system of pruning, rapid irrigation and fertilization, and a third system of defoliation of trees using some caustic spray materials as defoliants (1). Horticulturists from the temperate regions will appreciate this fact since, under temperate conditions, flower buds develop normally only in the spring months after a normal winter defoliation, and fruits ripen from early summer to late fall. Under temperate conditions there is only one fruit season a year and there is little choice in this matter. Experimental evidences now being gathered seem to indicate the latter two methods, or combinations thereof, are better than simply pruning to induce new vegetative growths and subsequent blossom bud formation. With the perfection and adoption of these methods in commercial guava production, it is anticipated that, 1) guava fruit set and harvest can be precisely regulated and controlled into a system of "fruit cycling" so that fruits will be harvested throughout the year from different fields to greatly increase the operational efficiency of the cannery, 2) cannery will then be operating throughout the year rather than on the "catch as catch can" or "feast or famine" bases from erratic fruit production in the field, 3) with the confinement of blossom set and fruit ripening over a very short period, mechanical harvesting is a definite possibility, 4) further shortening of the ripening period is being attempted with the usage of ethapon, 5) the current indication is that one fruit crop can be expected every 8 months, or 3 harvests every 2 years, and 6) total yield per year seems to be considerably increased over the now practiced operational procedures. A complete report on this work should be publishable in two years.

Literature Cited

1. Shigeura, G. T., R. M. Bullock, and J. A. Silva. 1975. Defoliation and Fruit Set in Guava. *HortScience* 10:590.

Pineapple Production

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INTRODUCTION

The pipeapple (*Ananas comosus* (L.) Merr.) is indigenous to the area covering central and southern Brazil, Northern Argentina and Paraguay (4, 6). Seedless clones were selected by the Indians and were widely distributed through tropical America, even before the discovery of the New World (6). Today, the pineapple has become a commercial fruit of great importance in many tropical countries. Before 1950, Hawaii contributed approximately 70% of the world production of processed pineapples (1). Contribution to the world market from Hawaii has steadily declined to less than 36% as other countries increased their production. The Ivory Coast of Africa, Kenya, South Africa, Malaysia, Taiwan, Philippines, Australia and Mexico began to increase their contributions to the world market. In 1974 Hawaii's pineapple acreage was approximately 22,800 ha which produced 9.4 million cases of canned fruits (2).

In recent years 3 of the 6 pineapple companies in Hawaii have discontinued their operations. Two of the remaining companies have been reducing their production acreages in Hawaii due to various factors, but have also extended their operations to foreign areas where competitive levels in production costs may be obtained.

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CULTURAL PRACTICES

Environmental Requirements

The pineapple is a tropical plant. However, when fruits begin to mature, night temperatures between 18° and 21°C and dry weather are desirable for best quality. Well-distributed rainfall of 50-100 mm per month is ideal but most tropical areas have pronounced wet and dry seasons. Plant growth is adversely affected during the dry season, unless some form of irrigation is available. Young plantings benefit from irrigation during the dry season (Fig. 1). Primary soil requirement is drainage. Poor drainage is conducive to root rots caused by *Phytophthora* sp. pH range between 5-5.7 appears to be the desirable range.

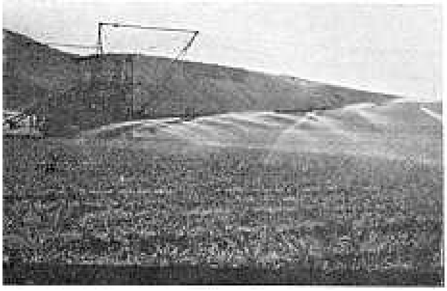

Fig. 1. Irrigating young pineapple plants during dry season.

Cultivars

The 'Smooth Cayenne' (Fig. 2) is the leading commercial cultivar grown throughout the tropics, except in Malaysia where 'Singapore Spanish' is cultivated for processing and for the fresh fruit market. The 'Red Spanish' (Fig. 3) (Spanish Group) is widely grown in Central and South America and in the Caribbean region (10). Cultivars of the Queen group such as the 'Queen', 'Z', and 'MacGregor' (South Africa); 'Natel', 'Ripley', and 'Alexandria' (Australia) are grown to some extent. Others such as 'Pernambuco', 'Sugar Loaf' and 'Monte Lirio' are grown in the American tropics (10).

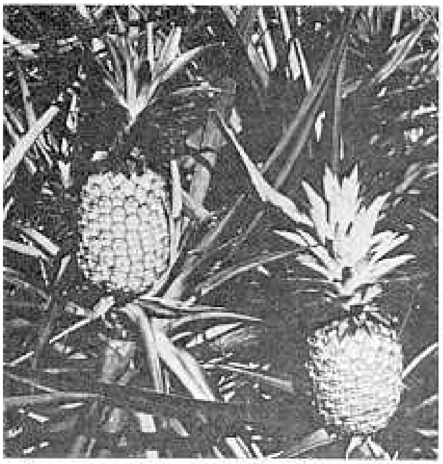

Fig. 2. Smooth Cayenne, the leading commercial cultivar.

Land Preparation

Inasmuch as drainage is of primary importance, deep plowing and careful land preparation are desirable practices. This is especially important in Hawaii where polyethylene sheets are used as bed mulches (Fig. 4). When land is planted continuously to pineapple as in Hawaii, nematodes can build up to affect plant growth severely and soil fumigation has become absolutely essential. Chemicals

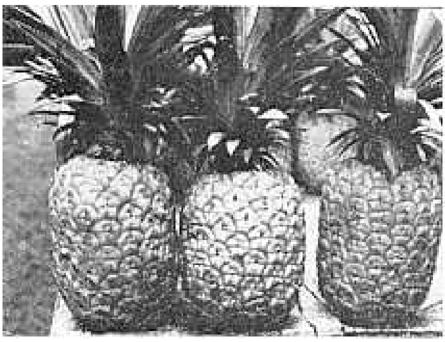

Fig. 3. Red Spanish cultivar used in Central and South America.

Fig. 4. Black polyethylene sheet mulch used in Hawaii to afford moisture retention, fumigation cover and weed control.

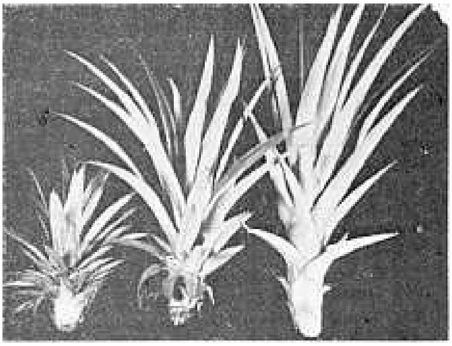

Fig. 5. Pineapple planting materials (left to right) crown, slips and suckers.

Fig 6. Double row system of planting pineapples on mulch.

such as DD (1-3-dichloropropene and 1-2-dichloropropane), BBC (dichloropropane) and EDB (ethylene dibromide) are used to fumigate the soil. The polyethylene mulch spread over the beds at the time of fumigation helps to keep the injected fumigants from escaping and also minimizes weed growth in the beds.

Planting

Pineapples are grown from crowns, slips, and suckers (Fig. 5). The time required to produce mature fruits differs with each material, suckers being the earliest to fruit (15-17 months), crowns requiring the longest time (22-24 months), and slips being intermediate (18-20 months) (6).

Planting schemes and plant density vary in different places but the double row system, long established in Hawaii, is becoming the standard method in other areas (Fig. 6). The following range of spacing are commonly found: 25-36 cm within row; 46-60 cm between rows, and 1.4-1.5 M between bed centers. Plant densities may range from 30 to 50 thousand plants per hectar. It has been shown that plant density can affect plant growth, fruit size, and slip and sucker production (6). At a density of 45000 plants/ha fruit yields of 100-125T/ha may be expected with good culture.

The time of planting may be extended over many months to produce a continuous supply of fruits, but generally, planting is done from spring to autumn, coinciding with periods of rainfall. In monsoon areas, early spring and late fall plantings may be risky due to lack of adequate soil moisture.

Floral Induction

Floral induction in pineapple by selective chemicals is practiced in commercial plantings to obtain uniform maturity of fruits within fields and for scheduled fruiting. Chemicals such as SNA (sodium salt of naphthaleneacetic acid) (5), ethylene and acetylene gases (6), acetylene producing calcium carbine (8), ethephon (9, 11, 12) and others have been used. Application of ethylene and acetylene gases requires specialized equipment, thus restricting their uses. Calcium carbide is widely used in many areas. A few pieces of granular material are dropped into the heart of each plant. Upon contact with water accumulated in the center of the plant, acetylene gas is emitted.

Chemicals may be applied when plants have attained 2.3-2.5 kg in weight. Flowering, fruit development and maturation take place within a period of 6-7 months after forcing.

Nutrition

Fertilizer practices vary widely in different areas. In Hawaii, except for pre-plant ground application of NP or NPK, all other applications of N, K, Zn, and Fe are by spraying solutions (Fig. 7). Ground application in the dry form is the usual practice in most areas. Generally, satisfactory results have been obtained by ground application of ammonium phosphate in an approximate ratio of 1:5 (20 g/plant) at planting time with no further application of P. Two to 3 months after planting, N and K in an approximate ratio of 1:1 or 1:1.5 (15-20 g/plant) are applied at 2-3 month intervals, terminating such applications approximately 2 months before forcing. High N level at time of forcing seems to lower the effectiveness of the forcing agent (3, 8). In Hawaiian soils where Fe and Zn deficiencies are observed, approximately 5 kg/ha of iron sulfate and/or zinc sulfate are applied as needed.

Cropping Cycle

The crop that is harvested from the planting of crowns, slips, and suckers is called the "plant crop". As has already been mentioned, the time required from planting to harvest depends upon the planting material. Best tonnage and size of fruits are obtained from the plant crop.

Immediately after the plant crop is harvested, plants are again fertilized

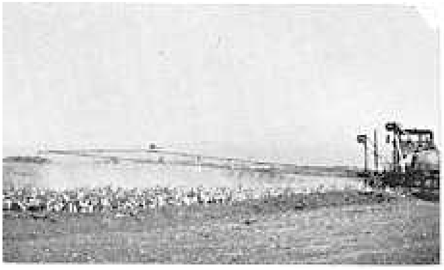

Fig. 7. Foliar application of some fertilizers after planting.

and maintained to produce a "ratoon crop". This crop is produced on the sucker that is produced on the mother plant. One or 2 suckers are left on the mother plant to produce the ratoon crop. Under good cultivation practices, 75-100T/ha of fruit can be expected from the ratoon crop in approximately a year after the plant crop. Harvesting a second ratoon is not the usual practice with the large companies in Hawaii but this is done in good fields when estimated needs for the following year cannot be met with the plant and first ratoon crop. Private growers, however, usually harvest a second ratoon. Ratoon crop is profitable inasmuch as cost of land preparation, planting and other initial costs are eliminated.

Pests and Diseases

Pest control is a constant problem in the tropics. Ants, which are closely associated with mealy bugs that produce the mealy bug wilt on pineapple, can be controlled by pre-plant application of an approved insecticide in the field. To maintain mealy bug control periodic post-plant spraying of plants with insecticide is recommended.

Fruit damage by the larvae of the Thecla moth (*Thecla echion* Linn.) has caused severe losses in places like Mexico (Fig. 8). Malathion or sevin is dusted on the young fruits for control. Gummosis of the fruit is frequently seen where 'Red Spanish' is

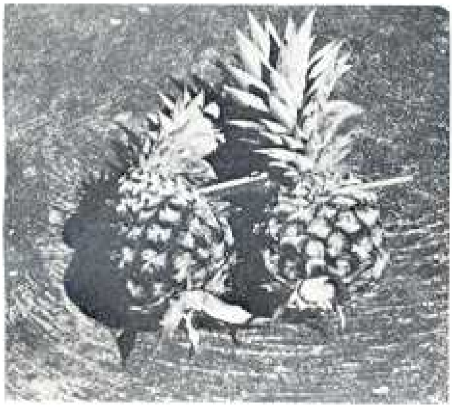

Fig. 8. Pineapple fruits damaged by Thecla moth.

Fig. 9. Heart damage on plants in high pH soil.

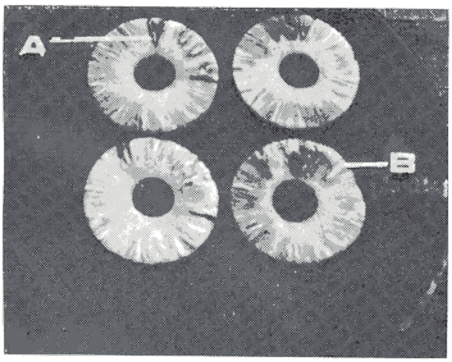

Fig. 10. Two fruit diseases—Fruitlet core rot (dark area—A) and Glassy Spoilage (translucent area—B).

grown. This is reported to be caused by the larvae of the moth, *Batrachedra* sp. (6, 7).

Heart rot and root rot are diseases caused by *Phytophthora* sp. High rainfall and poor soil drainage are favorable conditions for these diseases (6). Control of these diseases is difficult. Heart rot is reported to be more prevalent in high pH fields (Fig. 9).

Fruit diseases such as Endogenous brown spot, Pink disease, Fruitlet core rot and a number of others can cause severe losses at times (Fig. 10).

Literature Cited

1. Anonymous. 1969. Pineapple Fact Book Hawaii/1969. *Pine-Growers Association*. Honolulu, Hawaii.
2. ————————. 1975. Statistics of Hawaiian Agriculture for 1974. *Hawaii Crop and Livestock Reporting Service*. Honolulu, Hawaii.
3. Aldrich, W. W. and H. Y. Nakasone. 1975. Day versus night application of calcium carbide for flower induction in pineapple. *J. Am. Soc. Hort. Sci.* 100: 410-413.
4. Baker, K. and J. L. Collins. 1939. Notes on distribution and ecology of *Ananas* and *Pseudananas* in South America. *Am. J. Bot.* 26: 697-702.
5. Clark, H. E. and K. R. Kerns. 1942. Control of flowering with phytophormones *Science*. 95: 536-537.
6. Collins, J. L. 1960. *The Pineapple-Botany, Cultivation and Utilization.* World Crops Series, Leonard Hill.
7. Perez, M. E. 1957. Pineapple gummosis in Puerto Rico and its control. *Tech. Paper* 21, Agr. Expt. Sta., University of Puerto Rico; Rio Piedras.
8. Py, C. and M. Barbier. 1966. Summarie-Les traitements de floraison en culture d'ananas. *IFAC Bull. de Information* No. 25: 1-8 .
9. ———————— and A. Guyot. 1970. La floraison controlee de l'ananas par l'ethrel, nouveau regulateur de croissance (fin). *Fruits* 25: 427-445.
10. Samuels, G. 1970. Pineapple cultivars 1970. *Proc. Fl. St. Hort. Soc.* 83: 325-332.
11. Wee, Y. C. and J. C. Ng. 1970. Flower induction in pineapple cultivation. *J. Singapore Nat. Acad. Sci.* 2: 69-73.
12. ————————. 1971. The effects of ethrel on the Singapore Spanish pineapple. *Malaya. Pineapple* 1: 5-10.