XIII　附　属　資　料

1. ラスプルハス園芸試験場で保有している温帯果樹とその品種リスト

2. ペンシルベニア大学（米国）が中心となって行ったウルグァイにおける輸出の為の果樹生産増大に関するレポート

3. 植物ホルモン施与によるリンゴの結実への影響について
（ペンシルベニア大学とラスプルハス園芸試験場との共同研究）

1. ESTACION EXPERIMENTAL GRANJERA "LAS BRUJAS".

LISTA DE COLECCIONES POMOLOGICAS

ALMENDRO

BRITZ
FERRADUEL (14)*
FERRAGNES (14)
KAPAREIL
MARCONA (14)
NEC PLUS ULTRA
N.PROLIFIC
NON PAREIL (14)
MARTINELLI (L.) (14)
PEERLESS

CIRUELO

ACE (7) *
BEAUTY
BURMOSA (14)
CASSELMAN
D"ENTE 711
DURADO (18)
EL DORADO (14)
FRONTIER (14)
FRIAR (18)
GAVIOTA (7)
GIANT
GOLD EN JAPAN
GOLDEN RING
HARRY PICKSTONE (5)
LARODA (7) (14)
LINDA ROSA (14)
METHLEY
MORRIS (3)
MUTACION PRUNE D'AGEN (5)
NUBIANA (14)
OZARK PREMIER (14)
PRESIDENTE
QUEEN ANN (14)
RED ACE
RED HEARTH (14)
RED BEAUT (18)
RED ROY (14)
ROYSUM

CIRUELO

SANTA ROSA
SHROPSHIRE (14)
STANLEY

DURAZNERO

ALBATROS (5)
ARMGOLD (3)
ASTENGO (1)
ALFA (17)
AGATA (17)
ANDROSS (14)
BABYGOLD 5 (2)
BABYGOLD 6 (2)
BABYGOLD 7 (2)
BABYGOLD 8 (2)
BLAKE (3)
BONITA (2)
BR - 1 (17)
BR - 2 (17)
BR - 4 (17)
BR - 6 (17)
BERARDI TARDIO (1)
BETA (17)
BABCOCK (17)
BRUNETTO (4)
CABURE (1)
CAPDEBOSC (2)
CAPITAN (2)
CARDINAL (6)
COLLINS (2)
COMPACT RED HAVEN (8)
CONVENIO (2)
CORONET (3)
CRESTHAVEN (1)
DESSERTGOLD (3)y(5)
CALRED (18)
CANDOR (7)
CORRELL (7)

DURAZNERO

CHIRIPA (17)
CHULA (17)
C-101 (14)
CORINGA
CHICO
CORAL
D IAMANTE (2)
DIXILAND (1)
DIXIRED (4)
DUPLESSIS (5)
DELTA (17)
DERBY (7)
EMERY (7)
ELLERBE (7)
EARLY CORONET (1)
EDEN (1)
EARLIGOLD (1)
EARLIRED (1)y(9)
EARLY RED HAVEN (6)
FAIRTIME (5)
FAIRWAY (8)
FLA 13-72 (1)
FLORD AQUEEN (2_)
FORTUNA (7)
FLORDAGOLD (17)
FLAMENGO (17)
FV 9-116 (1)
FAYETTE (1)
FLAMECREST (18)
FLORD APRINCE (18)
GAMA (2)
GLOHAVEN (1)
HALE HARRISON (9)
GOLDEN RED (17)
HARBINGER (17)
HARBBLLE (1)
HALFORD (14)
INGWE (5)
JERSEYLAND (1)y(9)
JERSEYQUEEN (1)
JIM WILSON (9)

* El número entre paréntesis es el origen del cv. (ver última hoja de referencias).

DURAZNERO (cont.)

JULY MEJORADO (1)
JUNEGOLD (1)
JULY ELBERTA (17)
JULY HEATH (OTHELLE) (1)
JEFFERSON (14)
J.H.HALE (14)
KAKAMAS (5)
KEIMOES (5)
KEYSTONE (7)
LA GOLD (8)
LAURETA Nos.1 al 7 (4)
LEVIS (5)
LIBERTADOR (1)
LIMON MARELLI (1)
LATEGOLD (17)
LATEGLO (17)
LOAD EL (14)
MAGNIFIC INTA 73 (1)
MANUEL MARQUISIO (4)
MARHIGH (8)
MAYGOLD (2)
MUIR (5)
MAGNO (17)
MERRILL SUNDANCE (4)
MUTACION TEMPRANA DE
FORTUNA (14)
NEMAGUARD (8)
NORMAN (7)
NJ 211 (17)
NJ 231 (17)
NJ 246 (17)
NJ 248 (17)
NJ 250 (17)
OURO (17)
ONIX (17)
O'HENRY (1)
PACELLI (1)
PAVIA MANTECOSO (4)
PAVIA SIXTO (4)
PENTO[illegible](4)
PRINCESA (2)
P ULLER'S CLING (5)
PALORO (14)
POPPY (1)
PEKIN (7)
PRIMO (17)

DURAZNERO

PILCHA (17)
RED CAP (7)
RED CREST (2)
RED GLOBE (1)
RED HAVEN (4)y(7)
RED LEADER (4)
RED SKIN (3)y(6)
RIO OSO GEM (3)
ROCHON (1)
RUTGERS RED LEAF (8)
REY DEL MONTE (4)
REY DEL MONTE TARDIO (4)
REAL JORGE (14)
RIC BEN (1)
RIO GRANDE (1)
ROYAL GOLD (1)
SAN PEDRO 16-33 (1)
SHASTA (6)
SOUTHLAND (4)
SPRINGCREST (6)
SPRINGOLD (1)
SUNHIGH (3)
SUNNYSIDE (8)
SUNRAY (5)
SUNSHINE (9)
SUWANEE (3)
SIGMA (17)
SIMGOLD (17)
SP 1031- D
SUMMERSET (14)
STARN (14)
TUFHT (14)
TATURA SUNRISE (5)
TATURA SUNSET (5)
TEJON (1)
TRIOGEM (7)
VELVET V.F. (7)
VESUBIO (1)
VIVIAN (6)
VILLA NOVA (17)
WINBLO (7)
WHY NOT (3)

NECTARINO

ARMKING (18)
ARMQUEEN (18)
AUTUMN GRAND (18)
CASCATA NECTARINA (2)
CAVALIER (17)
CASSIA (17)
DALIA (17)
DELICIOUS (14)
EARLY SUNGRAND (9)
FAIRLANE (1)
FANTASIA (1)
FLAMEKIST (5)(9)(1)
FLAVORTOP (9)(1)
FIREBRITE (1)
FLORDAKING (1)
FRESIA (17)
GARDEN STATE (9)
INDEPENDENCE (1)y(7)
IACN 674-4 (17)
LOTUS (17)
LEGRAND (14)
LATE LEGRAND (14)
MAY RED (18)
NECTARED No.2,4,5,6,7,8,10 (1)
NECTARED No. 9 (17)
NECTARROJO INTA (1)
NECTACREST (17)
NECTAROSE (17)
OBLIGADO INTA (1)
PANAMINT (4)
PELON TUNEU (4)
PETUNIA (17)
PELON TARDIO (14)
RED JUNE (6)
STARK DELICIOUS (1)
SUNLITE (2)
SUNRED (1)
REGIA (17)
ROSA (17)
SUNKING (1)
SUNKIST (18)
SP 3.7.N (1)
SP 4.8.N (1)
TULIPA (17)
VIOLETA (17)

MANZANO

AORI No. 2 (11)
ANNA (17)
BLACK WINESAP SPUR (4)
ANGIUS SPUR (16)
ATWOOD SPUR (16)
DELBARSTIVALE (10)
DOUBLE RED DELICIOUS (9)
EMPIRE (8)
EIN SHEMER (17)
ERVIN SPURED (16)
FIRMGOLD (9)
FUJI (11)y(17)
GALA (17)y(16)
GOLDEN DELICIOUS (7)
GRANNY SMITH V.F. (8)
HAWKES BAY (8)
HI EARLY DELICIOUS (8)
ISRAEL 2-48 (8)
ISRAEL 8-6 (8)
JERSEYMAC (8)
JULY RED (8)
KINSEI (11)
MOLLE'S DELICIOUS (8)
NJ 44 (12)
NJ 53 (12)
NERO 26 (17)
OREI (11)
PAULARED (8)
PRIMA (5)
QUINTE (8)
RED CHIEF (8)
RED KING OREGON (16)
RED DELICIOUS HARROLD (7)
RED PRINCE (8)
RED SPUR DELICIOUS (13)
ROME BEAUTY V.F. (7)
SEKA - ICHI (11)
SHINNOSEY (7)
SKYLINE SUPREME (9)
SPLENDOUR (5)
SPUR ROME
STARKING DELICIOUS (7)
STARKRIMSON (4)
STURDESPUR (7)
TOHOKU Nº 3 (AKANE) (11)
TOP RED DELICIOUS (8)

MANZANO

TOP RED SPUR (16)
VISTA BELLA (NJ 36) (12)
VERED (17)
WELLSPUR (5)

DAMASCO

BARACCA
BOCUCCIA
BULIDA
BULIDA HUSSEIN
BULIDAS (14)
BULIDA REGNICOLLO (4)
BANDERA ESPAÑOLA (14)
MANCHU V.F.
MONIGNI (A-500)
MOORPARK (14)
NJ 31
NJ 13
OLD TREE BALBEC
PIET CILLIERS (Sel. 35/9)
ROYAL V.F.
SEMILLA DE TARDIO DE BORDANEIL
TILTON

PERAL

BEARRE D' ANJOU (9)
BEAURRE PRECOCE MORETTINI
DEVOE (9)
DOYENNE DU COMICE
DUCHESSE D' ANGOULEME
EL DORADO
FAVORITA DE CLAPP (4)
IMPERIAL BARTLETT (9)
MOONGLOW (9)
OLD HOME (4)
PACKHAM'S TRIUMPH (4)
PASSE CRASSANE
Q 1
Q 2
RED BARTLET (4)

PERAL

RED BARTLETT (4)
SANTA MARIA (4)
WILLIAM'S
WINTER NELLIS
WORDEN SECKEL (9)

FRAMBUESO

HERITAGE (9)
LATHAM (9)
SCEPTER (9)

KIWI

HAYWARD
MATUA
TOMURY

REFERENCIAS:

(1) Estación Experimental INTA San Pedro, Argentina.

(2) VEPAE Cascata, Pelotas, Brasil,

(3) Texas A & M University.

(4) Productor particular, Uruguay.

(5) Stellenbosch, Sudafrica.

(6) INRA Bordeaux, Francia.

(7) International Repository, Estados Unidos.

(8) Estados Unidos.

(9) Bountiful Ridge Nurseries, Estados Unidos.

(10) Pepiniéres Delbard, Francia.

(11) Japón, Morioka

(12) Rutgers University, New Jersey, Estados Unidos.

(13) INTA, Argentina.

(14) INTA Junín, Argentina.

(15) INTA Rama Caída, Argentina.

(16) INTA Alto Valle de Río Negro, Argentina

(17) Centro Nacional de Pesquisa de Fruteiras de Clima Temperado (CNPFT), Pelotas, Brasil.

(18) Estación Experimental La Platina INIA. Chile.

VID

ALPHONSE LAVALLE (15)
ARAMON (8)
ALMERIA (8)
BACO BLANC (8)
BARBERA (8)
BEAUTY SEEDLES (8)
CABER-NET SAUVIGNON (8)
CARDINAL (15)
CHASELAS DOREE (8)
CANNER (8)
CEREZA ITALIANA (15)
CORNICHON VIOLETA (15)
CRIOLLA GRANDE (15)
DATTIER DE BEYROUTH (15)
DANLAS (6)
DELIGHT (8)
EMPEROR (8)
GAMAY (8)
GOBERNADOR BENEGAS (15)
ISABELLA (8)
ITALIA (8)
LIVAL (6)
MISSION (8)
MOSCATEL ALEJANDRIA (15)
MOSCATEL ROSADO (15)
MOSCATEL HAMBURGO (15) y (8)
MOLINERA (15)
OLIVETTE BLANC (8)
PINOT NOIR (8)
PROUNE DE CAZOULS (15)
RED OHANES (15)
RIBOL (6)
SEMILLON (8)
SULTANINA (THOMPSON SEEDLES) (8)
TANNAT (8)
VALDEPEÑAS (8)

2. Pennsylvania State U., Michigan State U., and Texas A & M U.

University Consortium in Uruguay

Contract AID/La-722

Report No. 25

IMPROVING PRODUCTION OF FRUIT FOR EXPORT

Dr. Chester W. Hitz

The Pennsylvania State University

Dec. 17, 1972 - March 31, 1976

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The problems of agricultural production in Uruguay are well documented (2, 3, 8, 13, 14, 18, 20, 25)[1/]. In earlier reports (18, 20) I too have presented such philosophies and it seems superfluous to use them again extensively in preparing another report. Peterson (25 b.) recently appraised the productivity of the Agricultural and Marketing project of the U.S. Agency for International Development. He cited the early history (1966-72) of the project and cited a decision made in 1972 as radically changing AID's approach to helping solve Uruguay's agricultural problems. Supporting the GOU's objective of increasing productivity and exportation of non-traditional crops, the Agency signed that year the Agreement La-722 with a Consortium of universities (The Pennsylvania State University, The Michigan State University and the Texas A & M University) with the aim of upgrading the research capabilities in fruit and vegetable production, thereby stimulating an industry-wide ability to produce and market internationally.

Uruguay's export market in deciduous fruits is primarily Brazil (15, 22, 23, 28). The merchandising advantages of Uruguay's nearness to that market currently are shared with no other country. It is believed, however, as has been stated (26), that for some crops such as apples and pears, the amount available for export from Argentina is a more important determinant of the level of exportation from Uruguay than is its own level of production. An example is the less-than-100 ton exportation of apples from 1968 through 1972 (15, 25) to the over-1000 ton record exportation in 1973 (23). Unless the international price is abnormal as caused by crop failure in Argentina in 1973, the high cost of production in Uruguay, including the high cost of packaging for export, prevents its fruit from consistently entering the Brazilian market in quantity (18, 29).

Several factors contribute to the high costs of production in Uruguay. Fletcher and Morrill (14) describe the protection the government gives producers through various subsidies but primarily through preventing imports of fresh deciduous fruits. "This and taxes imposed on imported pesticides and equipment have permitted 'carelessness' in the control of costs of production and of sales quality to develop." (18)

1/ The numbers within parenthesis refer to literature citations listed elsewhere in this report.

I believe that the primary determinant of production costs in Uruguay and the current low competitiveness of its fresh fruits in foreign markets is productivity: per plant, per hectare and per operator. In 1970 for example the productivity of Pennsylvania, U.S.A., orchards was calculated to be twice the level per hectare found in Uruguay (18). The higher the productivity, the lower the cost of production and marketing and the more competitive is the product. Working within the scope of my responsibilities, as defined for the pomologist assignee in the AID-PSU contract (3), I have consistently encouraged those research investigations that attack the cost of production of a fruit crop or improve its attractiveness on foreign markets.

In this termination presentation I will describe several production situations and procedures that influence cost of production and market attractiveness and will discuss the attempts of station personnel and Consortium pomologists to investigate the modification of such procedures.

CLIMATIC FACTORS

A. Winter Cold.

The most significant climatic effect on productivity of fruit trees in Uruguay results from its relatively mild winter.

The commercial orchards near Montevideo are located at the northern edge of areas generally considered suitable for production of deciduous fruits. The varieties grown in the area and their management must be governed by the trees' response to low amounts of winter cold, at least until breeding programs produce commercial cultivars that bloom and set good crops with few hours of effective cold.

The number of hours of winter cold at 7.2°C. required to stimulate uniform spring growth and bloom of deciduous fruit plants is considered quite specific in many parts of the world, in spite of recent recognition (11, 12) that temperatures near the level cited also are effective. According to the calculations of Hatch (17) and Gowen (7) and their counterparts, several peach varieties that grow and fruit more-or-less well in Uruguay would grow spasmodically or die when grown in southern U.S.A. The variety Red Haven, for example, although not matching in Uruguay its world reputation of heavy annual productivity, often bears very profitably. It is said to require 900 hours of effective cold, whereas in Uruguay in the years 1969-75 there were never more than 750 hours registered (7) and in several years the hours were below 500. Gowen (7) estimated that even the most ideally adapted varieties Rey Del Monte and Melilla, both of local origin, would require around 800 hours of cold by U.S. standards.

Both workers, while on assignment in Uruguay, sought means of explaining the response of various cultivars to the growing conditions of the country. Hatch proposed the use of chilling degree days calculated as the number of days:

$$I\left[18^{\circ}C. - \frac{max.temp. + min.temp.}{2}\right] \quad \text{for the period May through August.}$$

He believed this measurement which included both daily maximum and minimum temperatures in its calculation would explain the situation in Uruguay and recommended it be tested in the years following.

Bowen (7) suggested the use of a reference temperature other than 7.2°C. (as has been done the last few years at Las Brujas) or better still to use the method of Erez and Lavee (11) which permits measurement of the accumulated differential effectiveness of all temperatures between 18°C. and -27°C.

Hatch and his counterpart, Ing. Formento, applied the chemicals which had been found to be effective in breaking peach-tree rest particularly in Israel (12). Little benefit resulted from the treatment the first year or upon Formento's repeat of the trials in 1974. The lack of favorable response to the trials in 1973 and observations of peach tree growth in the country led Hatch to believe that factors other than lack of chilling were causes of low productivity in Uruguay.

Bowen, from observations made during the summer of 1975-76 and from correlated studies of winter temperatures and yield records, suggested that tree vigor as influenced by pruning, thinning and nutrition may have a marked effect on tree response to winter cold or perhaps was more important than cold in influencing annual yields of some peach cultivars. Hatch in 1975 recommended and Bowen in 1976 complimented the more extensive test of varieties now being conducted by Ing. Borsani.

For only a few years have observations been made at or near Las Brujas on the results of application of spray oil to apple or pear trees before bloom. The hastening of bloom and the possible earlier harvest of fruit to result in an export period ahead of the Rio Negro Valley of Argentina is worthy of continued study. In the 1976 data exists the possibility that the earliest blooming flowers of Delicious produce fruits of the most desirable shape, see next section.

B. Growing Season Temperatures.

Compared to the more famous South American apple producing areas in Argentina and Chile, Uruguay has one tremendous climatic advantage. Fruit specialists at Las Brujas can remember no season when frost near blossoming time has reduced Uruguayan production of apples. This advantage is not without its faults. The Delicious, the chief variety of both Argentina and Uruguay and probably the world, is pictured mentally as an elongated conic fruit, distinctly crowned with 5 lobes at the calyx end. In localities where temperatures are cool and frost possible during blossoming and immediately following, the Delicious apple assumes the shape mankind has attributed to it. Most Delicious harvested in Uruguay are not of such shape but are round or oblate without prominent lobes and to the Brazilian consumer, more accustomed to shaped Delicious of Argentina, are not recognized as Delicious.

Experiments with the objective of modifying the shape of Delicious apples have been conducted in four of the past 5 years. The treatments have consisted of applications of a mixture of growth substances applied at full bloom and shortly afterwards. The formulated mixture (Amdal 3001) of Gibberellin A_4A_7 and the cytokinin benzyladenine was furnished by a U.S. company -Abbott Laboratories.

The results of the experiments in brief:

1971-72

The fruits from treated trees had larger length/diameter ratios than fruits from check trees; when data derived from a statistical model, proportioning L/D with lobe development were compared, several spray treatments yielded fruit shape statistically superior to untreated fruits; the treatments had no significant effect on fruit set and yield of trees.

1973-74

The only spray treatments applied permitted an evaluation of the effect of 2 applications of the mixture of growth substance applied near blossoming. Untreated fruits necessarily were obtained from trees outside the orchard of spray treatment.

Fruits of sprayed trees had a significantly greater L/D ratio and yielded greater values for the statistical model utilized in 1971-72.

Weight and volume per fruit were determined on fruits from sprayed and unsprayed trees following separation of the fruit into 5 sizes by diameter. Within each diameter classification fruits from sprayed trees were heavier and of greater volume than were fruits of untreated trees.

A series of measurements from the base of an apple to the point of its widest diameter and from the calyx to the same point revealed that the elongation of affected apples occurred only in the latter section.

1974-75

The experiments were conducted on the same farm as the year before but in different trees than previously used. Three replicates were on young trees and three were on rather old, low-vigor trees. Treatment and application methods were similar to those used previously.

In the records accumulated there was no statistically significant influence of treatment on fruit set or yields, although values for all the spray treatments were numerically inferior to those of the unsprayed trees. The fruit L/D ratios of all treatments except the one where two applications of 500 ppm were applied, were significantly greater than on those from unsprayed trees. The ratios of the treated fruits were around 0.86 whereas this measurement on a few Washington State Delicious purchased in the U.S. was 1.02 and on selected groups of fruits from a local orchard -where shape normally is extraordinarily good- the ratios averaged 0.97 (wood from some trees of this orchard are being vegetatively propagated at Las Brujas to determine if this superior shape is a genetic factor and therefore can be made available to all growers).

Williams (26) has stated that ratios of 1.0 or more are most desirable. Ratios below 0.9 have been considered unacceptable (19).

1975-76

In each experiment until now it always has been possible to find within any treatment fruits with L/D ratios varying widely. In two years the flower buds not open at time of spraying were removed from selected branches. Fruits remaining on these branches generally had higher L/D ratios than the tree averages. In order to determine the influence of bud development at time of treatment, modifications were made in the timing of the applications, and at each application for each tree of three of the replications, buds at full bloom, past full bloom and not yet in bloom were tagged.

Luckily there was enough set within each classification to permit some interpretation of results. Subject to a more detailed evaluation with the completion of harvest and the total analysis of results, I suspect that trees receiving these applications (at weekly intervals) will yield a higher percentage of well formed fruits than trees receiving fewer applications; that flower buds already past bloom were affected by applications but that those not yet open were not affected.

There are now sufficient data and experience available at the Las Brujas Station that recommendations regarding the commercial use of the gibberell-cytokinin mixture can be made as soon as it becomes generally available.

If more research time is available for this program I suggest that trials with the two components used separately would be of value. The gibberell is said to stimulate fruit elongation; the cytokinin stimulates the production of the lobes. It is possible that gibberell used alone would be more effective than in a mixture. The lobes formed in our trials usually have been abnormal in appearance and size. It is possible that concentration and time of application would affect the stimulation exerted by the cytokinin.

C. Distribution of Rainfall.

Fletcher and Merrill (14) reported the summer climate of Uruguay to be humid, with an average rainfall enough to grow most crops, although droughts of various durations are not uncommon during the growing season. Much of the fruit production around Montevideo is on soils somewhat heavy and shallow (by U.S. standards) with poor internal drainage (9 b.). The poor drainage no doubt limits depth and spread of roots which in turn limits the amount of moisture available to trees during the periods of drought. The commonly employed clean cultivation of orchards springs from a recognition of the need to conserve moisture against the drought periods, thereby insuring the trees' ability to carry heavy crops, and to maintain productivity and vigor. However, it is probable that the deep plowing, used to remove the weeds and to move the soil to and from the trees as drainage and conservation conditions dictate, counter-balances the conservation of clean cultivation by reducing still further the soil areas exploitable by tree roots.

I have found tree mortality and unhealthy trees to be unusually high in some orchards in Uruguay. Missing and weak trees decrease productivity. Although the direct cause of tree weakness may be attributed to sunscald, canker diseases or something else, I believe the trees fail to resist or outgrow these adversities mainly because of loss of vigor from limited rooting.

In my opinion the general lack of beneficial soil management practices that would improve drainage, improve the conservation of soil moisture and prevent erosion is among the most important of the factors retarding productivity in Uruguay. There are several wellknown soil-management systems which have these characteristics but which are not practiced in Uruguay.

Sod cover with chemical weed control in the rows. Sod is allowed to grow vigorously in the row middles when moisture is plentifull and is closely mowed when deficient. Chemical weed control in the rows eliminates practically all weed ~~control~~. Competition.

Sod plus mulch. Row middles are managed as above. Organic mulch, thick enough to prevent weed growth, is spread from near the tree trunk to just beyond the periphery of the tree. In my several experiments with orchard soil management, this system generally has promoted the best growth and yields on soils a little too light, a little too heavy or a little too shallow. Drainage can be improved, especially for size-controlled trees by moving soil, prior to planting, to the tree rows so as to make the rows higher than the middles.

The economics of irrigation, especially drip irrigation, and subsurface tiling for drainage should be investigated.

An extensive, short-term experiment with seedling plants was designed in 1973 to determine the factors most responsible for early mortality and slow growth of newly set apple trees. The planting plan isolated the factors of soil drainage conditions, good planting and management methods versus careless handling methods and planting immediately after the digging of the nursery stock versus 30 days of delay. The drainage conditions were: a) moving and ridging of top soil so that the trees had abnormally great depth of well-drained top soil in which to grow; b) planting in areas from which the top soil had been removed; c) planting over a gravel-filled drainage ditch 2 feet below planting depth --to stimulate excess drainage; and d) planting in soil of normal depth for the area. The well managed trees were not root-pruned at planting, were watered after planting add were mulched with organic material to such depth as to prevent the growth of most types of weeds; the trees poorly managed had 2/3 of the roots removed at planting and received no watering or mulching; a third group received identical treatment except that only 1/3 of the roots were pruned. The sub, sub plots of the experiment permitted comparison of immediate versus delayed planting.

In the first year of growth of the experimental plants, the mulched trees, that is, those of carefully planted and managed treatment were outstandingly superior to those of any other isolatable treatment. The advantage of size and vigor of this treatment continued through 1975 when the closeness of the planting tree-to-tree was considered to have ended treatment separations and the experiment was terminated.

At least one of the larger growers in Uruguay, after observing this experiment, has commenced a mulching trial of his own. Hopefully the practice will spread. Las Brujas personnel, Tallco and Canale, have commenced a larger trial comparison of mulched versus non mulched trees where moisture and nutrient availability and soil temperatures will be recorded. These trials will be beneficial but larger scale demonstrational trials are urged in order to obtain a quick appraisal-adoption of the practice.

VARIETY ADAPTATION

In the earlier discussions of the problems of rest periods and fruit shape variety adaptation was of frequent mention. New varieties of peaches are needed to extend the duration of the export market; is there a Delicious sport that has both the red color and the shape to compete with the Rio Negro Delicious? Although varieties originating from breeding programs in neighboring countries, in Europe and in other parts of the world are under test at Las Brujas, most of those imported for test within the past few years have been from the United States. Through response to AID and Consortium requests, some 35 varieties of stone fruits, over 40 varieties of apple and pear and 25 varieties of grapes have been imported since 1970 for propagation at Las Brujas. Included in these varieties are ones originating in Japan, Israel and Australia. Principal centers of supply and the assignee originating the request have been: peaches and other stone fruits -- the national virus-free repository at Pullman, Washington (Boyle, Hitz), The Texas A & M University (Cowen), Rutgers University (Hitz); apples -- Michigan State University (Carlson), Rutgers University (Hitz), Pennsylvania State University (Hitz), grapes The University of California, Davis (Hitz).

Among all the varieties under test, which in the 1975 propagation included also 14 from France and 43 from South Africa, may there be some that in Uruguay are characterized by good tree vitality and by high yields of exportable quality. A well-adapted variety is cheaper to grow than one only partially adapted to a climate and market.

Dr. Carlson, a short-term Consortium assignee, is a recognized international authority on the commercial utilization of size-control stocks. In his termination report (9 b.) he describes the use of dwarf rootstocks, i.e. roots which keep the mature tree at less-than-standard size. Such trees of apple and pear, are planted at greater density than standard trees. Their smaller size necessitates less powerful spray equipment and less expensive (and more efficient) harvest and pruning equipment. Such trees, when properly trained, have few shady areas per plant and when planted at the correct density have more leaves (and leaves more efficient in the synthesis of organic materials) and consequently more yield per hectare than standard trees. These higher yields can lower the costs of production to produce a more competitive product on international markets. It is unfortunate that an increasing percentage of the production of the Rio Negro Valley is coming from dwarf trees. (21)

Although I recognize well the need for Las Brujas to test the response of various dwarfing rootstocks and interstems (there are some 10-12 of recognized value in commercial use) with the varieties grown in Uruguay under Uruguayan conditions, I doubt that its production for the international market can await the proven 'best' stock-scion combination. I recommend that station personnel make an intelligent guess of the most suitable combinations and that they and their planting distances be recommended for trial plantings; else the productivity and cost-of-production advantages of the Rio Negro Valley will continue to widen over Uruguay's cost.

The specialists of Las Brujas have the responsibility of maintaining their contacts with the assignees cited earlier so that there are available to Las Brujas those new scion and rootstock varieties which are most likely to be adaptable to Uruguayan cultivation.

UPGRADING NURSERY STOCK

In 1972 I remarked (20) of the need to improve the quality of the nursery stock that is available to growers. Carlson expanded the basic premise (9 b.) and in a special report (9) prepared with Ing. Borsani, described how a certification program might work in Uruguay. In their opening paragraph the authors emphasize the role of healthy nursery trees toward affecting productivity in that "poorly propagated trees can cause problems for the fruit grower in the forms of tree losses, lack of uniformity and weak, nonproductive trees."

The producers need a reliable source of true-to-name and healthy trees whether they be from a government or station-controlled nursery or through a government or nursery-financed inspection and certification program. Now, when the Las Brujas extensive testing of rootstock and scion varieties soon should be yielding recommended introductions new to both producers and nurserymen would seem a logical time to upgrade the quality of the nursery stock available for purchase.

NUTRITION OF FRUIT TREES

An important determinant of fruit tree productivity is the supply of soil nutrients available for the life processes of the tree. The key element of productivity in Uruguay as in other parts of the world is nitrogen. Trees growing under cultures supplying insufficiencies of this element show reduced fruit bearing areas and small crops of undersized fruits undesirable for export.

Among the elements considered essential for successful fruit culture, potassium is very important. The element is in ample supply in the soils surrounding Montevideo, and no doubt can or should be omitted from most fertilizer programs in Uruguay. Phosphorus is of low availability in local soils and, were not fruit trees such excellent foragers for this element, would need consideration in the fertilization program for these plants. Only a few experiments world-wide have revealed a response of fruit trees to applications of phosphorus fertilizers and these on soils totally unlike those of Uruguay.

In 1971 I helped locate and design experiments for the fertilization of apple and peaches. These probably were the first fruit tree experiments ever employed in Uruguay with a design permitting statistical analysis and interpretation of the results. Both the experiments had the primary objective of determining the level of nitrogen which would stimulate tree productivity. In each experiment 3 or 4 levels of nitrogen applications in the form of urea were checked against a zero level treatment and one of a complete fertilizer (15% nitrogen, 15% phosphorus and 15% potassium) at a rate to supply nitrogen equivalent to one of the levels of N--plus phosphorus, plus potash.

The experiment with peaches was located in an orchard showing symptoms of nutritive shortages. Although leaf color and growth responses were evident even the first year of treatment the trial had to be abandoned after the 1972 harvest because tree mortality had confounded the statistical analyses and interpretations seriously.

Another experiment was designed in 1973 on a very uniform block of peach trees. By 1974-75 the experiment was providing evidence of the influence of both tree pruning and tree nutrition on growth and yield. In the short crop of that year the experimental trees, which were pruned much less severely than other trees in the orchard had at least twice the productivity as the classically pruned, non-experimental trees. Also the trees were responding to the nitrogen fertilization: in growth (weight of prunings), tree productivity and in nitrogen content in leaves. A more complete separation of treatment responses can be expected as more years and data accumulate.

Through the harvest season of 1975 the fertilizers applied in the apple tree experiment were stimulating no response, in trunk growth, fruit yield and size, and foliar analyses (N,P and K only). Adding potash and phosphorus to the fertilizer was of no benefit.

It is recommended that this experiment be abandoned. If after 5 years of treatment, there is no significance in response of fertilized over non-fertilized trees, it is evident that the trees, if not at their upper limits of productivity and growth for the conditions under which they grow, have factors other than their supply of nitrogen, phosphorus and potash influencing vigor and fruiting. These factors are unknown at present but are not believed to be of a nutritional nature since no visual symptoms of deficiency have been recognized. The variability among trees has increased and some have been lost perhaps due to unequal drainage as indicated by water frequently standing in some row middles. Roots damaged by the cultivation procedures have been observed yet compaction from traveling over the wet soil with tractors and sprayers is possible.

I believe that fertilization can and will have an influence upon the productivity of apple trees, especially upon the vigor and precocity of young trees. I, therefore, recommend that a new fertilizer trial should be commenced in an orchard of uniform young or newly set trees where soil depth, excess moisture and cultural methods are not likely soon to become factors limiting responses among treatments.

Treatments should be basically a measurement of the influence of nitrogen level not unlike the old experiment. In none of the experimental data accumulated thus far has there been any evidence of benefit of adding phosphorus and potash to the orchard fertilizer, which must be applied at a rate which provides the proper supply of nitrogen. Three times as much 15-15-15 as urea must be applied to supply an equivalent amount of nitrogen. Rarely is urea 3 times as expensive as 15-15-15.

I doubt that any benefit of a complete mix will be shown in the continuation of comparisons of complete versus nitrogen-only fertilizers in the orchards surrounding Montevideo. I, therefore, advise station personnel to recommend even more strongly the use of nitrogen only programs in fruit orchards. This is a relatively safe declaration since the specialists already own a great deal of data supporting the recommendations;and monitoring of experimental and grower orchards through a foliar-analysis laboratory will soon be possible in Uruguay. Such monitoring should forewarn of any difficulties developing from the utilization of this cheaper fertilizer material (per gram of nitrogen).

Minor element supply (i.e. elements other than nitrogen, potash and phosphorus) is apt to be deficient or poorly balanced with other elements in soils of the nature and pH of those surrounding Montevideo. Although I found evidence of boron deficiency (or perhaps manganese excess) as early as 1967, I did not encounter additional serious deficiencies until Dr. N.F. Childers pointed out boron deficiency during his visit to Uruguay in early 1975. Subsequently it was found to be a serious problem in several orchards and an experiment testing control method was initiated the spring of 1975 by Ing. R. Menendez. In his experiments, Menendez -who received a M.S. at Washington State University with the support of AID- is combining spray applications of boron and calcium. The latter element could be expected to enhance fruit finish and possibly protect fruit from the physiological disorder "bitter pit".

Visual symptoms of deficiencies of other elements have been identified or observed. The chlorosis of iron deficiency has been seen in the spring; magnessium deficiency could be expected, stimulated by the high levels of soil potash common to Uruguay. Apple measles, unlikely to have been caused by an excess of soil manganese under the pH conditions of Uruguay was observed in 1967 and could have resulted from a manganese-boron imbalance.

Positive confirmation of visual symptoms need await in Uruguay the installation of a foliar-analysis laboratory. For fruit trees soil analyses rarely reflect their nutritional status for the simple reason that it is practically impossible to obtain soil samples representative of the fogaging areas of the roots. Most soil analyses do not correlate well with foliar analyses or with the nutritional status of the trees.

Fortunately, through support provided by AID, Uruguay is expected to have complete foliar-analysis facilities for research and for a recommendation service to growers by late 1976. It is recommended that these facilities and their specialists be utilized fully by research personnel at Las Brujas and that no attempt be made to duplicate any equipment or function of these facilities. There is so much to be done by so few people with so little financial support that the specialists and the Ministry can ill afford to duplicate any facility or function at Las Brujas or Salto that can be done elsewhere.

TRAINING AND PRUNING

An American fruit specialist traveling through the fruit areas of Uruguay always is attracted to the tree forms resulting from the traditional methods of training and pruning free-standing trees. In the U.S. a cone-shaped, central leader type tree is desired because this form exposes the greatest proportion of leaves to the sun; the typical tree of Uruguay has the shape of a baseless goblet. In the U.S. most pruning is through thinning cuts to a lateral, or by the complete removal of laterals; in Uruguay heading back cuts are common to leave trees formally level across their tops and across the orchard. Strong tree structure is sought in the U.S. by spacing wide-angled scaffold limbs vertically around the trunk; in the traditional open-vase tree of Uruguay several scaffolds originate at one point on the trunk and often are narrowly angled to the trunk and one another.

The basic objectives of training and pruning are:

to obtain structurally strong trees capable of supporting heavy crops over a long life span;

to obtain a large bearing surface per tree;

to obtain profitable production early;

to maintain trees at a size of greatest economic return; and

to maintain a balance between fruiting and growth.

The Consortium specialists assigned to Uruguay believe that most of these characteristics are found in the cone or central-leader tree or in some slight modification from it. Certainly the severe pruning of young trees as traditionally practiced in Uruguay must delay bearing, it must dwarf the trees and the goblet shape the trees assume permits the shading of many leaves. But spring foliage develops earlier and more completely on "cut-back" limbs than on growths not shortened. (Perhaps the cutting back excites dormancy-inclined branches into growth). Perhaps the dwarfing resulting from severe pruning keeps tree tops more in balance with a root system limited in area by deep cultivation and a shallow, poorly aerated soil. Certainly heavy pruning reduces the fruit thinning that might otherwise be necessary or reduces the amount of nitrogen that need be applied, although in trying for this objective, the profits of a crop can be lost.

I doubt that the severe pruning traditional to Uruguay is the most productive. I doubt too that the vase type of tree is structurally strong enough to withstand the heavier cropping that could result from utilization of well-adapted varieties and improved cultural practices. Clear is the need of experimentation to prove the effect of tree form and severity of pruning on the productivity of fruit trees for the growing conditions of Uruguay. The controversy regarding the training and pruning to recommend will be greatly confounded by general adoption of tree dwarfing, spur-type varieties and high density plantings. These factors, as well as the general nutritional status and the soil management employed, need consideration in planning experiments in training and pruning.

In 1971 two training-pruning experiments -one on young apples, one on young peaches- were initiated. Within a short time it became necessary to abandon the apple study because of excessive tree mortality. The experimental trees were entirely of replants within a commercial block, and as such, failed to receive the care expected of new plants; also each replant may have been a replant because of the adversities the first plant had not survived at the site.

Records of trunk diameter and yields have been collected on the experimental planting of peaches each year since the experiment started. Through the harvest records of 1976, the data reveal a tree response much as would be expected in Pennsylvania. The unpruned or slightly pruned trees are larger and more productive than those trees heavily pruned, i.e. trees of the traditional vase pruning and trees severely pruned in order to maintain a particular form of tree (the Michigan side branch). Trees of the most severe pruning yielded larger fruits but smaller tonage than the lightly pruned trees. In the 1976 yield data it is noteworthy that trees trained to the "Street" system averaged the largest yields but the smallest fruits.

A program of year-to-year photography in this block has yielded a set of slides of excellent value for teaching and demonstration.

The same year that the apple experiment was terminated, I and my counterparts, not possessing enough trees and space to set up a new experiment of approved statistical design, made planting at Las Brujas where different tree trainings could be demonstrated and photographed year-by-year. Because of a lack of suitable replication in type, rootstock and tree age at planting, the growth and yields of these Delicious trees are not suitable experimental parameters. The photos and the trees themselves should continue to be good teaching and demonstration aids.

I recommend that a training block of minimum experimental size be designed for apple trees and planted as soon as possible. The differential pruning experiment with peaches should be continued but the experiment station should attempt to insure that the trees receive proper fertilizing and thinning each year -- even to the extent of underwriting the costs of these operations if necessary. It is recommended also that the scaffold selections be accomplished this year on the trees of the Street system and that the removal of unwanted scaffolds commence with the plan that it will take 3-4 years to bring the trees to the form desired.

I further recommend that the fruit specialists continue and expand their research with training and pruning. As stated previously the many innovations in tree culture (dwarf stocks, spur types, growth retardants, tree density) and their probable influence upon productivity and cost of production all demand attention from the standpoint of training and pruning.

FRUIT THINNING

The first chemical thinning experiments for the Delicious apple were designed for the growing season of 1974-75. The expected response of the variety to several thinning chemicals was considered before the growth substance naphthaleneacetic acid (NAA) was finally chosen. Of the comparative advantages and disadvantages arising from the use of this chemical, its ability to induce "come-back" blossoming in addition to its thinning action, was considered most important in regulating crop size and production costs year-to-year in Uruguay.

Because I feared over thinning on trees generally less vigorous than those of Pennsylvania, rather low concentrations of the growth substance were recommended. Bedause the bloom period extends over many days in Uruguay and because differential thinning action is reported for different dates of treatment (24), single applications of the material were made at 15, 20 and 25 days after full bloom.

Because in none of the treatments was fruit or crop size differing significantly at harvest from the no-application treatment, it was decided that the concentrations applied were too low. Helpful to future testing was the revelation that fruit set on selected branches on either the north or south side of the tree did not differ from set on the other side.

Experiments in chemical thinning were continued for the 1975-76 season, but at this writing the results are not available.

Many experiment stations in the U.S. recommend the insecticide Sevin in preference to NAA for thinning Delicious. As soon as possible the thinning experiments should include studies of Sevin in comparison with NAA, especially in their stimulation of "come-back" bloom, a most important aspect of fruit thinning. The other two recognized chemical thinners would seem unlikely to succeed in Uruguay: DNOC (dinitro) because it is erratic in humid areas; naphthylacetamide (NAD) because it causes too many dwarf Delicious to hang on the trees.

Peaches and plums respond well to the thinning of heavy crops with increased fruit size of improved quality and competitiveness. Bowen (7) suggests overcropping may be an important determinant of irregular annual cropping in well-adapted peach variety Rey del Monte. Chemical thinning of peaches has not been adopted in most parts of the world. This means that mechanical thinning is generally employed. Thinning by hand, if enough careful laborers can be found to cover the orchard in time, is no doubt the most reliable means of mechanical thinning. But this is several times more expensive and slower than other means of thinning mechanically. Tree shakers and systems of knocking off fruits with a pole (pole thinning) are faster, and cheaper than hand thinning; they are reasonably effective and, therefore, are widely utilized, often in combination with hand thinning, in the U.S.

Because I think it is no easier to get Uruguayan growers to hand thin than it is Pennsylvania growers, I urge that the Station re-evaluate hand with pole thinning, especially in relation to effectiveness and cost. Pole thinning is much easier to sell than is hand thinning.

In discussions of thinning with growers it is important to recommend that the thinning of early varieties start early, even at blossoming, and that the completeness of thinning be determined not by the number of fruits on the ground but by the number remaining on the trees. No more than 600-700 fruits should be carried by most peach trees -even those not severely cut back each year.

Plums are mostly still hand thinned in the U.S. The rule-of-thumb there is to thin the fruits to 2 inches apart, starting immediately after the pollination (June) drop.

In view of the conclusions by Bowen (7) regarding the importance of thinning Rey del Monte toward regulating annual productivity and because of the recognized influence of chemical thinning on saleability and annual productivity of apples, the studies with thinning must continue if the objectives of exportability are to be met.

POST HARVEST STUDIES

The determinants of exportability of any fruit crop are numerous. Of equal importance to its availability for export i.e. its production and productivity, is the ability ofthe product to survive the transport of its export and to arrive at the market place attractively priced. To attain this status the fruit must be well grown at the lowest possible cost per export unit, but not necessarily at lowest cost per acre. The cost of preparation for transport and market must be low. There is relatively small return to the entire fruit industry from flying one or two-layer containers of fancy , cell-packed fruit to distant markets. The costs are high and the demand is limited. But there is value to all producers and to the country if large quantities of quality fruit can be moved cheaply in low priced (returnable?) containers to neighboring countries.

It has been the objectives of the investigations in post harvest to provide the means by which Uruguayan fruit can survive the rigors of transport and storage to arrive in quantity at export markets at an attractive price and attractive in appearance.

Stone fruits and apples will be discussed separately.

Peach Rot Control

The peach is second only to citrus crops in its export importance and potential (2, 10, 13, 15, 22). Problems of exporting Uruguayan peaches, even the attractive, firm-fleshed Rey del Monte, have been reported, but seldom mentioned as a factor of exportability is rot susceptibility. Yet the well recognized perishibility of peaches and other stone fruits results not so much from over-ripeness as from an increasing liability to rots as softening develops. It is the rots caused by Monilinia (*Monilinia fructicola*) and Rhizopus (*Rhizopus stolonifer*) that limit the marketability and sales life of peaches.

Cold retards the growth of these fungi and refrigeration sometimes may be recommended to control the diseases. But cold does not kill the organisms and they may grow rampant when the fruit is returned to ambient temperatures. "The best interests of the peach industry are not served when refrigeration is mainly depended upon to hold rot in check." (16)

However, it was because the precooling and refrigerated transport facilities were and are not adequate to protect significant quantities of export peaches from rotting and ripening that these experiments were started. If rot could be held to around 10 percent or less without refrigeration for ten days the export market for Uruguayan peaches could be greatly increased.

The first experiments to improve the post harvest protection against rots were conducted in 1970. There were additional studies in the harvests which followed. The highlights to the experiments can be noted.

We, my fellow workers at Las Brujas and I, were among the first researchers to recognize the relatively high specificity of the fungicides Botran[1/] against Rhizopus and of Benlate[1/] against Monilinia; among the first researchers to mix solutions of the two together to use as a post harvest dip; and Las Brujas probably was the first experiment station in the world to recommend the use of baths of the fungicidal mixture for post harvest control of these two diseases. This was in 1971.

Most generally the work over the succeeding years has been with the variety Rey del Monte because of its attractive export quality. All studies were designed to permit statistical interpretation of results involving the isolatable factors: concentration of each product in a single-dip treatment; duration of the bath treatments, temperature of the baths, effectiveness of pre-harvest treatments, influence of cold storage and package types; effectiveness of the baths in preventing contact spread of the diseases and the interaction effects of several of the factors listed.

These experiments will not be discussed in great detail but several overall conclusions can be presented.

1/ Trademark names. Benlate (benomyl) is methyl 1-(butylcarbamoyl) -2-benzimidazole carbamate.
Botran (DCNA is 2,6-Dichloro-4-nitroaniline.

1. The specificity of each fungicide has been very pronounced. No beneficial effect of Benlate in controlling Rhizopus has been observed, but it is very effective against Monilinia, even in very dilute concentrations. Botran, sometimes called Dicloran, is far more effective in controlling Rhizopus than Monilinia, although it is sometimes used to control the latter.

2. Increasing the temperature of the bath increases the effectiveness of each chemical to such an extent that heat can substitute, at least in part, for the fungicides. Baths of higher than 50°C. temperature and longer than 2 minutes in duration have not been tried. The fungicidal baths have been relatively ineffective when used at precooling temperatures.

3. The effectiveness of the treatments of the fungicidal dip increases with duration of treatment. At ambient temperatures there probably is no increased value resulting from durations greater than ten minutes.

4. Both Monilinia and Rhizopus characteristically spread peach-to-peach by mycilia "nesting". The fungicidal bath is very effective in retarding mycilia growth or preventing mycilium entrance to uninfected fruits. This is of inestimable value in maintaining quality of peaches bulk-packed for export.

5. The bath treatment is outstandingly effective in controlling the rots of cold-stored peaches. It prevents the infection and rapid development of rots upon removal of the fruit from cold storage. The cold itself, if of sufficient duration, kills the larvae of several insects that spread the disease.

6. Pre-harvest application of the two fungicides offers no benefit to the post-harvest control of Rhizopus. It is doubted that a pre-harvest application can protect export fruits against the Monilinia and Rhizopus infections that they may incur during harvesting, packing and transport. A post-harvest bath treatment offers the best protection.

The described experimentation has been of great value to growers and exporters of peaches. During the just-past harvest season CALFORU-member cooperatives UFRUCA and JUMECAL are reported to have exported around 1,200 tons of peaches and plums, mostly to Brazil. Most of the peaches were shipped to processors in bulk packages (about 20 kilos each). All peaches exported were subjected to a post-harvest, Botran-Benlate bath treatment. Officials at UFRUCA reported that not a single complaint of rotten fruit was received, even from the processors purchasing their peaches in bulk packages. This is something new for the exporters of Uruguay and they can visualize a decided increase in Brazilian demand for fresh peaches.

I recommend that exporters be helped to modernize their dipping facilities. Most of the export fruit treated this year were hand dipped in the fungicidal solutions for indefinite durations, most only momentarily it is reported. Immersion tanks, with facilities for heating the dip solution, could be constructed for which the fruits would need two or more minutes to traverse. I fear that momentary dipping in unheated solutions may not protect peaches in a season of severe infection.

Station personnel, if these post-harvest operations are continued, need investigate the effectiveness and economics of utilizing baths below 50°C. The 50°C. baths have been used in the investigations for the purpose of obtaining treatment effectiveness at reduced cost for fungicides. This temperature at a two-minute duration is believed to be near the point of damaging the skin of Rey del Monte (and has damaged Melilla). A 45°C. bath, if nearly as effective as 50°C., would provide a greater safety margin against skin damage and would require less heating. The costs of fuel and the safety and effectiveness of any fungicidal concentration will change at each modification of the bath temperature.

<u>Post-Harvest Treatment of Apple</u>

I believe that the *Uruguayan producers of today will reap* their greatest reward from their proximity to the large market that is Brazil by immediately shipping their apple harvests to that Market. The higher the cost of transport proportional to the total cost of the product, the greater is proximity-to-market advantage that Uruguayan growers have over those of Argentina's Rio Negro Valley. The more cost a Uruguayan grower has in his export product (costs arising from expensive containers, cold storage, etc.) the less is his transport cost proportional to his total costs, thus allowing the cheaper production costs of the Valley to negate the advantage of his proximity to the markets of Brazil.

This system of export marketing would mean that a large part of Uruguay's apple exportation would be in orchard-run fruit. It remains to be tested whether this would be more profitable to the individual grower than selling primarily to the domestic market.

The post-harvest studies with apples then have as much the objective of improving the quality of apples available on the domestic market over a long storage and sales season as of improving the exportability of the commodity at any time during its storage life.

The most severe post-harvest rots of pome fruits are caused by the fungi <u>Penicillium expansum</u> and <u>Botrytis cinerea</u>. <u>Penicillium</u> is the more common and considered the most damaging fruit rot of pome fruits; <u>Botrytis</u> is the fastest growing fruit rot under cold storage conditions.

Control of post-harvest rots is one phase of the post-harvest studies my counterparts and I have conducted at Las Brujas. Equal attention is given to the physiological disorder -scald, bitter pit, internal breakdown- that appear in apples of long-term storage.

The factors isolatable one or more times over the past 3 years from designs permitting statistical interpretation of results have been: fruit maturity; storage period; concentration of the fungicide Benlate1/ and of the scald inhibitor diphenylamine2/ mixed in a post-harvest, one dip treatment; temperature of the dip-treatment mixture; duration of the dip treatment; and the interaction effect of these, one with others.

Some of the general conclusions and beliefs can be presented without detailing specific experiments.

Penicillium generally has been easier to control than Botrytis.

There is increased control of the two diseases with increased concentration of Benlate in the bath.

Increasing the temperature of the Benlate bath up to 50°C. has so improved the effectiveness of the bath treatment that 1/4 the Benlate concentration in a 50°C bath is as effective as 800 ppm in an ambient temperature bath.

In 1974 it was found that dipping apples one day following an artificial inoculation with Penicillium provided good control of the rot. Dipping one day prior to the inoculation also was reasonably effective. But dipping more than 24 hours before or after inoculation did not yield satisfactory control. The test solution was not strong enough or warm enough (see above) to provide control of Botrytis growth even when the apples were dipped the same day they were inoculated. The effectiveness of the bath was reduced still further in inoculations made 24 hours before or after the dipping.

These data reveal that the post harvest dip can be expected to retard rot development in lesions occuring during the packing house operations, but cannot be expected to yield material control of rots initiated much before or after the bath treatment.

1/ A trade-mark name. The active agent in Benlate (benomyl) is methyl 1(butylcarbamoyl)2-benzimidazole carbamate.

2/ Commonly called DPA or DFA.

There was little effective control of either organism if the fungicide was prevented from directly contacting the inoculation. No systemic effect of the fungicide was evident.

Increasing the concentration of DPA in the treatment bath sometimes has shown interference with the action of Benlate, i.e. any concentration of Benlate may be less effective in rot control in baths containing high concentrations of DPA. The concentrations of Benlate used did not appear to have interfered with the scald-control action of DPA.

The isolates date of harvest, concentration of DPA in the dip solution and temperature of the solution have shown importance and significance as determinants of scald development. The response to these factors signifies that the greatest care for scald control must be exercised on fruits of the earliest harvests; and that product costs can be reduced by heating the treatment solution.

Delicious apples dipped in the 50°C. solutions in 1974 developed significantly less bitter pit than fruits treated at 36°C. or at ambient temperature. This effect was most marked at the highest concentration (2000 ppm) of DPA employed. An isolate of this experiment was date of harvest with significantly less bitter pit being recognized the first harvest than for others. The fact that bitter-pit development in storage usually is more serious on the samples harvested earliest would indicate that we were not measuring truebitter pit or that there was masking of the spots of pit.

In the experiment the apples of the earliest harvest when dipped in a bath of 800 ppm Benlate and 2000 ppm of DPA showed a visible residue that often was the site of skin burning during cold storage. The residue and burning were most evident on fruits dipped at 50°C. Apples damaged as described were susceptible to internal and mealy breakdown, disorders associated with over-ripeness. It is possible that the burning and the ripeness breakdowns masked the spots of pit.

The Station at Las Brujas periodically has warned growers and packers about storage rots and scald and has issued control recommendations based on our experimental results.

A disorder causing considerable deterioration of appearance in Granny Smith apples and which frequently has been incorrectly identified as storage scald is subburn. Granny is a green apple. Any yellowing, especially that developing on one cheek only is apt to be sunburn rather than over-color (blush). This sunburn often becomes quite dark brown or black during storage and the fruit becomes unattractive. In 1975 we commenced a photographic study of the sun damage to the Granny Smith fruit. The cheeks of some apples which had little yellow at the time of harvest developed quite large brown areas during the ambient storage following the removal of the apples from cold storage. It is recommended that the study of this disorder be continued. The response of the sunned areas to DPA treatment should be investigated. Too, I have wondered if interference with normal gas exchange -as might happen if a piece of plastic film lay tightly against a fruit for the duration of the cold storage period- might cause skin discoloration.

Other factors that could influence the appearance of the disorder would be fruit exposure during the growing season, date of harvest (fruit maturity) and duration of the cold and post storage period.

The investigational results with pome fruits cannot be so neatly packaged as with peaches. Fields that need study are:

a) Role of post harvest calcium treatments and of bath temperatures on bitter pit development and on the condition of cold stored apples.

b) How to prepare (ripen) Williams and other pears for export and domestic markets. Now that a range of storage and ripening temperatures is available with the new "walk-in" and its neighboring air-conditioned laboratory at Las Brujas, a pear-ripening procedure seems possible to develop.

c) The relation between fruit maturity of Delicious and concentration and temperature of the post harvest dip treatment with the occurrence of residue burn (see earlier section) is not yet well determined.

d) Indices of apple and pear maturity, i.e. determination of the proper harvest date for best storage life and market quality need continued study.

SUGGESTIONS IN GENERAL

This section of my report, perhaps viewed by some as being critical, is intended only to be constructive for the industry of Uruguay and its program at Las Brujas.

Fruit Wastage

I have always been appalled at the carelessness with which fruit is handled in Uruguay. At Las Brujas and on the farms there is little understanding of the extent of damage from rough handling of the individual fruits and their containers.

During harvest fruit is often dropped or tossed into a picking container sitting on the ground; soft-sided picking containers are allowed to bump against ladder rungs, and are roughly emptied into the orchard lugs; ground or drop apples are added to those hand picked. In loading onto the wagons the lugs are tossed and dropped so much that the apples bounce, sometimes to outside the containers. Orchard roads are rough, the wagons without springs, so that the fruit is rattled and bounced during the entire trip to the packing house. Often the mechanical sizers are primitive and there is insufficient protection against drops, squeezes and sharp corners.

The punishment continues through loading into storage, during transport to market and in the sales channels.

I suggest that a survey be planned to discover the extent fruits are damaged and wasted during the harvest and marketing processes. Perhaps a thousand fruits could be selected at random at several different stations: at the tree; from the orchard lugs, at the beginning and completion of packing, at the storage, etc. After selection the fruit should stand at ambient temperature long enough for bruises and cuts to discolor; then the fruit is peeled and the injuries are classified as to type and severity. Employees involved in the various operations should not know the nature of the survey.

Pollination Facilities

Although I am generally surprised, upon being in apple orchards at time of bloom, at the number of bees working the trees, I fear that in most orchards the pollination facilities are inadequate. Inadequate in that there are insufficient numbers of bees or that pollination blossoms are so far away, so few in number or so different in stage of ddevelopment that they are carrying relatively little pollinating pollen to the blossoms being pollinated. Too, if bees must travel long distances from their hives, more time is spent in flight, they may be diverted to other flowering plants and there is little activity during bad weather.

I believe the fruit and entomology specialists could cooperate in setting up demonstrations or experiments illustrating the importance of arranging proper pollination facilities each spring. A procedure for this is to place a few strong hives at points widely separated in an apple orchard, but each hive near the pollinating variety. At harvest the yields at various distances from the sites of the hives can be estimated or measured.

The hives should be strong -at least 2-2½ kilos of bees per hive. Maintain the friendship of the beekeeper by avoiding the use of insecticides when the bees are in the orchard, and remove the bees immediately upon completion of the pollination season. Kill or mow flowering plants that compete with apple trees for the attention of the bees.

Land Use at Las Brujas

It is my opinion that there is at Las Brujas an excess of land planted to fruit trees that are relatively unproductive of experimental data capable of being analyzed and interpreted statistically. Although with my primary interest in post-harvest investigations I favor and recommend a production always allowing these investigations, I realize that all trees whether valuable experimentally or not need equal attention for pest control, nutrition, management and harvesting. I recommend that the plantings at Las Brujas be carefully evaluated and those that are just "standing" be removed or otherwise be made available for high priority fruit research.

Fruit Tree Cankers

Fruit-tree pathologists assigned to the Consortium program in Uruguay have been shown various cankers on apple and peach trees. The most recent of these assignees, Dr. Sam Alexander and his counterparts, identified Black Rot *Physalospora obtusa* as being common on apple and they found twig canker *Fusicoccum amygdali* which I was misnaming Brown Rot to be common on peach, especially on Red Haven. Both diseases are present in the orchards at Las Brujas as well as in commercial plantings.

I urge that the pruning crew at Las Brujas be trained to recognize these diseases and every tree with canker at Las Brujas or in experimental plots be map-located so that it is easily found for tree surgery or for testing of other control procedures whichever is appropriate. Lack of control confounds experimental data.

A Demonstration Orchard

Early in 1971 I found (18) the production skills of growers of Uruguay to be below those of growers of other countries. In that report I suggested a method of improving grower skills. Frequently discussed at that time and later among my counterparts and associates was the possibility of teaching through setting up a model planting. The IATA Loan (6 b.) now under preparation by AID and MAP at one time included the provision of a demonstrational model tree fruits.

I strongly recommend that such a demonstration be conducted. If possible it should include wherever possible comparisons of 2 or 3 of the systems believed best: in training and pruning, rootstocks, planting density, soil management system, etc. Considerable technical help might be needed in the planning and early management of such a demonstrational planting.

Hydraircooling

The most recent innovation in preparing peaches for market in the U.S. is hydraircooling. Low-temperature, high-humidity air is blown at high velocity over the fruit being chilled. The method of cooling conserves the protective fungicide that might be lost from dipped peaches hydrocooled (i.e. cooled with cold water) and yet is faster than cooling in cold storage. Fruits that are dipped in solutions heated to improve the efficacy of rot or scald control treatments may need special, fast cooling to retard ripening. It is recommended that cooling velocity studies be undertaken with the new cooling facilities at Las Brujas or from structural modifications (wind tunnels for example) fabricated from them.

Fruit Research Personnel

In my opinion the fruit staff at Las Brujas, individual by individual, is extremely talented and productive, especially in consideration of its size and the facilities at the station. Whether the staff can be increased in order to speed the improved competitiveness of fruits in foreign markets is an administrative or political decision.

Although the potentiality of earning foreign exchange from the increasing exportation of fruits and fruit products I consider very promising and worthy of increased support from governmental and international agencies, I realize that the administrators who must make the important decisions of support may not agree with me. I remind them that throughout the world the return per unit of land from fruit plantings is among the highest for any agricultural production. Fruits, of basic food and health attributes generally remain in high demand in all important countries. It would seem important that Uruguay with its relatively small land area utilize all the land it has suitable for high value, intensive agriculture. Fruits are such a crop.

If the various research projects and grower services that are needed to make the country a center of fruit production and that production an important source of foreign exchange, expansion of personnel and programs even greater than described in this report are necessary.

The maintenance of research at or near the present level depends primarily on the ability of the CIAAB administrators to keep intact the present fruit staff at Las Brujas and provide facilities for them to do research. This too is an administrative decision. There is great risk of loss of investment and progression if the fruit research program is allowed to deteriorate.

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Improvement of Apple Form in Uruguay with a Prepared Mixture of Gibberellins and a Cytokinin[1]

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Abstract. Sprays of a diluted, commercially prepared mixture of 2% gibberellins A_4A_7 and 2% benzyladenine were applied at or near full bloom to whole-tree plots of 'Delicious' apple (*Malus domestica* Borkh.) in Uruguay. Each year of the four years of trial the applications stimulated improved, elongated and lobed fruits as indicated by length/diam ratios, a lobe-development index and a formula value calculated from the proportioning of the other two

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measurements. A marked reduction of treatment effectiveness was found on fruits harvested from spurs on either side of full bloom at time of treatment, regardless of the general bloom status of the whole tree. Two applications of 25 ppm of the 2:2 commercial mixture were found the best of several combinations attempted to ensure the coverage of the most blossoms at the full bloom stage in Uruguay where an extended blossom season is common.

Over the past several years, the Ministry of Agriculture and Fisheries of Uruguay has attempted to widen the country's spectrum of agricultural exports in order to diversify its sources of foreign exchange beyond the harvests of pastures and grain fields. A primary effort has been with fruit and vegetable production. Furnishing the technical aid in such efforts have been various U.S. agencies, including a tri-university consortium (Michigan State University, Pennsylvania State University and Texas A & M University) 1972-76.

The exportation of Uruguayan apples to the massive markets of neighboring Brazil probably has been more influenced by the tonnage available to Brazil from Argentina than by Uruguay's own production (11). Unless the regional price was abnormal, such as was caused by Argentina's severe crop reduction in 1973, the minimal quality and the high cost of production, including the cost of packaging for export, have prevented Uruguayan apples from consistently entering the Brazilian market in quantity.

Among the quality factors that lower the competitiveness of 'Delicious' apples of Uruguay with those of the Rio Negro Valley of Argentina is their falure to develop the shape typical for the variety. The Uruguayan climate seldom endanging the crop to frost, stimulates a form of 'Delicious' quite oblate and practically lobeless.

The nearer the orchard site to the tropical edges of deciduous fruit production the more atypical (based on the "typical" fruit produced in the state of Washington, U.S.A.) becomes the form of the 'Delicious' apple at harvest. Typical Washington shape is not produced every year in many production areas of the United States and the world and is almost unknown in Mexico, northern New Zealand (10), the San Juan province of northern Argentina, northern Chile and in Uruguay.

The objective of the studies reported was to test the effectiveness of the tree application of a commercially prepared mixture of gibberellins and benzyladanine (now available under the trademark Promalin) upon the form development of 'Delicious' apples grown in Uruguay. Such applications have proven effective in stimulating fruit elongation and lobulation in the U.S. (1,2,9,12,13,15,19,22).

Methods

1971-72. This experiment included 5 treatments on 4 replicates applied to trees of an unrecognized sport of 'Delicious', estimated to be 15 years old. The trees were wetted well but not to run-off with a Solo knapsack, powered mist-applicator. Wind was no problem during either the first application on 28 Sept. or the second on 7 Oct. Drying was slow both days and a rainy cool period commenced 6 hours following the second application. The GA+BA mixture was applied at about 12 liters per tree at the concentrations and time indicated in Table 1.

Fruit data were obtained primarily from a marked limb(s) on each tree where blossom clusters approximately 2 days more or 2 days less advanced than the full-bloom stage had been removed the date of the first treatment. Only the more advanced flowers were removed from treatments

A., C and E. If the marked limb(s) failed to yield 25 fruits, the number lacking were taken at random from the general harvest of the tree except that fruits obviously deformed by insect or disease were not used for measurements.

The fruit length/diam data in Table 1 and in all others of this report resulted from caliper measurement of the greatest length divided by the mean of the greatest and least diameters of each fruit. The column presenting percentage acceptable is based on L/D standards for Washington State production as suggested by Williams (23).

The lobe values were obtained from a 2-person visual evaluation of lobular development for each apple compared with selected standards later photographed, Fig. 1. Values alloted were from 0 (without lobes) to 5 (a pronounced lobular development).

The formula value was calculated from the formula: L/D x 10 + Lobe Value x 2. This model was devised to evaluate the overall effect of treatment upon fruit shape. The relatively great value allotted to L/D ratio resulted from our belief that the roundness and oblateness of Uruguayan 'Delicious' apples were more objectionable atypical characteristics than was imperfect lobular development so far as the export market was concerned.

1973-74. The experiment was designed and the spring sprays were applied by junior author Formento and Consortium assignee Dr. Anthony Hatch of the Pennsylvania State University. The objective was to obtain an orchard-wide evaluation (more replications) of the effectiveness of the GA+BA in stimulating a more typical 'Delicious' shape.

The trees utilized were approximately 8 years of age in a commercial planting, reportedly 'Red Spur Delicious'. Two applications of GA+BA were made, one on Oct. 11, estimated to be one day past full bloom, and the second on Oct. 19. The concentration was 25 ppm, applied to 30 trees scattered throughout the planting. Trees neighboring the treated trees served as checks. Whole trees were sprayed at dilute concentrations at an average of 6 liters per tree at 250 lbs. pressure. This amount covered the trees to drip, but run-off was small.

Unfortunately, the fruits were harvested and stacked before individual tree samples could be selected. Therefore, 5 fruit samples were collected without bias from each of the 38 boxes of fruit harvested from the 30 sprayed trees and from 37 boxes from their neighboring check trees. The measurements, identical to those of 1971-72 were made on site. Lobulation of the individual fruits was estimated from fruits selected as standards by the senior author. These standards were practically identical to those illustrated in Fig. 1.

1974-75. The trees utilized for the tests this year unfortunately were not ideal for experimental use. Due to scarcity of bloom only 4 replicates could be located on young trees of 'Red Spur', approximately 6 years of age. Two replicates were located on 30-year-old trees of an unknown variety top-worked to standard 'Delicious'. An objective of the experiment was to determine effect of spray treatments upon fruit set as well as upon fruit shape as in previous tests.

Growing points and blossoming spurs were counted on four marked limbs of each experimental tree. Limb no. 1, rotated in directional exposure for successive trees, had all buds not yet to the full bloom stage removed the day prior to first application. Limb no. 4 had all buds removed which were developed beyond the full bloom stage. Branches marked 2 and 3 had no blossom clusters removed. Spur counts were completed and blossom removal accomplished on 29 Oct.

The initial applications of GA+BA were made 30 Oct when most trees

The trees utilized were 9 year old 'Royal Red' trained to Palmettes. The experimental trees were selected for uniformity of size and potential productivity. Although the individual trees in each of the 5 replications were located near one another, some replications were several meters apart.

The GA+BA was applied at 25 ppm with a Bean Spartan sprayer. The trees were wet to drip on the dates presented in Table 3. The application rate averaged 7 liters per plant for the first spray and 8 liters for each of the last two. It was cloudy, more than 25 km/hr of wind, humid (83% RH) and cool (17°C) during the first application; for the second the wind was recorded at 13-14 km/hr, the relative humidity 39% and the temperature was 18°; during the third the wind averaged 18.6 km/hr, the temperature 19.3° and the humidity was 50%.

First harvested the third week in March were the fruits of the tagged, identified spurs. These fruits were placed on marked trays so the fruit later could be individually measured. The rest of the fruits were harvested according to position on the branches. First of these to be removed were fruits growing at terminal positions on spurs bearing their first crop. Finally harvested were all other fruits per tree, i.e. the general harvest. This general harvest well may have included some fruits from marked or first-year spurs not found at the earlier pickings.

Results

1971-72. All the mist treatments presented in Table 1 improved the L/D ratio. The most pronounced and statistically significant improvements resulted from 25 ppm applied at full bloom and the same concentration applied twice. These treatments, B and C, were numerically superior to other treatments and always statistically superior to the check treatment.

The data taken this year revealed no significant influence among the treatments on percentage of fruit set.

1973-74. Statistical analyses of the measurements presented in Table 4 were by "t" test to unpaired varieties (6). The results confirmed those of 1971-72. For each measurement consistent and highly significant improvement resulted from the spray treatment.

1974-75. The results of the fruit-set and yield records were inconclusive. No influence of treatment upon productivity was revealed but the data were so scanty and variable as to preclude any assured conclusion.

A beneficial influence of spray treatments upon L/D ratio and upon the proportion of acceptable fruit with L/D ratios of 0.9 and greater, Table 2, was recorded. These measurements were made on 20 randomly selected fruits per experimental tree. So few fruits of commercial size at harvest had positive lobulation that this measurement and therefore that for formula value are not presented. Most well-shaped and lobed apples remained pygmies, Fig. 2.

Although L/D values of fruits from both sprayed and check trees were low, the significant improvement resulting from treatment was consistent and permitted a proportionally large and highly significant difference in the percent of acceptable fruit harvested per treated tree.

1975-76. The mean results of treatment for the measurements L/D, lobular development (proportioned 1-4 instead of the 1-5 grades used in previous years) and the formula value on fruits of each harvest are presented in Table 5. The numbers shown in parentheses in the L/D columns are the totals of the fruit measurements available for the calculation of means and apply equally to each of the 3 measurements.

Analyses of variance were calculated only on samples of the general harvest (easily the largest harvest). For these data a 20-fruit, pest-free sample per replicate tree was randomly selected from the bins of the 88-133 sizes of fruits during the sizing operation immediately following harvest. Details of the statistical analyses for this harvest -- considered the best presentation of commercial-like results -- are contained in Table 6.

The measurements for fruits harvested from spurs identified by stage of blossoming at time of treatment are presented in Tables 7 and 8. Statistical analyses were by application of "t" test to unpaired varieties (6,8). No statistical analyses are presented for the harvest from spurs of first blossoming because all treatments and replicates were not sufficiently represented in the means.

In Table 6 all spray treatments are shown to have stimulated form improvement as indicated by each measurement presented. The treatments consisting of 2(V) or 3(N) applications were best, significantly better than their check. A single application beginning at full bloom (BR) or one week past full bloom (RS) was superior to its check in two of the four measurements. No spray treatment was significantly better than any other spray treatment. The numerically greater response of one application beginning one week after full bloom (RS) over two applications beginning at the same time (RJ) and the failure of the latter ever to differ significantly from the check is not understood.

The measurement 'percent acceptable fruit' (a measurement of great commercial interest) responded, of course, as did L/D in its order of significance among treatments. The order of significance for formula value was more like that for lobe value than it was for L/D, the other component measurement of formula value.

There was great variability in form among the samples representing the experimental trees. For example the sample fruit of treatment V (Table 6), had a mean lobe value of 2.31 but the sample fruits of one tree averaged only 1.26. The sample of one tree of the RJ treatment averaged 2.90 in lobe value when the general mean of the treatment was only 1.74. Even the unsprayed trees showed variability in the evaluations of lobular development.

Possible explanations of variability in fruit and tree responsiveness to GA+BA were studied. From the several hundred spurs identified and tagged as in full bloom at the time of the first or only application of GA+BA, 72 fruits were harvested from the trees receiving treatments BR, V, N, RS and RJ, Table 4. From the same trees 114 fruits were collected from spurs classified as past full bloom (petal fall or more advanced).

From the spurs identified as not yet in full bloom at the only time GA+BA was applied (treatments BR and RS), or at the date of the second application for treatment V, 25 fruits were harvested; 43 of the 72 full-bloom fruits mentioned above were harvested from the same treatments (BR, RS and V). None of the few flowers not yet in full bloom on the date of the final application on trees of treatments N and RJ developed into harvestable fruit.

The 5 check trees (treatment B in Table 4) yielded 64 fruits from spurs identified by blossoming stage on 20 Oct. Fourteen fruits developed from full-bloom spurs and 25 were harvested both from spurs not yet in full bloom and from spurs beyond full bloom on that date.

The mean measurements of the spur-identified fruits, presented in Table 7, are arranged to delineate those values among the blossom stages significantly lower than full bloom and those among the treatments significantly above the check. The incongruities of some relatively large differences showing less significance than others smaller resulted from insufficient individuals composing one of both of the unpaired varieties subjected to the "t" test (6,8). The number of individuals included in each mean is shown in part B of Table 7.

Spurs at full bloom at time of application of GA+BA responded more to treatment than did spurs less or more advanced; compare within columns, especially in column $\tilde{M}$ within part A, B, C, or D of Table 7. In most cases, the differences denoting the superior responsiveness of the spurs at full bloom reached statistical significance to 1% or greater.

For none of the fruit measurements utilized did check-treatment spurs at full bloom on 20 Oct. (column B, Table 7) yield fruits significantly superior to those from spurs of other blossom stages, although a numerical trend of possible significance with greater numbers is evident.

Only treatment N stimulated a fruit shape consistently superior to that of fruit harvested from unsprayed trees; compare the values in columns N and B, especially along line number 4 in each part of Table 7. The L/D value of 0.949, the lobe value of 2.58 and the formula value of 14.66, each is greater than its corresponding value for fruits from unsprayed trees. The improvement in percent acceptable fruit is noteworthy. Forty percent more acceptable fruit were harvested from the sprayed trees than from unsprayed.

Also noteworthy in Part B Lobe development and Part C Formula value, in Table 7, is the negative response of those spurs past full bloom on trees of treatments RS and RJ where the first application was one week later than on the other sprayed trees. Compare values along line 3 in each part and between columnar values RS and RJ on lines 2 and 3 in Parts B and C of the table. The lobe value of 0.80, for example, is materially and significantly less than the other values of line 3, excepting those for treatment RJ and check treatment B, and is significantly less than its corresponding value for spurs at full bloom in line 2.

Dosage, or more specifically repeat applications, appears to be the most significant factor affecting the previously mentioned superiority of treatment N. Treatments BR, V, and N received 1, 2 and 3 applications of GA+BA respectively, beginning 21 Oct., the day most of the experimental trees were considered at full bloom, Table 3.

To give weight to ascending values possibly associated with number of applications, some measurements of Table 7 have been restated in Table 8. Letters denoting significant differences among these values have been added. For each type of measurement the lowest value is from the BR treatment of 1 spray; the 2-spray values (V) are higher and the 3-spray values (N) are still greater. The values for the 3 applications are significantly higher than those for the 1 application, with few exceptions, and for the 'mean, 3 stages', the 3-application values are higher than those of the other two treatments. The relationship between number of treatments and effectiveness did not exist for treatments RS (one application commencing 28 Oct.) and RJ (an application on 28 Oct. and a second one week later).

Discussion and Conclusions

In Uruguay where warm winters cause the production of most cultivars of deciduous fruits to be rated as marginal, the 'Delicious' and its sports are the apples most favored in commercial plantings. At harvest this fruit tends to be oblate and relatively lobeless, quite different in form from the 'Delicious' type described by Williams (23) and Greenhalgh and Godly (5).

This lack of typiness no doubt affects the sales appeal of export 'Delicious' even in the practically insatiable apple market of neighboring Brazil.

GA+BA, a commercially prepared 2:2 mixture of 2% Gibberellins A_4, A_7 and 2% 6-Benzyladanine, reported to better the typiness of 'Delicious', was tested 4 seasons between 1971-72 and 1975-76 inclusive. In each year, GA+BA applications stimulated the length/diam ratio and increased the percentage of acceptable fruits harvested, i.e. fruits with a minimum L/D ratio of 0.9. In all but one year lobe development, based on standards originated for these studies, and a measurement we call "formula value" were improved.

These latter two measurements were devised because improvement of form in 'Delicious' in Uruguay (or in commercial orchards anywhere) should be comprised of both fruit elongation and lobular development. The formula value was set up as 10 L/D + 2 Lobe Value and was determined on each fruit sampled. Ideally, future studies should permit a determination of the consumer acceptability of fruits differing in formula values, and the components of the model should be modified as needed to represent the shape most desirable in markets. A modified model also could reflect the negative attractiveness of such malformations as undeveloped lobes, lobes of abnormal location and structure and wide-open calyxes found in these and similar experiments (12,15,22). These abnormalities should be more generally measured and discussed in reports of growth substances influencing fruit shape.

The stimulation from treatment, especially with one or two applications of 25 ppm was statistically less distinct in 1974-75 and 1975-76 than in 1971-72 and 1973-74. In 1971-72 application was with a Solo knapsack mister;

in the other three seasons dilute applications were made. Although mist application is recommended (1), method of application is not the sole explanation of the differences encountered in the four years.

A comparison of the L/D measurements for the check treatments in Tables 1, 2, 3, and 6 allows the supposition that the trees utilized in 1974-75 and 1975-76 basically produced less well shaped fruits than those utilized in 1971-72 and 1972-73. Genetic differences surely exist in the commercial orchards of Uruguay where knowledge of the names and origins of the 'Delicious' strains are mostly unknown. Three of the 4 tests reported here were in such commercial orchards.

In Uruguay where lack of typiness is normal for 'Delicious', fruit specialist invariably note trees or orchards producing abnormally well-shaped fruit. Some trees with such characteristics were located between 1970 and 1976. The perpetuation of these shape characteristics is being tested in variety plantings. Differences in shape among the various strains of 'Delicious' are generally believed to exist (3,4,18), although in a recent report (7) such differences are discounted. Tukey (18) states the commercially prepared mixture of GA+BA to be most effective on the sports of 'Delicious' with the genetic capability of being typey.

Sullivan (16) found that date of pollination influenced 'Delicious' shape, especially the L/D ratio and lobe development. Wide variance in date of pollination and thereby a variance in the average temperatures experienced by the newly set flowers the first 28 days following pollination could induce quite variable typiness among fruits harvested in Uruguay and elsewhere where a long bloom season results from a slow break of winter rest or spring weather inclement to blossoming. McKenzie (10) and Greenhalgh and Godley (4) limit the temperature influence to only 7 days following full bloom.

Unfortunately, the data in this experiment do not support the hypothesis. On check trees the spurs past full bloom on 22 Oct. (column "check: no spray (B)" in Table 7) yielded fruit with insignificantly smaller L/D's and lobe values than did spurs at full bloom. Neither do the various stages of blossoming among the check trees shown in Table 4 reveal any relation with the data analyzed for Tables 5 and 6.

The king blossom of a spur is reported (20,21) to yield more elongated fruit than do lateral flowers. This could be a temperature factor as defined by Sullivan (16) and others (4,10,14,17). In an area or season of a long bloom period, lateral flowers pollinated later than the kings could experience higher temperature the first days following pollination than those pollinated sooner and developed slowly during the cool weather.

In the experiment here only fruits of first-crop spurs were positively identified at harvest as having developed from king flowers. It is assumed that fruits harvested from spurs identified by blossom stage at time of treatment also developed from king blossoms. Cursory examinations made when L/D measurements were taken during the growing season supported the assumption as did the scarcity of multiple-set fruits on the blossom-identified spurs. The only obvious explanation for the superiorities in form from the first crop spurs shown in Table 5 is age of spurs. First-crop spurs expectably would be better lighted and more vigorous than older spurs. The fruits of the general harvest no doubt were composed of fruit developing from spurs of many ages and possibly included as well some fruits borne in a lateral position on one-year shoots. A few flowers so located were observed during the blossoming season.

Even without statistical comparisons the differences favoring fruits developing from first crop spurs for almost every measurement in every treatment, Table 5, are noteworthy, but the failure of the fruit of marked spurs to rank materially better than fruits of the general harvest prevent the data of this experiment from supporting completely the reports of Westwood and Blaney (21) and Webster (20).

The cause of variable results from application of GA+BA most clearly isolated in these experiments was stage of blossoming at time of application. A spur, and probably a blossom as well, is most responsive to treatment if it is at full bloom, regardless of the bloom status of the other spurs on the tree. A blossom not yet opened or one advanced to petal fall at time of treatment is less responsive.

There was an accumulative effect of repeat applications for blossoms not yet in bloom, for those in full bloom and for those beyond full bloom, Tables 5 and 8, but the greatest benefit from 2 or more applications would appear to result from the surety of treatment to a maximum number of blossoms at full bloom. This would apply to orchards in Uruguay and probably to all those situations where spur development is sporatic or delayed as a response to climate or inclement spring weather.

Thus, the current recommendations for the use of the commercial material in Uruguay is for 2 applications at not less than 25 ppm and not more than 50 ppm. the first application at 'general' full bloom and the second a week later. Spray adjuvants have not been tested.

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Table 1. Form evaluations resulting from mist applications of GA+BA starting at full bloom on a sport of 'Delicious' - Rancho Grande 1971-72.

Treatment symbol	Treatment description	L/D ratio	Lobe development (0-5)	Formula value	Percent accept fruit (L/D 0.9 +)[y]
A	12 1/2 ppm, full bloom (28 spt) F.B. + 10d (7 Oct)	.952 b AB[z]	3.1 b AB	15.8 b AB	86.0 ab
B	25 ppm F.B. (28 spt)	.979 b B	3.7 bc B	17.2 bc B	94.0 b
C	25 ppm F.B. (28 spt) + F.B. + 10d (7 Oct)	.977 b B	4.0 c B	17.7 c B	90.0 b
D	50 ppm F.B. (28 spt)	.955 b B	3.6 bc B	16.8 bc B	88.0 b
E	Check, no applic.	.912 a A	2.4 a A	13.9 a A	68.0 a

[z]Mean separations in columns by Duncan's multiple range test. Upper case 1%.

[y]Calculated on transformed values (8).

Table 2. Form evaluations resulting from spray applications of GA+BA starting near time of full bloom of 'Delicious'. Boccino. 1974-75.

Treatment description	L/D ratio	Percent acceptable fruit (L/D 0.9 +)[y]
25 ppm F.B. (30 Oct)	.860 b[z]	27.3 B
50 ppm F.B. (30 Oct)	.860 b	29.2 B
25 ppm (30 Oct), (6 Nov)	.860 b	30.6 B
50 ppm (30 Oct), (6 Nov)	.845 ab	31.2 B
Check No Applic.	.820 a	9.2 A

[z]Mean separations in columns by Duncan's multiple range test. Upper case 1%.

[y]Calculated on transformed values (8).

Table 3. Treatment symbols and dates of application of GA+BA 25 ppm to tree replicates identified by stage of blossoming. 'Royal Red Delicious', Las Brujas, 1975-76.

Treatment symbol	Dates of application	Stage of blossoming on Oct 28[z] by replicate				
		A	B	C	D	E
BR	21 Oct (F.B.)	FB	FB+1[y]	PF+3	PF+2	PF+3
V	21, 28 Oct (F.B. and F. B. + 1 wk)	FB+1	PF-2[x]	PF-2	PF+2	PF-1
N	21, 28 Oct, 4 Nov. (F.B. + 1 wk + 2 wks)	FB	FB	PF+2	PF+1	PF+3
RS	28 Oct (+ 1 wk)	FB+1	PF+2	FB+1	PF+3	PF+2
RJ	28 Oct, 4 Nov. (+ 1 wk, + 2 wks)	FB	PF	PF-2	PF+2	PF+3
B	none	FB+2	FB+1	FB	PF+2	PF+2

[z]Estimated by authors, aided by Consortium assignee Robert F. Carlson, Michigan State University.

[y]FB+1 = 1 day past full bloom

[x]PF-2 = 2 days before petal fall

Table 4. Form evaluation means for randomly selected fruits from untreated trees and from trees sprayed with GA+BA at 25 ppm on 1 and 9 days past full bloom. 'Red Spur Delicious,' Boccino, 1973-74.

Measurement (mean/fruit)	Fruit from unsprayed trees	Fruit from sprayed trees	Difference favoring sprayed[z]
L/D	.927	.987	.06
Lobe development (0-5)	1.36	3.01	1.65
Formula value	12.00	15.83	3.83
Percent acceptable fruit (L/D 0.9 +)	80.00	95.8	15.8

[z]Each difference is significant to 0.1%.

Table 5. Measurements of fruits of 3 harvest identities from trees of the different spray treatments. Las Brujas 1975-76.

Measurement:	L/D			Lobe development			Formula value		
Harvest Identity	First crop spurs	General Harvest	Marked spurs	First crop spurs	General Harvest	Marked spurs	First crop spurs	General Harvest	Marked spurs
Treatment[z]									
BR	.930 (41)[y]	.919 (78)	.898 (57)	2.42	1.70	1.75	15.0	12.6	12.4
V	.960 (48)	.930 (95)	.912 (49)	3.01	2.31	1.97	15.3	13.9	13.0
N	.950 (67)	.938 (72)	.949 (36)	2.68	2.26	2.58	14.6	13.9	14.7
RS	.928 (45)	.916 (78)	.918 (38)	2.73	2.09	1.92	14.8	13.4	13.0
RJ	.918 (62)	.907 (66)	.909 (31)	1.99	1.74	1.71	13.5	12.5	12.5
B	.908 (58)	.882 (99)	.903 (50)	1.16	1.07	1.43	11.4	11.0	11.6

[z] Treatments are described in Table ~~4~~.3

[y] Number of fruits measured, in parentheses.

Table 6. Mean measurements for fruits representative of the general harvest from experimental trees. GA+BA test, 'Royal Red Delicious.' Las Brujas 1975-76.

Treatment symbol, table 3	Number fruits measured	L/D	Lobe development[z] (1-4)	Formula value	Percent acceptable (L/D .90 +)[x]
BR	78	.919 b[y]	1.70 ab	12.59 ab	61.7 b
V	95	.930 b	2.31 b	13.90 b	67.0 b
N	72	.938 b	2.26 b	13.89 b	77.8 b
RS	78	.916 ab	2.09 b	13.41 b	59.2 ab
RJ	66	.907 ab	1.74 ab	12.54 ab	55.8 ab
B	99	.882 a	1.07 a	10.97 a	35.3 a

[z]Significance is at 18:1 odds, not at 19:1 as in other columns.

[y]Mean separations in columns by Duncan's multiple range test 5%.

[x]Calculated on transformed data (8).

Note: Earlier "Treatments by symbols, see Table 3" [illegible]

Table 7. Form evaluations of fruits identified by spur development at the time of the treatments listed. 1975-76 Experiment, Las Brujas.

Line	Spur devel.	Treatments by Symbols, see Table ~~3~~ 4: (BR)	(V)	(N)	(RS)	(RJ)	Mean ($\bar{M}$) sprayed	Check: no spray (B)
Part A L/D.								
1.	Before full bloom	.880	.850	---	.885	---	.876**z	.887
2.	At full bloom	.910	.941	.950	.939	.948	.938	.925
3.	Past full bloom	.900	.909*z	.947	.917	.883*	.909**	.908
4.	Mean of treatment	.898	.912	.949aay	.918	.909	---	.903
Part B Lobe development. Analyses by $\sqrt{X + 1/2}$ (6)								
1.	Before	1.08*	1.88	---	1.88*	---	1.46***	1.43
2.	At	2.04	2.79ay	2.94aa	3.07aa	2.62	2.69	1.69
3.	Past	1.89	1.68**z	2.26aa	0.80**	1.13**	1.62***	1.38
4.	Mean	1.75	1.97	2.58aa	1.92	1.71	---	1.45
Part C Formula value.								
1.	Before	10.18**	10.35	---	12.60*	---	11.70***	11.36
2.	At	13.07	14.82a	15.39aa	15.51aa	14.80a	14.01	12.38
3.	Past	12.76a	12.46**	14.01aaa	10.75***	10.99***	12.31***	11.62
4.	Mean	12.43	13.00aa	14.66aaa	13.01a	12.46	---	11.63
Part D Percent acceptable fruit. (L/D 0.90 +). No statistical analysis								
1.	Before	40.8	25.0	---	37.5	---	31.0	36.0
2.	At	62.5	75.0	76.5	80.0	83.4	75.0	57.1
3.	Past	46.4	57.4	68.4	53.3	42.1	54.4	56.0
4.	Mean	47.4	59.2	72.2	60.5	58.1	---	51.5
Part E Number of fruits per treatment~~, unless otherwise indicated~~								
1.	Before	13	14	---	8	---	25	~~25~~ 21[x]
2.	At	16	12	17	15	12	72	~~14~~ 8[x]
3.	Past	28	33	19	15	19	114	~~25~~ 21[x]
4.	Total	57	49	36	38	31	---	~~64~~ 50[x]

[z] Significantly below value for fruits from spurs sprayed at full bloom for this treatment. Compare only within columns for each measurement: *5%; **1%; ***0.1%.

[y] Significantly greater than value for fruits harvested from spurs at same development stage on unsprayed trees. Compare only within rows: a 5%; aa 1%; aaa 0.1%.

[x] A slightly greater number of fruits were available for L/D measurements.

Table 8. Influence of number of sprays of GA+BA on fruit-form measurements. Data extracted from Table 7. Las Brujas, 1975-76.

Measurement:	L/D			Lobe development			Formula value		
Treatment	BR (1)[z]	V (2)	N (3)	BR (1)	V (2)	N (3)	BR (1)	V (2)	N (3)
Spur development:									
Full bloom	.910[y] a	.941 a	.950 a	2.04 a	2.79 ab	2.94 b	13.07 a	14.82 ab	15.39 b
Past full bloom	.900 a	.909 ab	.947 b	1.89 ab	1.68 a	2.26 b	12.76 ab	12.46 a	14.01 b
Mean, 3 stages	.898 a	.912 a	.949 b	1.75 a	1.97 a	2.58 b	12.43 a	13.00 a	14.68 b

[z]In parentheses: Number of weekly applications of GA+BA at 25 ppm.

[y]Compare only with other treatments of same blossom stage. Values marked with letters alike do not differ statistically by application of "F" ~~, Duncan's multiple range~~ test, 5% (6,8)

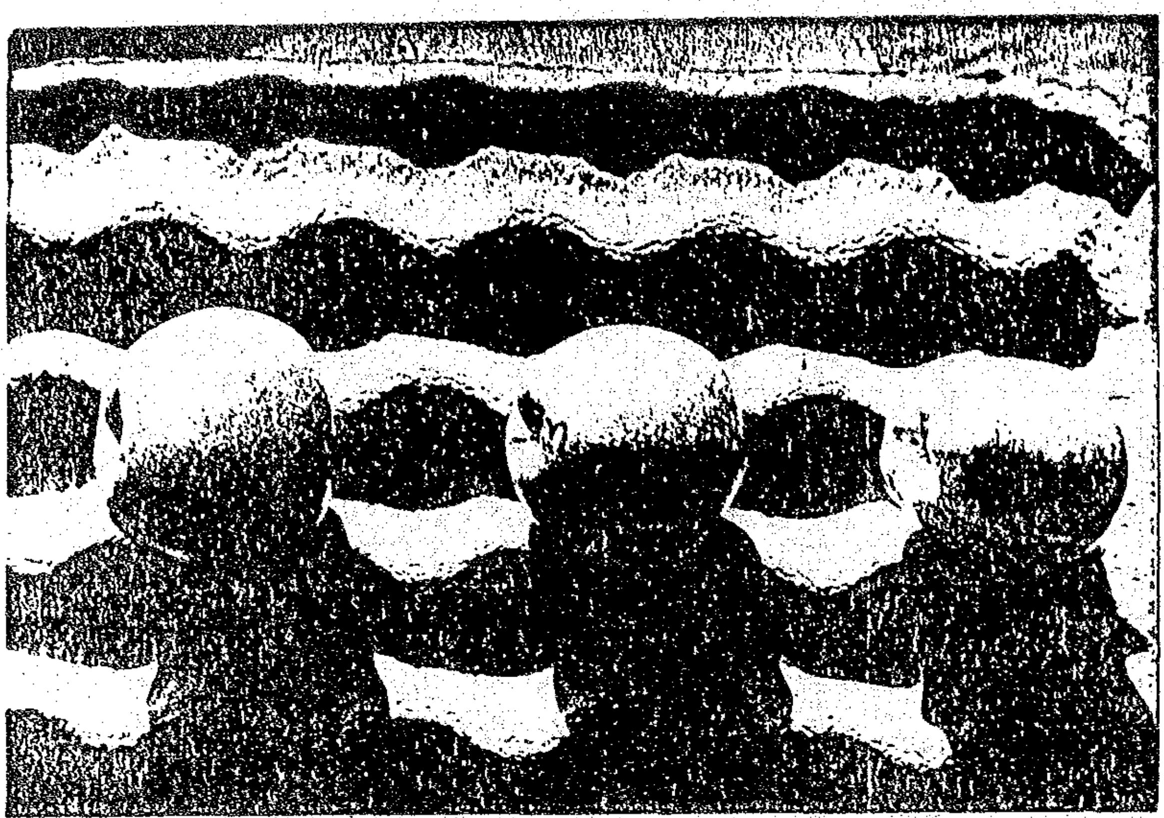

Fig. 1. Fruits used as standards 0-5 for appraising lobe development in 1971-72: 0, left to 3, middle and 5 on right. Like standards were used in 1972-73 and on a scale of 0-2-4 in in 1975-76. The most favored U.S. 'Delicious' type would grade about 5 on the 1975-76 scale.

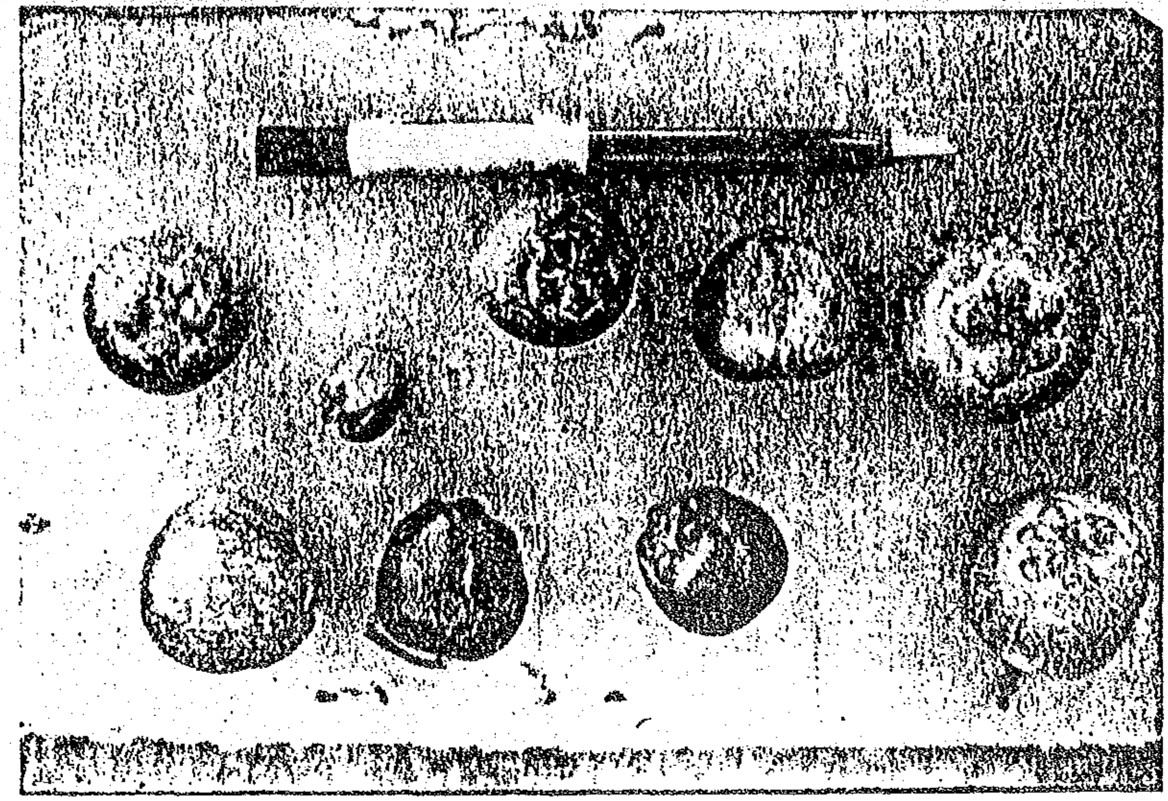

Fig. 2. Pygmy fruits often found hanging at harvest in trees sprayed with GA+BA. Such pygmies were the only well-lobed fruit observed in 1973-74 and were not uncommon at other harvests.

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