, different cultivars are required. Brasil and Valinhense, two selections made in S.P. are present in most orchards established in the past 20 years. Two newer cultivars, Rainha and Culinaria, released by the Insti-

tuto Agronomico de Campinas and Anna from Israel are being planted now.

Golden Delicious. This U.S. cultivar is not well adapted to the low chill climate of Brazil and like most cultivars, it has to be sprayed with mineral oil and DNOC or other dormancy-breaking chemical agents. Golden Delicious is susceptible to *Glomerella singulata* and to *Alternaria* sp. Rusting is always present on the fruit. Even with all the problems, it is possible to obtain yields of 60 kg per tree.

Gala. Originated in New Zealand from a cross of Kidd's Orange Red and Golden Delicious. In the highest areas of Santa Catarina (1100-1400 m) it breaks dormancy without chemicals, but in warmer regions its adaptation is marginal. Gala is very productive and has good appearance and quality but is very susceptible to scab.

Fuji. Was developed in Japan from a cross of Ralls Janet x Delicious. Trees are very vigorous. Fruits are medium to large size and of good quality. Skin color is yellow with red stripes. The color is not intense enough but some spur types such as Fuji No. 1, Fuji No. 2 and Fuji Spur are better. In humid climates, Fuji is susceptible to scab.

Anna. Originated in Israel from a cross of Golden Delicious and Adassia Red. Anna is well adapted in Sao Paulo, but in Rio Grande do Sul, Santa Catarina and Parana it blooms very early and is subject to frost damage. Apparently, its chilling requirement is very low and it is a good parent in breeding for low chilling requirement. Fruits of Anna are early ripening, are red in color, and have good shape and quality. It is very susceptible to scab and mildew. Anna requires cross pollination and the Israel cultivars Ein Shemer and Vered are used as pollinators.

Belgolden. Adaptation is marginal in most areas. Fruits are similar to

Golden Delicious but are usually larger and have less russetting.

Willie Sharp. Early ripening, but not well adapted in southern Brazil. Shelf life of fruits is very short and it cannot be stored. Bloom period is very long and it has been used as a pollinator.

Melrose. Fruit size is large, with average weights from 140 to 220 g. Eating quality is good but appearance is poor. Adaptation is better than Golden Delicious.

BR-1. Recently released by EMBRAPA - UEPAE de Cascata. It is an open-pollinated seedling of Delicious. Fruits are very large with yellow skin color and just slight russetting around the pedicel. BR-1 ripens early and is not good for storage. The flesh is white, juicy, sweet and low in acids. The adaptation is marginal and it requires spraying with rest breaking chemicals.

Valienhense. Also known as Ohio Beauty. The cv. is supposed to have originated near the city of Valinhos in Sao Paulo state. It is not suitable for fresh market but is good for commercial processing and for home baking. It is marginally adapted in subtropical climates.

Brasil. Also known as Bruckner do Brasil, this cv. was selected by a grower, A. Bruckner, in Piedade, SP. Fruits are deficient in color, shape, flavor, and keeping quality. However, it has been planted some in Sao Paulo.

Rainha. Released by the Instituto Agronomico de Campinas from a cross of Golden Delicious x Valienhense. This cv. is increasing in Sao Paulo. In tests in Cascata, RS, it shows very good production and fairly good adaptation. Fruits have red stripped skins and good shape, flavor and appearance.

Culinaria. Released by Instituto Agronomico de Campinas from a cross of Rome Beauty x Valienhense. Adaptation is marginal and it is not as wide-

ly planted as Rainha. Fruits are very firm but of low quality.

BR-2. Released by UEPAE-Cascata in 1979. Adaptation is marginal but it performs well when sprayed with rest-breaking chemicals. Skin color is yellow with pink blush and free of russetting. Fruit quality is good and it stores well.

Major Problems:

The average apple yields in Brazil are low (about 10 tons/ha) and a considerable proportion of the fruit does not have a very good appearance nor quality. These problems are associated with lack of climatic adaptation of the cultivars being grown, pollination problems due to delayed and extended bloom periods, and diseases, especially scab and soil borne diseases.

Climatic conditions are not ideal for growing apples in Brazil. Most of the production areas are very humid, which favors disease development, and the accumulated chilling hours range from less than 100 hr. in Sao Paulo to about 650 hr. in the highlands of Santa Catarina and Rio Grande do Sul.

Objectives and Scope of Breeding Program

A small breeding program was started by the Instituto Agronomico de Campinas in Sao Paulo state in 1953. This program was largely based on crossing Valienhense with good quality cultivars from abroad, such as Golden Delicious, King David, Primazio, Jonathan, and others. From that program six cultivars were released in 1975: Culinaria, Rainha, Paulista, Delicia, Bonita and Dulcina. This program still continues on a small scale and is achieving good results for subtropical regions.

In 1965, the UEPAE de Casata started a small program based mainly on evaluating seedlings from open

pollination of Winter Banana, Delicious, Golden Delicious, York-A-Red and others. Shortly after, this program was curtailed for 10 years, during which seedlings were evaluated but no new seedlings were produced. In 1976, the breeding program was reactivated at Cascata and at present there are more than 7,000 seedlings to be evaluated. Recently Dr. L. F. Hough of Rutgers University and Dr. E. Williams of Purdue University began collaborating with Cascata by supplying pollen of scab resistant germ plasm.

At present, apple breeding at Cascata is considered of high priority. Plans are to increase seedling production and develop more cooperative exchange with institutions abroad. Plans are underway to begin screening for scab resistance in 1981. In 1980, more than 100 crosses were made of which 60% were for scab resistance and the remainder for climatic adaptation.

Apple breeding began in Santa Catarina state in 1973. Objectives there are scab resistance, low chilling and good fruit quality. Some of the first selections from this program appear promising.

The major objectives of apple breeding in southern Brazil are: 1) To develop cultivars with low chilling requirement that do not have to be sprayed with dormancy breaking chemicals. 2) To develop cultivars resistant to diseases, with emphasis on scab. 3) To develop early maturing cultivars that ripen before Argentina apples to avoid market competition. 4) To develop cultivars with firm fruits, good storage qualities, high yields, good shape and appearance and preferably with red skin color. 5) To develop a series of cultivars ripening at different times to expand the harvest season.

Of these objectives, the first two are most important, and most of the work to date has been in this direction.

PEAR

Pear is one of the most important temperate fruit crops in Brazil. In 1968, Brazil was cited as one of the major producing countries in South America, with production of 55,000 mt (Layne, R. and Quamme, H. in *Advances in Fruit Breeding*). At present, however, Brazil imports more than 80% of its total consumption of fresh fruits and 100% of fruits for canning. The biggest problem in pear production is disease. The humid climate in the south favors the development of both leaf spot (*Fabrea maculata*) and scab (*Venturia pirina*), the most serious diseases of this crop.

Cultivar testing has been going on for quite some time at UEPAE de Cascata but a breeding program had not been seriously undertaken until a year ago. The program is being handled in collaboration with EMPASC (Empresa Catarinense de Pesquisa Agropecuaria), Santa Catarina and Instituto Agronomico do Parana. Aside from the obvious objectives of desirable quality for fresh market and canning and adaptation, resistance to leaf spot and scab are the major objectives of the breeding program.

Among the introduced cultivars, the following are being observed carefully at UEPAE Cascata, either for probable commercial planting in Pelotas and areas with similar climatic conditions, or use in the breeding program:

Carrick: Adapted, tree vigorous, trunk free of necrosis, large fruit of good quality, apparently has some resistance to *Fabrea maculata*. Pollination requirement of this cultivar is being studied as production has not been satisfactory so far.

Packham's Triumph: Adaptation satisfactory, tree vigorous, medium size fruit of good quality, good production, susceptible to *Fabrea maculata*.

Garber: Very well adapted, tree vigorous, high production, apparent resistance to *Fabrea maculata*, poor fruit quality.

Cultivars adapted in the warmer Sao Paulo area had been released by Instituto Agronomico de Campinas, the most widely grown of which is Seleta.

Seleta, a hybrid of Packham's Triumph x Hood, has medium size fruit of good quality, is susceptible to *Fabrea maculata* and has chilling requirement of about 200 hours or less.

PLUM

There are approximately 1,300 hectares devoted to plums in the south of Brazil (RS, SC, PR), 90% of which are planted to Santa Rosa. The popularity of Santa Rosa is due, in great part, to its resistance to bacterial spot. The industry is, however, being seriously threatened by plum leaf scald which causes early tree "decline." In the past 3-5 years, production has decreased tremendously and many orchards have been abandoned due to the disease. A strong program in Plant Pathology dealing with study of the disease and its control measures was started in 1980 at UEPAE de Cascata in collaboration with two national institutions (Instituto Agronomico do Parana and Universidade de Brasilia) and the University of Florida.

Plum breeding in the country is basically being handled by two institutions. The program at Instituto Agronomico de Campinas has been underway for quite some time and has released many cultivars adapted to Sao Paulo and warmer areas (chilling requirement of about 200 hrs or less) e.g. Gema de Ouro, Golden Talisma and Kelsey Paulista. Bacterial spot and leaf scald are not problems in Sao Paulo area so far so that breeding for resistance to these diseases are not primary objectives of the program.

The breeding program at UEPAE de Cascata is still in its infancy. Re-

sistance to both bacterial spot and leaf scald are primary objectives in the program in addition to quality and adaptation. Different cultivars from abroad have been tested at this station and many have good production and adaptation, such as Friar, Methley, Golden Japan, Satsuma, and Abundance. Some of these cultivars are being grown in limited scale in view of their susceptibility to bacterial spot.

BLACKBERRY

The blackberry industry in Brazil is small but promising. Research on the blackberry began only in 1972 when the UEPAE de Cascata received the first collection through the collaboration of Dr. J. N. Moore of the University of Arkansas. This material was received as root cuttings, and the first trial was established in 1974 on a private farm in Cangucu, near Pelotas, RS. In 1975, UEPAE de Cascata received hybrid seeds of several crosses from Dr. Moore. These produced about 12,000 seedlings for evaluation and resulted in several very promising selections.

At present there is a commercial planting in Rio Grande do Sul of 10 hectares of the cultivars Comanche, Brazos and Cherokee. Fruits have been processed by industry for two years and have sold readily. An additional 25 ha planting is planned by the same industry next year. Other companies are now interested in the new crop and prospects are good for a large blackberry industry in the near future.

The UEPAE de Cascata has begun a small breeding program primarily aimed at obtaining cultivars that do not overlap in harvest with the ones now planted. Also, there is interest in cultivars that do not ripen in the same period as peaches, to avoid competition in processing time and equipment. Other breeding objectives are for good processing quality, vigorous

plant with resistance to diseases, and for erect, and preferably, thornless canes. At present, two thornless selec-

tions and several thorny ones are in advanced stages of testing and appear very promising.

Introduction and Evaluation of Low Chilling Peach and Nectarine Cultivars in the Bolivian Highlands¹

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ABSTRACT

Low chilling peach and nectarine cultivars introduced from the University of Florida, Gainesville, Fruit Crops Department breeding program undergo normal vegetative and reproductive growth cycles in Bolivia at 1848 m altitude, latitude 16° 25' S. Measurements of fruit weight and external color indicate that this area can produce fruit of quality comparable to the same cultivars grown in Florida.

Peach and nectarine cultivation in Bolivia is limited to the highland areas 1800 to 3000 meters in elevation between latitudes 15° 44' and 21° 32' S. Production is low. Most trees are white fleshed seedlings of poor quality or imported cultivars such as Cardinal, Dixired, Redhaven, and Elberta, which do not receive adequate chilling for proper growth or fruit production (1, 2, 3).

MATERIALS AND METHODS

In 1976, through agreements between the Bolivian Institute of Agriculture (IBTA) and the University of Florida, Gainesville, budwood of low-chilling peach and nectarine cultivars and advanced selections from the Uni-

versity of Florida Department of Fruit Crops breeding program was sent to the IBTA Irupana nursery for testing. Irupana is located at latitude, 16° 25' S, 1848 meters in altitude on the eastern slope of the Cordillera Real range of the Andes. Weather data for 1959-1979 obtained from the Bolivian National Hydrological and Meteorological Service show that the lowest monthly mean temperature is 16°C in July (Fig. 1). This temperature correlates closely with 270 chill hours (4). Budwood of 8 advanced peach and nectarine selections (one, TA 170 has subsequently been released as Earligrande peach) and 4 named cultivars was received by the Irupana nursery in November of 1976 and budded on seedling rootstocks. The cold requirement of the introduced varieties ranged from approximately 100 to 350 chill hours (Table 1).

Trees were planted in the field at the Irupana nursery in December 1976. An 18-46-0 fertilizer was applied to each tree in August of 1977, 1978, and 1979 at 300 grams per tree. Pruning was minimal. Thirty trees were in production in 1979. Individual trees were harvested as fruit ripened, each

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