Pineapple News

Issue No. 8 Newsletter of the Pineapple Working Group, International Society for Horticultural Science June, 2001

Contents

Pineapple Working Group (PWG)

Duane Bartholomew, Editor

Dear PWG colleagues. The first announcement of the 4th International Pineapple Symposium is out and available on the internet, dates have been set. I hope to see many of you in Veracruz, Mexico next April. Other topics of interest over that past year, most coming by way of E-mail or via the internet, include a question about iron sulphate quality, a notice of the death of friend and colleague Dr. John (Jack) Beardsley , and several inquiries about organic culture of pineapple. Additional details on these items are provided below.

You will notice a long list of references on pineapple in this newsletter. That is mainly the result of increased availability of databases over the internet. Also, Graham Petty has sent a complete list of publications he has authored and all are included in the list at the end of the newsletter. I welcome such complete lists from others as it willd help to build a more comprehensive database of publications on pineapple. I have accumulated a large reference database on pineapple and will be glad to provide reference searches on topics of interest to readers.

Problems With Iron Sulphate

An interesting inquiry came in last year about a lack of response to iron sulphate sprays. Though iron sulphate sprays are recommended for the correction of iron deficiency, none of the publications on pineapple has much to say on the subject. Since mineral nutrition is not my area of expertise, I sought the help of Dr. N.V. Hue, soil chemist/soil fertility specialist. Dr. Hue explained that iron is absorbed and utilized in plants in the ferrous (Fe++) form, which also is the form that good quality (green colored) iron sulphate is in. When exposed to air, iron sulphate gradually oxidizes to the ferric (Fe+++) form, which is brown (dark red) in color. Ferric iron readily forms insoluble ferric hydroxide, is strongly chelated by organic compounds, which makes it less available to plants and it must be reduced in the plant before it can be utilized. Dr. Hue explained that it is desirable to acidify iron sulphate to about pH 3.5 because the rate of oxidation is slower and iron sulphate is more soluble at low pH. Acidification with citric acid was recommended rather than sulphuric or acetic acids because it is easier to control the pH with citric acid than it is with sulphuric acid and citric acid chelates the iron, thereby reducing the rate of oxidation, while acetic acid does not. The ratio of citric acid to iron sulfate should be between 1/10 and 1/5. Dr. Hue also explained that acidification of a ferric iron sulphate solution will help keep that form of iron in solution, but it does not overcome the absorption or utilization problems. Thus, the best solution is to purchase only good quality (green) iron sulphate and store it under conditions that limit exposure to oxygen.

John W. Beardsley, In Memorium

Dr. John W. Beardsley passed away February 5, 2001. Graham Petty kindly contributed the following euology, which is followed by additional details from Dr. Beardsley's published obituary.

On Monday, February 5, I walked into "my" Agricultural Research Council library attached to my office in Bathurst, South Africa. It houses perhaps 2000 volumes of relevance to agricultural research and, being an entomologist by profession, the library' bias is towards entomology. On one shelf is a set of "Annual Review of Entomology" volumes. I idly reached out for one of the volumes, and noticed that it was for the year 1975. I opened it to the Contents page and started to glance through the subject matter reviewed in that volume - and reached the 3rd chapter. It was written by Dr John Beardsley and was a review of the Biology and Ecology of Armored Scale Insects. I never looked any further, but reflected on the fact that John Beardsley was an eminent member of the entomological fraternity so long ago. I wondered how his health was and what was occupying him in his well earned retirement. Three days later Duane Bartholomew who lives on the opposite side of the globe, with a 12 hour time difference, advised me by e-mail that on February 5, John had passed away. I don't know the time of his passing - could it have been at the time that I was looking at his Scale publication?

John is renowned around the world for his research involvement and contributions in matters relating to pineapple mealybugs. It was he who clarified the taxonomic distinction between the grey pineapple mealybug *Dysmicoccus neobrevipes* Beardsley and the pink pineapple mealybug *Dysmicoccus brevipes* (Cockerell). Prior to his taxonomic study people spoke of the "grey strain" and the "pink strain" of *D.brevipes*. It was because of John's expert knowledge of pineapple mealybugs and their natural enemies that, in 1985, I had the privilege of meeting him at the University of Hawaii, whilst on a month-long visit to the Hawaiian Islands, for purposes of collecting hymenopterous parasitoids of mealybugs. Despite his busy lecturing and research schedule, he still put aside a whole morning and lunch time to meet with me. In 1992, on occasion the ISHS International Pineapple Symposium, a most delightful evening was spent with John, and other delegates, visiting Sea World near Honolulu. However, he was not nearly as enamoured as we foreigners were with the lessons being given in Hula dancing by a rather large Polynesian lady.

Because of his expertise in pineapple associated arthropods, especially armored scale insects, a collection of hymenopterous parasitoids of pineapple scale insects - which I had collected in South Africa - was sent to him for identification. Once again, despite his heavy workload, he found the time to unravel the identities of these species - a very time consuming task.

John will be sorely missed by numerous entomologist colleagues, and numerous post-graduate students who worked under him have much to give thanks for because of the guidance and direction he gave to their studies.

Graham Petty , ARC-ITSC, Bathurst, South Africa

Excerpts from the Obituary of Dr. John W. Beardsley

University of Hawaii Emeritus Professor of Entomology, John W. Beardsley passed away last Monday while working at the Bishop Museum. At the time of his death, he was collaborating with Museum entomologists on two large Hawaii Biological Survey projects. He was 74 years old. After retiring from the University of Hawaii, Beardsley moved to California but was a frequent visitor to Hawaii, continuing his work at the Bishop Museum and Hawaii Department of Agriculture. Beardsley was an internationally recognized authority in the areas of biological control and insect systematics, particularly with respect to the mealybugs and scale insects of major significance to agriculture in the State of Hawaii. He was recognized as an authority on Hawaiian insects as well as the mealybugs and scale insects of the world. During his extensive career, he authored over 150 scientific articles in refereed journals, book chapters, and reviews. He contributed over 500 published scientific notes on new immigrant insects, new host records and new island records.

Originally from California, Beardsley's first exposure to the Pacific area came during his service in the U.S. Navy from 1944-1946. He had a long association with Hawaii, beginning with his work on the Oriental Fruit Fly Program of the University of California, Berkeley. He received his BS degree from the University of California, Berkeley, in 1950, and both his MS (1952) and PhD (1963) from the University of Hawaii.

Beardsley joined the faculty of the University of Hawaii in 1963 as an Assistant Entomologist and Assistant Professor of Entomology. He became a Professor of Entomology in 1972 and served as Chair of the Department of Entomology from 1981 until 1991. During this period, he conducted research in many different areas of biological control and systematics, particularly the parasitic Hymenoptera used in

control programs, as well as maintaining his interest in and concern for the endemic Hawaiian fauna. During his academic career, Beardsley taught undergraduate courses in both general entomology and insect systematics, and graduate level courses in immature insects, biological control of pests, and specialized courses on systematics of scale insects and parasitic Hymenoptera.

Beardsley served the community in more than his University role. He was a research associate of the Bishop Museum since 1955. He studied and wrote scientific papers on Museum specimens, donated specimens to the Museum he personally collected, provided identifications, and added significantly to the development and value of the Museum's extensive Pacific collection.

Beardsley was an active and valued member of the Hawaiian Entomological Society for over 40 years, serving as Secretary, Treasurer, President-elect and President. He served as Editor for the Proceedings of the Hawaiian Entomological Society for 15 years. In 1991, he received the first Hawaiian Entomological Society Award for Outstanding Service and, in 1995, received the Hawaiian Entomological Society's Lifetime Excellence in Entomology Award. He served the Entomological Society of America as local representative of the Membership Committee of the Pacific Branch and was a member of the Executive Committee of the Pacific Branch of the Society until 1984.

Aside from his many accomplishments, he will be remembered by colleagues and students as an enthusiastic teacher and mentor. He had a love of his profession not frequently encountered, often appearing most content while examining specimens in the laboratory or conducting field research. This enthusiasm was passed to those students in his classes and those pursuing graduate degrees under his supervision and guidance. His personality and contributions will be missed by all who had the pleasure of knowing him.

He is survived by his wife, Peggy, and children, Steven, Laurel, John and Claire, sister Nancy, and brother Edward. Memorial services were held Saturday, February 17, 2001, in the Atherton Halau, Bishop Museum, 1525 Bernice Street, Honolulu, HI.

International Pineapple Symposia

3rd Symposium: The proceedings of the 3rd Symposium have been published as Acta Horticulturae Vol. 529. The volume is available for purchase from the ISHS.

4th Symposium: The first announcement for the 4th symposium is out and the meeting will be held in Veracruz City from April 16-19, 2002. The announcement can be seen at http://mx.geocities.com/fips2002mx/ (English and Spanish versions are available). For more information, contact Andres Rebolledo Martínez, INIFAP-Centro de Investigación Regional Golfo Centro, Calle Ocampo # 234 Despacho 322, Tercer piso, Cd. de Veracruz, México, C.P. 91700; Phone: (2) 931-87-84; Fax: (2) 932-74-95; E-mail: rebolledomtz@prodigy.net.mx.

Organic Pineapple

Several people have written about growing pineapple organically. Over the past year or two, I have corresponded several times with two people who are helping small holders in Mexico and India to grow pineapple for the organic market.

Growing pineapple organically on a commercial scale presents a number of problems that are not encountered with shorter-term crops. Pest controls must be maintained for many months to a few years because a pineapple crop is in the ground for a minimum of 12 months (large suckers planted in the tropics) and may be in the field for three or more years if ratoon crops are harvested. Crop rotations, fallowing, and other practices designed to break a pest life cycle in many cases do not provide adequate pest control for pineapple. Rotations and fallowing reduce nematode populations, drastically in many cases (Sterling *et al*. 2001), but do not eliminate them in fields where they are present. Studies show 1 to 5 nematodes present in a 200 cc soil sample at planting time, a very low initial population, can reduce the ratoon yield by 10% (Sterling *et al*. 2001). Under such conditions, it is possible to harvest a very good mother-plant crop, but there is no known cultural practice or rotation crop that will reduce nematode populations to levels that will prevent damage to a ratoon crop. Without adequate controls or the complete absence of nematodes, nematode pressure almost always builds up during the long pineapple crop cycle to the point where ratoon crop yields are somewhat to greatly reduced.

Mealybug wilt, another wide-spread problem in pineapple, also is poorly controlled by fallowing and crop rotation because ants move mealybugs from weed hosts in wayside areas into the field. Unless the mealybugs or their tending ants are controlled, large losses to mealybug wilt are the end result. Suresh Mathure (see News from India) is doing interesting work on organic control of this important pest problem. Weeds also are an important pest in pineapple fields because they can overtop the slow-growing pineapple plants and reduce yields.

Current standards for organic production also make it difficult or costly, or both, to produce pineapples through out the year. Having the natural environment determine the time of flowering induction (natural induction) is returning to practices abandoned by commercial growers nearly 50 years ago. The peak period of natural induction almost always is in the fall-winter season and seldom induces 100% of plants. A summer harvest assures that the fruit are of the highest quality, but competition in the summer fresh fruit market also is high. Reliance on natural induction prevents growers from exploiting the almost unique physiology of the pineapple plant that makes it readily susceptible to flower induction with the plant growth regulator ethylene. Thus, in contrast with most fruit crops, it is possible to produce ripe pineapple in most months of the year, albeit pineapple that varies somewhat in quality.

On the subject of quality, some have implied to me that fruit produced as a result of natural induction are of the highest quality. In fact quality has little to do with the method of induction and much to do with the weather prevailing during the several weeks leading up to fruit maturation. The optimum conditions are not known with great precision, but studies and much experience show that fruit of the highest quality are produced when the temperature is warm and solar irradiance is high, i.e. the summer months. Natural induction typically occurs in the winter and those fruits mature in the summer when temperatures are warm and sunlight levels are high. Thus, such fruit invariably are of high quality.

At present there seems to be no viable commercial method of forcing plants into flowering that meets organic standards. Smoke, which produces ethylene as a byproduct of combustion, works when plants can be enclosed or covered. The practice could be feasible for

small areas, but is impractical for larger fields and it may pose a health risk. Ripe fruits produce ethylene and many years ago the Pineapple Research Institute of Hawaii recommended that home gardeners place a cut apple in the center of a plant to induce it to flower. However, getting the ripe fruit or other ethylene-producing substance to the center of the plant where it is needed to induce flowering is a costly and labor-intensive process. To date, it appears that there is no solution to this problem because those organizations promulgating standards for organic produce do not allow the use of caclium carbide or ethylene that has been synthesized or collected by chemical means. Please see the web section below for the addresses of organizations that establish organic standards.

I would like to include information on well-documented organic practices in future newsletters. I researchers or growers developing such practices to share their information with readers through the newsletter. If there is sufficient interest, perhaps it will be possible to have an informal workshop on organic practices at the 4th symposium.

Reference:

Sterling, G., E. Sinclair, N. MacLeod, D. Christensen and C. Scott. 2001. Nematode Management in Pineapples. In Pineapple Field Day Notes, Queensland Fruit and Vegetable Growers Pineapple Field Day, Queensland, Australia

ISHS Issues and News

Pineapple Working Group members are encouraged to also become members of the International Society for Horticultural Science. For those considering joining the ISHS, it is an organization of individuals, organizations and governmental bodies interested in the field of Horticultural Research and Horticulture in general. The ISHS is registered as a society in the Netherlands. To inquire about membership in the ISHS or to order publications of the society, write to: ISHS Secretariat, K. Mercierlaan 92, 3001 Leuven, Belgium (E-Mail: info@ishs.org) or visit the ISHS web site at http://www.ishs.org/.

Contributions to Pineapple News

Please plan now to contribute to the next issue of **Pineapple News**. When submitting articles for publication in the newsletter, please follow the guidelines below.

1. All contributions should be written in English. Assistance with editing is provided.
2. Preferred contributions are timely news about research on issues related to culture, processing, storage, and marketing of pineapple, new, interesting, or unique problems encountered by growers, and status reports on the pineapple industry within a country or region.
3. If possible, please send contributions by E-mail as attached files in MS Word or WordPerfect format or on floppy disks. Printed copy should be clean and sharp so it can be scanned to speed conversion to a wordprocessor format.
4. Columns in tables should be separated with tabs. Please do not use Tables features of word processing programs. Photographs or image files that can be printed in grey scale with a laser printer at 600 dpi are acceptable.
5. Mail contributions and inquiries to: **D.P. Bartholomew, Dept. of NREM/TPSS, Univ. of Hawaii, 1910 East-West Rd., Honolulu, HI 96822 U.S.A.** (Phone (808) 956-7568; Fax (808) 956-6539; E-mail: duaneb@hawaii.edu. ***Pineapple News*** is available on the Web at: http://agrss.sherman.hawaii.edu/pineapple/pineappl.htm.
6. **Address corrections:** Please send mailing and E-mail address corrections to D.P. Bartholomew at the above address.◆

News From Australia

Pineapple Fresh Fruit Breeding Program

G. M. Sanewski, Queensland Horticulture Institute, Maroochy Research Station. Nambour, Australia.

The pineapple fresh fruit breeding program commenced in 1991 with the objective of developing pineapple cultivars specifically suited to the fresh fruit market. A major emphasis has been placed on eating quality.

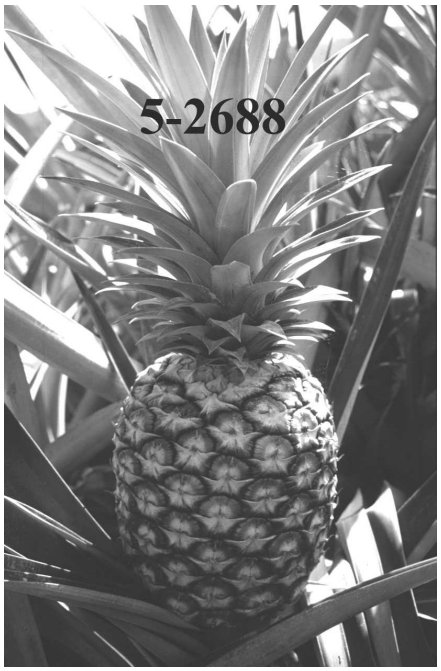
The generation and planting of seedling populations has been completed. We are now concentrating on multiplying and testing over 600 preliminary selections that were made from 50,000 seedlings. Most of the preliminary selections were discarded after re-planting and fruiting for a second time. Those that were re-selected have been advanced into tissue culture in preparation for genotype by environment (G X E) trials in tropical and sub-tropical regions. Twenty eight selections have so far been placed in tissue culture. It is expected an additional 5-7 will be selected as the remainder of the preliminary selections are evaluated for a second time.

It is anticipated that several cultivars will be released, the first in 2002. It is likely that different cultivars will be released for production in tropical North Queensland as well as Central and sub-tropical South-East Queensland. The program is due for completion in 2004.

Selections

Some of the important fruit characteristics of 10 of the 28 selections being prepared for G X E trials are compared with Smooth Cayenne (SC) fruits harvested from the same planting below; S is the selection number, P indicates the parents, and Cay is the comparable Smooth Cayenne

S - 1-12,802, P - 73-50 X Cay. Fruit about 2.2 kg with 20% TSS in summer vs. SC at 2.6 kg & 15% TSS. Fruit has low translucency and a fruit salad flavour.
S - 1-12,981, P - Cay X 73-50. Cylindrical fruit with solid yellow flesh and a slightly aromatic flavour, about 2 kg & 17% TSS in summer with medium acidity. SC, about 2 kg & 15% TSS. Appears less prone to translucency than Cayenne.
S - 5-2094, P - 73-50 X Cay. Similar external appearance to SC, about 2 kg & 19% TSS in summer compared with SC at 2.6 kg & 15% TSS. Less acid than Cayenne with a more yellow and firmer flesh. Slightly fibrous, not prone to translucency.
S - 5-2688, P - 73-50 X Cay. Cylindrical fruit with solid yellow flesh and a small core, about 1.9 kg & 18% TSS in summer vs. about 2 kg & 15% TSS for SC.
S - 6-1154, P - 73-50 X 24-80. Medium-sized fruit with solid yellow flesh and slightly aromatic flavour, about 2.5 kg & 15% TSS with low acidity in winter vs. 3.2 kg & 11% TSS for SC. Up to 20% TSS & 2.1 kg in summer vs. 2 kg & 15% TSS for SC.
S - 7-569, P - 73-50 X 53-116. A low acid fruit of approx 2.1 kg and 17% TSS in early winter.
S - 7-2879, P - 73-50 X F200. Fruit about 1.5 kg & 19% TSS with medium acidity in mid winter.
S - 8-576, P - 73-50 X Cay. Fruit with solid, yellow flesh with low to medium acidity. About 2.3 kg & 19% TSS in late winter vs. 2.4 kg & 12% TSS for SC. Can be up to 22% TSS and 2.3 kg in mid spring. Very sweet.
S - 10-1389, P - 73-50 X Cay. Fruit about 1.5 kg & 17% in summer vs. 1.6 kg & 14% TSS for SC; 2.1 kg & 17% TSS in mid spring with yellow flesh and medium acidity. Slightly fibrous.
S - 10-1472, P - 73-50 X Cay. Tall fruit with bright yellow flesh. 1.5 kg and 24% TSS in late spring.



Generally the selections are smaller, sweeter and less acid than Cayenne. In most cases, the flesh is also more yellow with a smaller core. The flavours are generally different to Cayenne. Some of these selections possess an aromatic skin when ripe. Plate 1 shows hybrid 5-2688.

Most selections tend to hold their fruit on a slightly longer stem than Cayenne. It is unclear at this stage whether this will be a major problem. It is also expected that the incidence of natural flowering will be greater in some hybrids compared to Cayenne.

Further evaluation will be performed in randomised complete block design trials in different sites in Queensland (G X E trials) including tropical and sub-tropical environments. Evaluations will encompass post harvest cool storage for screening of blackheart resistance, and replicated taste tests using experienced tasters.

Commercialisation of new cultivars

It is likely that cultivars released from the breeding program will be subject to Plant Breeders Rights and production and marketing of the cultivars will be strictly controlled with a royalty applied on fruit sales. This represents a new direction for the Australian pineapple industry and discussion has been initiated with industry representatives on how this can be best achieved.

2000 Pineapple Field Day

The Queensland Fruit and Vegetable Grower's Pineapple Field Day was held at the Glasshouse Mountains Sports Club on 21 July, 2000. The major theme of the 2000 field day was Soil Pest Management.

Summaries or excerpts, or both, of articles considered to be of general interest to readers of Pineapple News were prepared by D. Bartholomew. Sincere apologies to the authors for any significant changes in meaning.

Dr. Eric Sinclair, a horticulturist with Golden Circle and an important contributor to the Pineapple Field Day Notes for a number of years retired from the industry in 2000 to pursue personal interests.

Soil Health Action Group (SHAG): the First 2 Years

Eric Sinclair, Golden Circle Ltd

The activities of the SHAG over the past two years were reviewed. Because of concern about the loss of EDB, the focus of the group has been on soil health. Meetings have been held with a group of farmers interested in soil health to:

1. Learn more about options for improving the general health of pineapple soils
2. Test soil management systems that might be useful, and modify them where necessary.
3. Assess the advantages and disadvantages of these systems and compare them with the current soil management practices that are used in the pineapple industry.

Grower interest in the SHAG has increased and the group has expanded since its inception.

Nematode Situation Review

Graham Stirling, Biological Crop Protection Pty. Ltd.

Since the withdrawal of EDB in December 1998, the pineapple industry has had several options for managing nematodes. Observations made by technical staff from Golden Circle Ltd. indicate the following practices are being used followed by the percentage of

the area planted in parentheses. The sum of percentages is greater than 100 because two control measures may be used together. Practices are: Cessation of nematicide treatment, but no other management changes (50); Fields monitored and no nematicide applied (10); Non-chemical controls introduced (e.g. longer fallows, crop rotation, continuous plant crops, organic amendments) (10); Pre-plant treatment with metham sodium (15); Pre-plant application of fenamiphos (Nemacur 100G®) granules (<1); Routine post-plant sprays of fenamiphos (Nemacur 400®) (20); Sporadic post-plant treatment with fenamiphos (10); and Nematodes monitored and fenamiphos applied post-plant (5). Because nematodes mainly affect the ratoon crop, it is too early to determine whether the withdrawal of EDB will have a significant impact on losses due to nematodes. However, the industry as a whole appears to be coping well without EDB. Most crops show few signs of nematode damage and crop appearance is similar to when EDB was widely used. A nematode monitoring service has been available to pineapple growers for the last two years. However, demand for the service has been limited; only about 15% of the area planted since the withdrawal of EDB has been monitored. Growers who are monitoring nematodes are mainly using it to decide whether they should or should not spray with fenamiphos. Thus most samples have been collected 9-12 months after planting and after plant crop harvest, when decisions about nematicide treatment have to be made. The nematode counts obtained at these times suggest that there are significant nematode problems in about 25% of pineapple fields and that some losses from nematodes may be occurring in a further 20-30% of fields. Results of recent research with metham sodium, fenamiphos and organic amendments were reported at the 1999 industry field day. Continuing observations of trials with metham sodium suggest that it gives relatively poor control of root-knot nematode, but sometimes improves root health. Ratoon crop yields from trials set up to determine the best time to apply fenamiphos, and further data from a trial on the suppression of root-knot nematodes with organic matter will be available in the next 12 months. The industry has survived for two years without an effective fumigant, demonstrating that in many situations, it is possible to grow good crops with limited input of nematicides. If 1,3 D (Telone II®) is eventually registered, growers will need to carefully consider whether they should start fumigating again. In many cases, it may be a better long-term option to try to optimise crop management, improve Phytophthora control and experiment with using organic amendments to increase the suppressiveness of soils to nematodes.

The Re-emergence of Symphylids

Tim Wolens & Doug Christensen, Golden Circle Ltd.

The visual symptoms of symphylid *Hanseniella* sp. damage are similar to those due to nematodes. Below-ground the roots show multiple branching in a 'broom' like effect. Less noticeably the destruction of root meristematic tissue and the complete loss of root hairs which symphylids target through their feeding. Symphylid damage can reduce nutrient and water absorption; thus decreased plant growth and delayed development within pineapple plants. As with most soil pests, symphylids are not evenly spread throughout the field so affected blocks show a patchy scattering of smaller plants forming troughs and hollows. The fruit size and maturity in these areas is affected.

The three lifecycle stages of symphylids, eggs, nymphs and adults, can be found in any month of the year. Peak egg production occurs primarily during early spring months but continues until autumn. An egg matures to an adult in two months at 27 °C. In the spring and early summer adult females can lay a total of 20 eggs. The eggs hatch 10 days later and nymphs feed on roots for 45 to 60 days. Eggs and adults can overwinter. Adults probably live one or two years, moulting
at more or less regular intervals.

Soil temperature and humidity affect moulting frequency and consequently the rate of development of nymphs and juveniles. Symphylids can not tolerate reduced humidity or survive when there is free water in the soil in cavities where they exist so heavy rainfall drastically reduces symphylid populations. Adverse temperatures and excess moisture in the soil lead nymphs and adults to seek more favourable conditions deeper in the soil profile, in some cases as deep as 2 - 3 feet. However, under good conditions, the main symphylid population is found in the top 6-8 inches of the soil.

Symphylids can persist on food sources such as crop residues in or on the soil. Buried plant material from former pineapple crops is favourable for building up symphylid populations. Main crop damage occurs from September through April, but with irrigation or with higher rainfall, greatest injury occurs in the spring and early summer months. In a normal growing season, decreased soil moisture and increasing soil temperature tends to reduce injury levels. In optimal conditions populations in cultivated soils can be between 100 to 600 individuals m^{-2}. The ability of symphylids to injure the crop decreases as the crop matures.

Symphylids are typically limited by soil type and tend to live in soil where rapid horizontal and vertical movement is favoured by soil structure. Populations are highest in soils which are open, stony or have a coarse-grained structure, especially if high levels of organic matter are present and tillage was minimal during land preparation. They are less common in compact or sandy loam soils, as these soils do not provide them with adequate tunnels for movement; they can not produce or dig their own tunnels. Soil fissures, microcavities and earthworm galleries favor their movement.

Management involves suppression of pest numbers below the prescribed economic threshold level or total elimination of the population. Integrated Pest Management control measures focus on breaking the pest life cycle at many different points.

Cultural practices suppress populations by focusing on the reduction of food sources and physical manipulation of the soil. Cultural practises include: 1) lengthened intercrop period to allow crop debris to dry out before incorporation and reduce the potential food sources within the soil; 2) deep ploughing; 3) packing the soil after planting to create a short-term buffer around the root zone, allowing young plants to become established. Cultural practises must be combined with other techniques such as chemical controls to effectively control populations.

Chemical applications are still the most successful method of managing symphylid populations. Principle methods of application are soil fumigation, pre-plant soil incorporation of pesticides and post-planting applications, for example through drip irrigation system. The choice of chemical is the main concern when managing symphylids. With the limited sources of Lindane and the uncertainty with the effectiveness of Lorsban, trials have been undertaken to evaluate alternative chemicals.

Golden Circle Ltd. currently is screening three new chemicals as an alternative to Lindane for the management of symphilids as well as evaluating the effectiveness of Lorsban. The new chemicals are: bifenthrin, active ingredient of Talstar®; imidacloprid, active ingredient of

Confidor®; and fipronil, active ingredient of Regent®. The treatments are: Talstar at 1.2L ha^{-1}; Regent at 0.5L ha^{-1}; Control (water); Lindane at 11.25L ha^{-1}; Lorsban at 5L ha^{-1}; and Confidor at 2L ha^{-1}. The chemicals are applied through T-tape in a drip irrigation scheme. Each treatment comprising two seedbeds, 30 m long with T-tape situated at the base of individual rows. The plots were wet up with water both for one hour before and after application to distribute the chemical through the soil profile. Soil samples were taken at random at the pineapple base and immediate root zone and symphylid counts were taken. After 60 days, all chemicals suppressed populations below the control (Figure 1). Populations in the control are beginning to display an exponential population increase resulting from a high rainfall period between 25 and 35 days. Confidor treatment has insufficient suppression to effectively manage populations, Lindane, Lorsban, Regent and Talstar are not significantly different at 60 days, and Talstar and Regent suppressed symphylid populations similar to that of Lindane.

Industry Assessment of Symphylid Problem

Doug Christensen, Golden Circle Limited

In 1990 it was estimated, by GCL, that Symphyla could potentially affect 35% of the industry. Recent estimates are that 15% of annual planting will be obviously damaged, 10% so serious as to make ratoon crops a potential write-off.

Symphylid damage usually builds outward from water-soaked areas in soil depressions. Draining these areas may limit symphylid damage and also avoid Phytophthora disease. In wet years, clay soils will not dry out enough to limit the effect of Symphylids. Surface and underground drains can be supplemented with deep ripping to improve drainage.

Rushed bed preparation favours symphylids so thorough cultivation and reduction of clods in the bed is a worthwhile practice. Large soil clods harbour symphylid breeding colonies and chemical treatment and fumigation will not penetrate soil clods and lumps of trash. However, the pest can still sometimes survive up to one metre below ground, well below cultivation depth.

Chlorpyrifos, 500EC incorporated into the soil is used to control of white grub and it also suppresses symphylids. Symphylids show avoidance behaviour in the presence of chlorpyrfos, but Waite G. (QDPI) showed chlorpyrifos can still be effective in controlling symphylids when Suscon™ granules are incorporated into soil, an unapproved use in Australia. In recent trials, lindane was about twice as effective as chlorpyrifos for symphylid control. It is injected into beds along the planting line or can be incorporated into the beds with a rotary hoe. Metham fumigation where practical, will have a good knockdown effect on symphylids in the plough layer. Soil should be properly prepared to minimize clods and trash. Rocky soil and very steep soil remain a problem for equipment use. Telone, with properties similar to EDB will also be effective.

The best single product trialed to date is Mocap™ (ethoprophos). This is very toxic and presents understandable grower health and safety concerns. It has so far been withheld from commercial use. New generation pesticides are being trialed and hopefully we will soon be have some new effective chemicals approved.

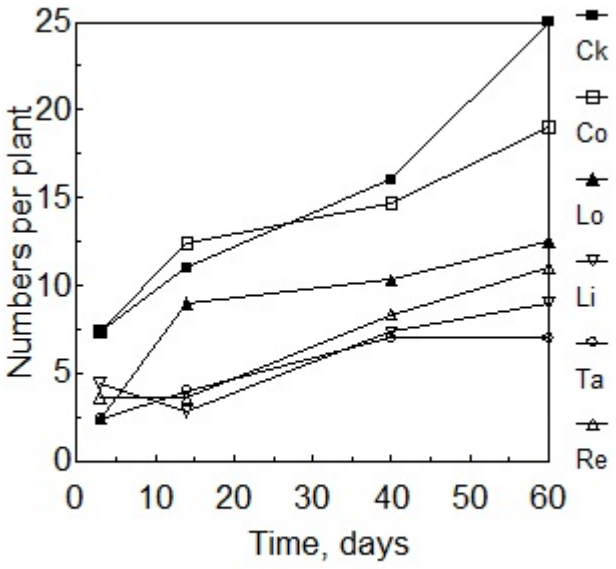


Figure 1. Effect of chemicals on symphylid numbers. Treatments are Control (Ck), Confidor (Co), Lorsban (Lo), Lindane (Li), Talstar (Ta), and Regent (Re).

Soil Fumigation Update

Doug Christensen, Golden Circle Limited

A decision on the registration for Telone II® (dichloro propene) is due in mid-2001. Sodium metham is proving a useful "stop-gap" product, even if difficult to use through long waiting times. Trials at the preferred rate of 600 L/Ha have given good yield responses at plant crop harvest.

This product is best used selectively and is unlikely to come into general use. The fumigant is only applied once every four years in the pineapple land rotation, so there is a reduced chance of the loss of effect reported in intensive vegetable cropping. Metham seems to control fungal root disease during crop establishment. This results in improved early plant size and root mass, particularly increased fine feeder roots. Metham is useful, but only partially effective, in nematode knock down compared to first-choice fumigants like EDB. This results in an increased need for post-plant Nemacur® when using Metham in high nematode situations.

Phytophthora root-rot is the most serious disease in Queensland pineapple. Regardless of the soil treatment or organic amendment used at planting, plant root systems are usually largely destroyed by the time of plant crop harvest in wet soil situations. But achieving robust early growth and root establishment, supported by a sound fungicide program allows the crop to tolerate some root damage and sucker for ratoon crop. Metham does not appear to affect nitrification bacteria and extend soil nitrogen, therefore crops will benefit from some increase in nitrogen application during crop establishment.

Recent Metham Trial Results

Doug Christensen, Golden Circle Limited

Metham at the intermediate rate of 600 L/Ha sustained high yields in the plant crop. This applies both without nematode pressure (Seven Peaks site) and with nematode pressure (Merbye site). Yield gains of 14% above untreated are possible. Over-application to 900 L/Ha, or planting too soon after application when fumigant residues are present can lead to crop damage due to phytotoxicity. The Metham (liquid) and Chloropicrin (gas) used simultaneously through a dual output fumigator resulted in good plant size and vigour, but did not result in economic fruit yield gains. Chloropicrin probably has no place in pineapple growing and is particularly ineffective for nematode control.

Effect of Molybdenum Applications on the Juice Nitrate Concentration of Pineapples

Col Scott, Golden Circle Ltd

Pineapple juice containing more than 8 ppm of nitrate can cause detinning of cans. In an intact pineapple fruit, nitrate concentrations tend to be higher in the top cut, basal cut and core, with somewhat lower levels in the skin and flesh. Thus there are many combinations of juice and flesh which can cause detinning. Detinning is caused by a chemical reaction between the tin coating on the can and the nitrate in the contents. The problem is characterised by dark discolouration of the contents and the presence of dark detinned areas on the inside of the can.

Trials on the effects of molybdenum in 1998 and 1999 did not produce consistent results so a further series of trials was conducted in 2000 to follow up on application rates and timing. The results showed that under the conditions prevalent in Queensland, it is extremely doubtful that sodium molybdate will reduce juice nitrate levels. If, however, nitrogen budgets are exceeded, sodium molybdate may help to reduce nitrate levels if applied after the last application of nitrogen. The most reliable way to maintain low levels of juice nitrates in fruit is to adhere strictly to the established nitrogen budget.

Erosion Control What's Available and Being Developed

Eric Sinclair, Golden Circle Ltd

The risk of soil erosion is a fact of life in a horticulture crop like pineapples because early in the crop cycle the soil is bare and unprotected. This erosion can be very severe and on-farm effects include a washed out crop, large gullies, loss of nutrients, and loss of soil and soil structure. Off-farm effects include silting of roads, gardens, and creeks and nutrient enrichment and increased turbidity in natural water bodies. There are some outstanding examples of soil conservation efforts in the Australian pineapple industry, but there are many problem areas. A severe cost-price squeeze on local growers results in a need to use the available land to its utmost capacity. Under the current economic climate, it is easy for growers to "externalise" the cost of erosion–silt deposits will be cleaned up by councils with the cost spread over all rate-payers. Whilst growers realise the adverse long term affect of such erosion on sustainability, they urgently know that it is important to produce the next crop to maintain cash flow. The cost of land and farm size makes it almost impossible to set land aside for conservation purposes and to undertake the land and money hungry measures to control erosion effectively.

With more non-farming people living in farming areas and using rural areas for recreation, more attention is being paid to such on-farm problems as erosion. Government agencies will take a greater interest in such problems, and may well impose costs on growers to control them. Private individuals also may take civil action against growers for off-farm erosion effects. If this occurs, many growers may not be able to bear the cost of such litigation, or to adopt the methods required to alleviate the problem. Thus, there are many good reasons for doing something about erosion.

Most erosion in pineapple occurs in the first 6 months before the leaves close over and protect the soil. Mulch reduces erosion, but the most available mulch to use to protect the soil during this period is pineapple trash. In hand-mulched plots, mulch reduced soil loss (tons ha^{-1} y^{-1}) for a 3-year crop from 152 to 9.3 with a reduction of almost 123 tons in the first year. There currently is no practical way to use pineapple mulch to control erosion.

Contours can minimise run-off volume and velocity, but large runs are needed to be efficient for a block-based system such as pineapple. Water disposal at the end of the contour is a problem, as it is with cross-drains, land shaping, and even with water exiting the end of pineapple beds. Water disposal can be by concrete drains or grassed waterways, but concrete is expensive to install and grass is sensitive to the herbicides used in pineapple, and can be slippery if used on roads. The right type of grass such as "African Star Grass" causes little problem in invading the crop. Tied ridges form small dams down the interrow that catch the water to prevent run-off. One grower has used this system on steep land, and is satisfied with the results. However, most of the work on tied ridges has been done in low to moderate rainfall areas where the method also conserves water for the crop. If the ridges overtop in heavy rain the ridges can wash out and very severe erosion damage can occur. Even if ridges don't fail, with heavy rainfall the ridges can increase infiltration too the point where excess water can be a problem.. In the DPI erosion experiment at the QFVG Pineapple Farm in Beerwah, soil washed from Conventional, Tied Ridges, and Surface Mulch was caught and weighed after rainfall events. After heavy rain in February 1995, kg of soil eroded from Conventional was 886, from Tied Ridges was 603, and from Mulch was 15. In lieu of tied ridges, pineapple tops/slips can be planted across the interrow every 10 m or so. Interrow plantings can catch silt but also let water continue down the row. Overtopping of these plantings can cause damage. Measures that slow water flow will increase the amount of water that enters the soil and flows sub-surface. Where excess water can cause problems, it is important to make high beds and provide suitable underground drainage to allow roots to develop.

Soil organic matter increases soil strength, thus reducing erosion. Organic matter leads to good crumb structure, which allows improved water infiltration and makes it more difficult for run-off water to move the bigger, heavier soil units. Few crops produce as much organic matter as does pineapple, and these days all of this is returned to the soil. Unfortunately, conventional farming methods break down organic matter mechanically, and it is then rapidly oxidised and lost.

Mulching represents the best solution to the soil erosion problem, but new machinery will need to be developed to utilize pineapple plants as mulch. A pineapple mulcher project was begun in March 1998. The machine concept is to have a single pass crop destroyer/bedder/mulch spreader. Funding for development work is being sought, and if the machine can be developed, it will not only help control erosion, but improve the efficiency of crop land preparation.◆

News from Brazil

Inhibition Of Natural Flowering In Pineapple, Cv. Perola, With Growth Regulators

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Abstract of PhD thesis, UFC - Ceara/Brazil

Pineapple flowering can occur naturally, related to climatic factors (photoperiod, temperature, solar radiation), and artificially, with the use of chemical substances (plant growth regulators). Natural flowering, mainly when precocious, is very inconvenient and has caused, with increasing intensity, significant losses in all pineapple producing regions around the world. The objective of this work was to determine the role of substances which inhibit the vegetative growth of the plant, in different seasons of the year, on the inhibition, reduction or delay of the natural flowering of pineapple, cv. Perola, the most planted in Brazil. Three field experiments were conducted at the experimental field of Embrapa Cassava and Tropical Fruit Crops, in Cruz das Almas, Bahia, during 1995-1999. The treatments were (a.i.): 2-(3-chlorophenoxy) propionic acid - ACP (45 to 300 mg L^{-1}), paclobutrazol - PCB (77.4 to 320 mg L^{-1}), mepiquat chloride - CM (60 to 480 mg L^{-1}), gibberelic acid - GA_3 (30 and 60 mg L^{-1}), tebuconazole - TBZ (60 to 180 mg L^{-1}), propaconazole - PPZ (120 mg L^{-1}), and urea (foliar, 5%, and solid, 1.5 g $plant^{-1}$); the treatments were applied from 2 to 4 times, fortnightly, from April to July, which is the critical period for natural flowering in the region. The experimental design was in randomized blocks, in factorial scheme (4x2+1) with 5 replications; the data (flowering %, growth, production and harvesting amplitude) were evaluated by the analysis of variance, and the averages compared by the Tukey's and Scott-Knot's tests (5%). In experiment I, PCB was the only product to present a significant effect, when applied in June (300 mg L^{-1}), inhibiting 82.2% of the flowering. In the lowest concentration (150 mg L^{-1}) it inhibited only 32.2% of the plants, without differing from the control (8.9%), neither from the other treatments. ACP (300 mg L^{-1}) reduced only 35.0 % of flowering and caused some morphological anomalies in the plants (leaf rosette distortion and adventicious roots on the leaf), while CM and urea did not have any effect on flowering. The products did not affect fruit quality. However, the number of slips per plant was significantly reduced, but only by the ACP (4.4 slips $plant^{-1}$), in relation to the control (7.8) and the other treatments (7.2). Greater flowering inhibition was observed when the products were applied in June. In experiment II, ACP (90 mg L^{-1}) and PCB (154 mg L^{-1}) presented the best results, when applied in May, inhibiting flowering until 85.7%. CM and GA_3 did not differ from the control, except the latter (60 mg L-1), applied in May (67.1%), which was the most favourable month, with a inhibition of 65.7%. In experiment III, ACP and PCB reduced the natural flowering, respectively from 70.2 to 92.7% and from 39.5 to 72.8%, in the critical period of June to September, and delayed harvesting, mainly the ACP. The treatments TBZ and PPZ did not affect flowering. ACP and PCB also inhibited vegetative growth (foliar elongation) of the plants, mainly the PCB, being that a temporary effect. With PCB, the leaves were larger and thicker, and this may have contributed to make them as heavy as the ones from the control. In season 1, the products showed significant effects only in relation to slips, when the plants treated with ACP produced an average of 3.6 slips $plant^{-1}$, while in the other treatments, including the control, this average was 5.1 slips $plant^{-1}$. The average general fruit weight was 1.03 kg and the average yield was 51.0 t ha^{-1}. In season 2, significant differences were observed among all variables. The heavier fruits were produced by ACP, with an average of 1.03 kg, followed by TBZ (1.02 kg), control (1.01 kg), PCB (0.96 kg), and PPZ (0.96 kg). In relation to yield (t ha^{-1}), the greater averages were also observed with ACP (54.6) and TBZ (51.5), followed by the control (50.6), PCB (48.3) and PPZ (47.8). ACP was still responsible for the least number of slips per plant (an average of 2.3), while the average of all the other treatments was 5.0 slips/plant, similar to the control (4.7). There was not a significant difference between the two seasons of application of treatments (April-May and May-June). According to the results, ACP and PCB are capable of inhibiting/delaying the natural flowering of pineapple. The best results were obtained when the growth regulators were applied in April/May, and also, with higher concentrations (90 to 240 mg L^{-1}). However, due to the variation in the effects and efficiency of the products, further field evaluation of the effectiveness of ACP and PCB under natural and cultural conditions in the main pineapple regions and with other cultivars is necessary, before their recommendation for practical use.

Domestication and Use of Ananas Lucidus by the Indians of Amazonia

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Ananas lucidus, or curauá, as it called by the Indians of Amazonia, is a wild relative of the pineapple. Its native habitat was probably the Amazon forest. The uncertainty about this is due to the fact that it is not currently found in natural habits.

Expeditions to collect pineapple germplasm have been carried out by the Brazilian Company for Agricultural Research (EMBRAPA). On these expeditions in the Upper Rio Negro, in the Rio Solimões basin and in the states of Acre and Rondônia, the curauá was not found in its wild form and was rarely found in indigenous settlements (Duval et al., 1997).

Despite being a relative of the cultivated pineapple *(Ananas comosus*), the curauá produces fruit that is inedible not only because of its insipid taste and very fibrous flesh, but also because it has almost no juice; furthermore, it is small in size. In spite of these characteristics, it has importance for the pineapple germplasm bank gene-pool since, among other aspects, the genetic variability in the species could prove useful as a source of resistance to some pest or disease.

Long ago domesticated by indigenous people, the curauá probably cannot survive in the wild any more without human interference. Besides, Ford-Lloyd & Jackson (1986) explain that the domestication of plants is the result of human intelligence in leading the evolution process towards the habitat created by humans. During the domestication process, plants cultivated differently from those in natural systems become dependent on humans for their reproduction and development.

The study area known as ethnobotany has come out of the observation of this interaction between humans and their vegetal surroundings. Its objective is to understand indigenous wisdom or the knowledge of so-called traditional peoples in relation to vegetal species. Without sophisticated laboratories they have developed alternative uses for vegetal species, using verbal communication and the collected knowledge of successive generations.

The indigenous peoples have sought alternative uses for the curauá and have given special attention to the fibers extracted from their leaves. Curauá fibers are very resistant and capable of supporting high tension, even at reduced thickness. This property has allowed indigenous people to make lines and nets for fishing, string, ropes and cords for various uses, and sleeping hammocks. In addition, the curauá has some medicinal properties.

With the advent of nylon and the contact of indigenous people with other cultures, this natural fiber has been neglected in favor of using synthetic fibers, leading almost to the extinction of the already domesticated species. The previously mentioned collection team noticed many times that the curauá was a plant cultivated for specific purposes, but that as it was no longer useful it was not being cultivated and did not exist any more in that area. Sometimes they found some plants abandoned in vegetable plots or plantations, generally with the help of older people, as younger ones did not even know of their existence or whereabouts.

Mercedes Benz of Brazil is currently encouraging the planting of curauá for fiber extraction. This is to be used in vehicle upholstery, especially for heavy vehicles such as trucks and buses, since as well as having the advantages of being a natural fiber (mainly those related to environmental preservation), the fiber is highly resistant, as the Indians had already discovered. Because of this, the company is planning to buy large quantities of the raw material, which has led the Pará state government to encourage planting of this species on a commercial scale. For this purpose, the Pará unit of EMBRAPA (CPATU) has received orders to produce two million seedlings grown from meristem *in vitro* culture (Osmar Lameira, personal communication).

The curauá therefore can be seen as an example of a domestication process carried out by indigenous peoples, followed by complete neglect of the species, almost to the point of extinction. After a long period, knowledge of the species has been salvaged in conjunction with the traditional populations, which has enabled it to be used once more, now with the status of a commercial plant.

REFERENCES

Ford-Lloyd, B., and Jackson, M. (1986) Plant Genetic resources: an introduction to their conservation and use. Baltimore, Maryland: Edward Arnold, Baltimore, Maryland. 146 p.

Duval, M.F.; D'eeckenbrugge, G.C.; Ferreira, F.R.; Cabral, J.R.S.; Bianchetti, L.B. (1997). First results from joint Embrapa-Cirad Ananas germplasm collecting Brazil and French Guyana. Acta Horticulturae, v. 425, p.137-144.

Ribeiro. B.G. (1987). Etnobiologia. Suma etnológica brasileira. Ed. Vozes, Petrópolis. 187p.

Slip Thinning - a New Cultural Practice for 'Pérola' Pineapple

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Plants of pineapple cv. Pérola usually produces 8 to 12 slips, most of them located at the upper part of the peduncle surrounding the base of the fruit. These slips differ in size and vigor. Even though used as the main planting material, their numbers are mostly in excess of the farmers' need. The formation of the slips overlaps mostly with the period of fruit development and maturation and hence they may be sinks that compete directly with the fruit for photoassimilates and reserve substances.

For a long time thinning of slips has not been neither a cultural practice used in the Brazilian pineapple fields nor an issue for research, except for a study carried out by Giacomelli *et al.* (1967), that did not show statistical significance for slips thinning treatments on 'Pérola' fruit weight. However, recently in some pineapple fields of Tocantins and Minas Gerais states slips have been thinned, apparently with positive results, but without scientific proofs. Therefore, from 1997, Embrapa Cassava and Fruit Crops has carried out studies in commercial plantations under different crop management - with and without irrigation - and climatic conditions - the semiarid of the "caatinga" ecosystem and the subumid of the North Coast region, both in Bahia state - in order to evaluate the effect of slip thinning on the accumulation of fresh and dry matter in plant organs, yield, fruit weight, size and quality of 'Pérola' pineapple.

In a completely randomized blocks design, with seven replications, were studied six treatments represented by the control (without thinning) and the following five levels of slips thinning: all slips removed; two slips kept on the sunset side; four slips kept, from top to bottom; four slips kept, from bottom to top; six slips kept.

Fresh and dry matters of the whole plant, roots, stem, leaves, peduncle and slips, were obtained at 90, 120 and 150 days after forcing of flowering(forcing), and their relationship with some fruit characters determined. Fruits were harvested from 160 to 170 days after forcing. Data were submitted to analyses of variance and correlation and means comparison tests (Tukey 5%).

Independently of slip thinning treatments, the distribution of dry matter among organs showed partition in favor of the fruit, with reduction of stem, peduncle and leaf dry matters during the fruit maturation phase, from 120 days after forcing treatment. Fruit weight, fruit length and yield increased consistently (up to 13%) in response to slip thinning, even though those differences were not statistically significant.

The reduction of slip number also resulted in significant increases in fresh and dry weights of slips kept and of the fruit crown, which is another type of plantlet. Total removal of slips changed the correlation between fruit and crown weight from a negative to a positive one, i.e., in plants without slip thinning the heavier the fruit the smaller the crown, but if slips are removed, the fruit crown became an important drain and its weight increases together with that of the fruit.

As expected, higher plant and leaf weights resulted in greater fruit and slip weights. Slip thinning did not affect fruit quality, with the chemical, physical and chemical-physical characteristics being within the patterns of the cultivar Pérola.

An economical analysis, based upon actual labor and fruit prices in the national market, showed that slip thinning may give the farmers an additional gain of about US$ 350 per hectare. Based upon these results, slip thinning of low intensity is recommended in 'Pérola' pineapple fields, removing only the less vigorous slips, allowing a better development of the remaining ones and a small increase of fruit weight. Thinning should be done immediately after closing of the last flowers, which happens about 90 to 100 days after the forcing treatment.

Higher Planting Density of 'Smooth Cayenne' Pineapple Crop

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and Luciana de Almeida Lima Santana (Post-graduate student at the Agronomy School, Federal University of Bahia, Cruz das Almas, BA)

Brazil's pineapple industry is one of the largest and most important in the world. Research and technology transfer efforts carried out under the leadership of Embrapa Cassava and Fruit Crops along the past 25 years, have improved crop management practices and strongly increased average fruit yields, that nowadays are about 23,000 fruits ha^{-1} according to the Brazilian Institute for Geography and Statistics (IBGE, 2000) and estimated to be 33 to 35 t h^{-1} a. The increase in planting densities, among other factors, has contributed to those positive results. However, further yield gains must be obtained to keep pineapple production competitive and to compensate for smaller returns per fruit unit obtained by the farmers in the last years.

Further increases in planting densities may be possible, as has been shown by results obtained in other countries, where densities above 50,000 plants ha^{-1} are common, specially in 'Smooth Cayenne' pineapple fields. Changes in the consumer requirements, such as the growing acceptance of smaller fruits by European and American consumers,
which may also occur in Brazilian markets, gives stimuli to such efforts. In addition, several small pineapple canning industries are looking for smaller fruits weighing about 1.0 to 1.4 kg as raw material, because they usually have the correct diameters for the can calibers used.

Studies carried out by Embrapa Cassava and Fruit Crops on different farms in the pineapple production areas of Bahia, Brazil, from 1996, aimed at evaluating the effect of high densities in double row planting systems on the quantitative and qualitative production of Smooth Cayenne pineapple. Planting densities varying from 51,280 to 100,000 plants ha^{-1}, were studied in a randomized blocks experimental design with five replications and 12 treatments, representing combinations of the following spacings: 90, 80 and 70 cm between double rows, 40 and 30 cm between single rows within each double row, and 30, 25 and 20 cm between plants within each row.

The analyses of variance determined significant statistical differences for the yield as a function of spacings between plants within the row. The smaller the distance between plants and hence the higher the planting density, the higher was the yield obtained. Average fruit weight, dimensions and quality (sugars, acidity, juice content, sugar/acidity ratio) were not significantly influenced by the densities studied, presenting values within the cultivar's patterns. For each 10.000 plants ha^{-1} increase yields grew by 10.36 t ha^{-1} and average fruit weight dropped just by 29 g. Under the environmental conditions of the Coastal Tableland of North Bahia, Brazil, the Smooth Cayenne pineapple crop showed good potential for the use of high planting densities, even under rainfed cultivation, producing yields above 80 t ha^{-1} and average fruit weight over 1.0 kg for densities up to 70,000 plants ha^{-1}.

Why Off-season Offer of Pineapple Has Increased in Brazil

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All the pineapple marketed in Brazil is produced within the country. The fruit is offered during the whole year, with larger volumes being offered and consumed during the warmer months, specially in late spring (October to December) and early summer (late December and January). The off-season period is from February to May with lower volumes and higher prices.

During the last few years an increasing production of pineapple in the off-season period has been observed, which has resulted in smaller differences in fruit offered and prices in relation to the main harvest season. Many reasons and factors have contributed to that, most of them related to a technological evolution in pineapple cultivation and to climatic characteristics in new production zones, as described in the following:

Flowering induction treatments have been improved by research efforts along the past 20 years and are nowadays applied on almost all commercial pineapple fields in the country, mostly with efficiency rates above 90%.

The pineapple area cultivated under irrigation has increased, representing nowadays about 10% of the total area planted. The use of that resource allows a spreading of planting and flowering forcing dates along the year, moving the harvest of a larger part of fruit production to the off-season period.

New production zones, specially in regions of the North of the country, such as the South of Pará state and the North of Tocantins state, have arisen, where the climatic conditions are favorable to obtain off-season harvests. In these regions, high air temperature and solar radiation conditions limit rather strongly the occurrence of the natural flowering differentiation of pineapple plants from June to August, which has been the main reason for the large amounts of pineapples offered from November to early January. Therefore, forcing of flowering can be done from September, obtaining fruit harvests from February/March in the next year.

The use of adequate combinations of the factors planting date, weight or size of the planting material and forcing date, which have been worked out for many production areas after years of studies, have also allowed improvements in spreading the pineapple harvest periods.

The delay of pineapple fruit harvests by the application of growth regulators, such as those based upon 2-(3-chlorophenoxy) propionic acid as the active ingredient, right after the closure of the last flowers, another technique adjusted to the conditions of some production zones, has contributed to move harvests from December to late January or early February.

Influence of Irrigation on the Cycle of 'Pérola' Pineapple in Coastal Tableland Area of Brazil

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This study aimed at evaluating the influence of irrigation on the 'Pérola' pineapple cycle. The work was carried out at Embrapa Cassava and Fruit Crops, Cruz das Almas, Bahia, Brazil, on a Yellow Latosol typical for the Coastal Tableland, a site with altitude of 220 m, annual rainfall of 1,170 mm and annual average temperature of 24.5 °C. The experimental design was in randomized blocks and the water was applied by sprinkler irrigation in a "line source" scheme, were 608, 568, 525, 468 and 334 mm $year^{-1}$. The effective rainfall was 671 mm $year^{-1}$ during the experimental period.

There was a positive effect of increasing irrigation on the natural differentiation and the timing of the fruit harvest period, resulting in a shortening of the plant cycle, without reduction of fruit weight, in the plots with the highest irrigation. In these plots, more than 70% of the fruits were harvested 22 days earlier in relation to the final harvest. The higher irrigation also resulted in a more even distribution of the fruit harvest over its period.

Brazilian Program for Improvement of Pineapple Commercialization and Package Standards

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This program was elaborated and launched in João Pessoa, PB, in August 2000, by a pool of institutions, among those Embrapa Cassava and Fruit Crops, the Rural Extension Corporation of Paraiba State (EMATER-PB), the Stock Market of Pernambuco and the Agricultural Marts Company of São Paulo State.

The standards of classification of pineapple fruits by pulp color, rind color and weight were defined. In addition, defects that may be presented by fruits are described and limits of tolerance determined for their incidence in the different fruit categories.

Fruits are classified in groups with yellow and white pulps and sub-groups with yellow, green, "flecked" (some yellow in mostly green) and "colored" (more than 50% yellow) rinds. Fruit weight categories within the yellow pulp group (Smooth Cayenne group) start at 900 g (class 1) and ending with class 6 (>2.5 kg). In the white pulp group (Pérola group), there are just four classes, from 900 g to above 1.8 kg.

The defects are divided into "light" and "heavy" ones. The first are those that may reduce the fruit value, but do not hinder its commercialization. The latter ones impede its commercialization and/or may cause contamination in the other fruits of the same package. Double or multiple crowns are examples of "light" defects, whereas fasciations, sunburns and fruit rots are defined as "heavy" ones.

As mentioned above, rind color is the main maturity stage criterion used for fruit classification during commercialization, but, in addition, the fruit must have a total soluble solids content of more than 12 °Brix. The program also presents some orientation for packaging and the obligation of product labeling according to Federal Rules. The label should give clear information on the origin and the classification of the product.

Packaging of fresh pineapple has been done only for a rather small part of the Brazilian production. Most of the fruits have been transported without packaging on trucks, usually not equipped with a refrigeration system. The implimentation of these new rules should help to improve the conditions of pineapple post-harvest handling and commercialization, offering a better quality product to the consumers and reducing the post-harvest losses, that are estimated to be around 20% of the fruits harvested.

Pineapple Played a Major Role in the XVI Brazilian Fruitculture Congress

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In Fortaleza, Ceará State, from September 25 to 29, 2000, was held the XVI Brazilian Congress of Fruitculture organized by the Brazilian Society of Fruitculture (Sociedade Brasileira de Fruticultura - SBF), with the participation of more than a thousand people representing 172 institutions from Brazil and seven other countries (Argentine, Cuba, Spain, Italy, Mexico, Mozambique, Portugal). Some 678 papers were presented and more than 20 conferences and panels carried out on the main issues of the fruit crop industry. Pineapple was addressed in several panels, conferences and by 28 papers presented as posters that dealt with micropropagation, propagation by stem sections, breeding, cultural practices, diseases, irrigation, post-harvest and economy. The most important panel on pineapple addressed perspectives, ways and problems for increasing the Brazilian exports, with emphasis on how to overcome the factors hindering the export of Pérola pineapple fruits, such as their less attractive rind color (usually rather greenish, even when ripe) and form (conical).

The next Brazilian Fruitculture Congress will be held in Belêm, Pará, in the Amazon region of the country, in the second semester of year 2002. The address for contacts with the Brazilian Society of Fruitculture is: SBF, Avenida Sílvio Vantini, 52 - Nova Jaboticabal-Jaboticabal, São Paulo, Cep 14.887-014. Telefax 0 55 21 16 3203 3102; E-mail: sbfruti@asbyte.com.br; Homepage http://www.asbyte.com.br/sbfruti.

Evaluation of the Predacious Capacity of Cryptolaemus montrouzieri on Dysmicoccus brevipes

Nilton Fritzons Sanches (entomology) and Rómulo da Silva Carvalho (integrated pest management), Embrapa Cassava and Fruit Crops Caixa Postal 7, 44.380-000 Cruz das Almas, Bahia, Brazil, e-mail: sanches@cnpmf.embrapa.br Edmilson Santos Silva and Ivani Pereira Santos (undergraduate students), College of Agriculture, Federal University of Bahia, Cruz das Almas, BA

Cryptolaemus montrouzieri Mulsant. 1853 is a predator largely used on biological control of mealybugs and aphids. The objective of this work was to evaluate the predacious capacity of this predator on pineapple mealybug. The experiment was carried out at the Entomology Laboratory of Embrapa Cassava and Fruit Crops, under controlled laboratory conditions (temperature of 26±1°C, 65±10% RH and 12 hours photoperiod) and under laboratory environmental conditions (temp.: 28±1 °C ; 75±5% RH). Specimens of *C. montrouzieri* recently emerged were individualized in Petri plates (5 cm diameter). Twenty individuals of *C. montrouzieri* (10 individuals/each environment) were evaluated. The pineapple mealybug *Dysmicoccus brevipes* Cockerell, 1893 were obtained by growing them in laboratories, using as substrate pumpkin *Cucumis maximo*. During its four larval phases, representing a total period of 13.3 days, the predator consumed on average, 2.9, 5.8, 8.8, and 31.2 adults of *D. brevipes*, respectively. In the adult phase (350 days) the predator consumed, on average, 900 adults of *D. brevipes*, corresponding to a daily average of 2.5 adults. The results were similar for both environmental conditions studied. Nymphs and adults of *C. montrouzieri* showed good efficiency as predators of the pineapple mealybug *D. brevipes*.

Control of Underground Termites Amitermes Sp. on the Pineapple Crop in the Semiarid Zone of Northeast Brazil

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Among the secondary pests of pineapple, the underground termite causes great losses in commercial plantations in the semiarid areas of Northeast Brazil. The losses on pineapple production under no irrigation condition are significant because underground termites destroy the basal portion of the stem where the roots are formed. The objective of the experiment was to evaluate the efficiency of five insecticides on the control of underground termites *Amitermes* sp. The experiment was carried out in a commercial plantation of Pérola pineapple in the region of Itaberaba, BA, from May to December 1999. The experimental design was in randomized blocks, with 6 treatments and 4 replications. Each plot had 2 double rows spaced 1.40 x 0.40 x 0.30 m with 11 m length and a total of 140 plants per plot. The treatments were the following: 1 - Control (only water); 2 - Relative control - Vamidothion - 330 ml of the commercial product /100 l of water; 3 - Imidacloprid - 60g c.p. /100 l of water; 4 - Thiametoxan - 60g c.p. /100 L of water; 5 - Fipronil - 30ml c.p. /100 L of water; 6 - Acephate - 100g c.p. /100 L of water. The treatments were applied two months after planting, with application of 30 ml of the solution/plant. Thiametoxan and Imidacloprid were sprayed directly to the base of the plant. Evaluations were performed at 15, 45, 75 and 105 days after application of the treatments, when five plants were sampled per plot. For each sampled plant, one soil sample (20 x 10 x 15 cm) was also collected. Both plant and soil samples were sifted and then carefully observed for the presence of termites. At 105 days after the application, the most efficient treatments were Thiametoxan and Imidacloprid showing control rates of up to 100%.◆

News From France

Ornamental Pineapple : Perspective from Clonal and Hybrid Breeding

M.F. Duval1, G. Coppens d'Eeckenbrugge[2], A. Fontaine[1], and J.P. Horry[1]
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Many bromeliad species are famous for their ornamental interest, generally as potted plants, and the best known representative of the family, the pineapple, is no exception. *Ananas bracteatus* var. *variegatus* is a traditional garden plant in tropical regions. Gardeners enjoy the attractive variegated wide leaves and the large bright pink inflorescence bearing long bracts and violet petals, despite the large size of its spines. Another ornamental garden pineapple is the spectacular red-fruited variegated mutant of *A. comosus* cv. Singapore Spanish, used in Malaysia in gardens around temples (Y.K. Chan, personal communication).

A more recent exploitation of ornamental pineapple is directed towards the cut flower market. For instance, in Ivory Coast, a private company grows different cultivars for export to Europe. Among these are the variegated *A. bracteatus*; a clone of Ananas nanus with a tiny candy pink inflorescence (3-4 cm), known as "ananas-boutonnière" because it can be used by gentlemen as a flower to be worn on the

lapel; and 'Chocolat', an *A. lucidus* cultivar whose smooth and narrow leaves are erect and burgundy-colored. Its small bright-colored inflorescence bears red bracts and deep purple petals. A smooth mutant of the variegated *A. bracteatus*, a green mutant of 'Chocolat' and a variegated mutant of the "ananas-boutonnière" have enriched this first set. Another mutant of *A. bracteatus*, showing unstable leaf variegation pattern, has also been maintained through constant selection. Its advantage resides in its production of a small proportion (about 5%) of surprising white crowns, contrasting with the long red bracts of the fruit. The other fruits exhibit crowns whose leaves vary considerably in the relative importance of green and white stripes.

Although less important than the pineapple cultivated for the fruit, the ornamental pineapples also deserve interest for the breeder, who can choose among the many small-fruited wild types and fiber cultigens. These pineapples generally transmit their high fertility, good vigor, and relatively short production cycles to their progeny. The selection is relatively easy, as most traits are highly heritable and easy to observe. Clones giving small fruits are favored for the cut flower or potted plant market while larger plants are preferred as garden ornamentals. In 1988, the Fruit and Horticultural Crops Department of CIRAD (CIRAD-FLHOR) started a study on the inheritance of incompatibility, leaf margin type, and other characters in pineapple, based on a wide diallel cross between 16 genotypes, including clones of *A. bracteatus*, *A. nanus* and A. *lucidus*. The breeders then launched a small breeding program, screening the progenies from theses species to seek hybrids of ornamental interest. About 30 hybrids have been shortlisted and assayed in the greenhouse and the field. Three out of these are considered to hold interest for the fresh flower market. They were given the commercial names 'Luciana', 'Geliana', and 'Carmina'.

'Luciana' has smooth green erect leaves, a small (5-6 cm) remarkable inflorescence with long bright pink bracts and long deep-purple petals crowning a thin straight peduncle. The plant produces an average of three ratoons, each producing a new inflorescence of commercial quality shortly after the flowering of the mother-plant. The attractive aspect of the cut inflorescence is maintained for at least ten days.

'Geliana' has smooth, semi-erect leaves, which are burgundy-colored in the groove and have green margins. The small inflorescence with deep-pink bracts and violet petals, is held on an erect peduncle. Each single plant can produce on average three ratoons simultaneously, so that three inflorescences can be harvested at the same time.

'Carmina' shares with 'Geliana' the same leaf characters, but differs in its somewhat smaller inflorescence bearing red bracts and violet petals. The peduncle is long as well as thin and erect.

All three varieties respond well to floral induction treatment, and inflorescences are harvested within six months after planting under field conditions in Martinique. Other selected hybrids are now on trial, and some of them will probably be exploited as potted plants.◆

News from India

Ed Note*: Below are a number of E-mail messages from Suresh Mathure of Cloy Foods in India printed here with his permission. I thought the work he is doing as well as the practices being developed would be of interest to readers of the newsletter so have included his messages with minor editing. D.B.*

Organic Pineapple in India

Suresh Mathure, Cloy Foods, 11, Saptasringi, M. Kalelker Rd.
Bandra (E), Mumbai 400 051, India. E-mail: cloyfood@vsnl.com

1-24-00

Some background. On my return to India after several years of working on overseas assignments, mainly to Western Europe and the Middle East, along with my wife we started this organization called "Cloy Foods" to export processed food products from India primarily to the European Union.

Soon we realised that the infrastructure necessary to sustain exports on a long term basis was inadequate in India. We thus integrated additional service to our contract processors on technical assistance to process products of our interest. However, as we got deeper into this business we realised "Pineapple" could change lives of thousands of villagers in rural India.

Although, pineapple is more or less naturalised in India over the centuries (Portuguese brought pineapple to India way back in 16th century) there are no real significant efforts to commercialise the crop. We thus set forward to collect information on Pineapple Cultivation through the net. And here we found a very valuable paper published by Hawaii Co-op Extn. Service.

Currently, we are in touch with certain state governments in India to conduct pineapple cultivation programs in view of poverty alleviation in rural areas.

4-2-00

We are now in the process of implementing our major project of commercial cultivation of pineapple in Assam a north-eastern state of India. Pineapple is a native product in this state, however due to lack of organised commercial cultivation yields are far too low, almost incompetetive for overseas market.

The main aim of this project is to cultivate pineapple by minimum or no use of chemical substance. This is a small size project covering about 35 hectares of land, because this project is viewed as a pilot project under poverty alleviation program.

We are actively involved in project implementation management, and would also be responsible for marketing produce from it. Being fully aware of European quality requirements particularly with respect to residual chemicals we intend to comply with Hazard Analysis and Critical Control Point (HACCP) standards right from the beginning of the project.

Ed Note*: Iinformation about HACCP standards is on the internet.*

4-10-00

The main aim of the project is to train tribals in cultivation, post-harvest handling, and marketing of pineapple. Thus to create a source of livelihood to the target population. The location is in North Eastern states of India. This area is perhaps the least developed and hence poorest in India.

Pineapple grows naturally in the wild of this region and the local population is already familiar with it. The region being hilly the soil drains naturally. There are two rainy seasons (monsoons) May to September and October to December. Pineapple flowers twice in the wild naturally though the quality of fruit is far from being marketable.

All target cultivators are predominantly tribals presently living well below the poverty line. Most of them have very low-grade land in many cases this land holding is less than a quarter of a hectare.

Through Non Governmental Organisations (NGOs) dedicated to poverty alleviation, co-operative consortiums of these tribals are being created for the administrative ease. The project is being implemented through constant liaison with elected leaders of these co-operative consortiums.

While material assistance is provided through concerned NGOs, Cloy Foods has pledged to contribute for the technical assistance and marketing responsibilities of the produce.

In addition to field technical assistance, Cloy Foods will provide central organic composting and compost sterilising facility as well as nursery facility for planting materials. Presently, we are in the process of recruiting young agricultural graduates to work as Technical Field Officers; these TFOs will need guidance from the peers.

We had to opt for deviation from conventional pineapple cultivation on account of following major considerations. The target population has never been exposed to chemicals and we do not want to risk their health by exposure to even non-hazardous chemicals. No chemicals are ever used in this target area. Hence the environment is sterile and therefore we do not wish to contaminate the environment by use of any chemicals.

Thus we are constrained to pure organic farming.

These considerations give rise to different set of problems and that is disease control in pineapple cultivation. We will therefore required guidance in disease control, plant nutrition etc. through alternative means.

7-11-00

Our ongoing pineapple plantation is just 45 days old and right now our monsoon is at its peak. In North-Eastern India it rains (rather pours 140 inches annually) between late May and early September and again between late October and early January.

Potassium Supplementation:

This will remain a problem as all long green leaves are planned to be used for fibre extraction. Pineapple fibre extraction is a traditional tribal cottage industry in this part of the world. Crowns however would be the only green of the plant that would be available for animal feed after being finely chopped. We also have a good poultry (industry) in and around the pineapple cultivating area and a lot of poultry manure is available along with rice straw and dairy animal waste for composting but of course this does not solve the problem of K supplementation.

True, during plant cycle a good number of leaves do disintegrate into the ground. At the time of preparing planting beds we have used a good quantity of green neem leaves primarily to control nematodes and other insects. But will that be enough? Guess we will know the contribution towards K supplementation of these factors a while later.

In the mean time we are exploring possibilities of using kainite, a type of soil (a natural source) rich in KCl, $MgSO_4$-$3H_2O$ is available abundantly in other parts of the country.

F**orced Flowering**

Ethylene and apple seem a very practical method and very organic too, we will try this out on other mature plants in the area. Guess we will have to cover section of plants under polyethylene sheets to retain ethylene produced by the fruit around the plant overnight. It reminds me on western coast (India), a major mango growing area, they use apples to accelerate ripening of mango.

7-13-00

Rain water does not bother pineapple plantation as pineapple is mostly grown on hill slopes, though some in small number is grown on the top of water retention walls in paddy field, but the height of these walls keep pineapple roots well clear of water level.

Kainite, is found in the great deserts of Kutch and Rajasthan in North-Western India as sandy rock. It has to be ground and washed to remove sand from kainite. Kainite crystals dissolve in water and this washed slurry is then used as mineral fertiliser. There is no chemical or heat treatment of any kind, just a physical extraction.

Apple as organic source of Ethylene, in mango belt they use whole fruit because it takes a while before it starts rotting. Guess we will use the same. Non the less immediately after the main furry of monsoon is over we will start our trials on forced flowering we plan to use both cut as well as whole fruit we will also try other ethylene producing fruits let's see which works better. Point regarding night temperature is noted. I will keep you informed of the outcome.

7-24-00

Neem and Citronella for insect control

This report may not be very significant to scientific world, but our recent experience is certainly very exciting to us. The experience is very exiting on two counts, (1) The economy of the operation. (2) The method is based on organic principles.

Per hectare cost of using Citronella is less than US$ 60/- per application (note that there are no farm subsidies in India for pineapple cultivation.) which not only is very significantly lower compared to conventional insecticides but even lower than other organic options like neem oil.

Background

Our company has a few pineapple cultivation centres in India and the older ones are on the western coast. All of them are mainly monsoon-fed farms. Our normal monsoon on the western coast of India is June to September. The last three years the monsoon in this region has been a bit erratic. As a result plant mite and ants (resultant Mealybug) invade plantation, affecting quality of fruit and in general plant health.

This year too the rains were delayed. To reduce the adverse effect of prolonged drought, farms were irrigated by sprinklers. Though sprinklers require a bit more water they help to reduce hot summer temperatures. This late summer irrigation, however, invites insect growth in the farm and also increases the ant population. On many occasions it is noticed that ants actually transport mealybugs physically. As we are adopting to organic cultivation, use of normal insecticides is restricted on the farms. We therefore had to devise an effective method to control insect invasion.

We have the option of using neem extracts or citronella extracts. Though we had no previous experience of using citronella extracts, the cost effectiveness of citronella encouraged us to use it on one of the properties of 5 hectares. All other farms were put on neem extracts, a time-tested organic substance.

Citronella extract used in this experiment was the oil extracted from citronella grass.

Preparations & Method:

Neem: 30 ml Neem oil, 10 L of water, 2 g of soap flakes as emulsifier (Note: soap made out of vegetable oils). About 60 litres of Neem emulsion are used per hectare. Emulsion is sprayed once a week in the late evening to minimise decomposition of the Neem (Summer temperature 35 to 38 °C). In case of prolonged higher temperatures this frequency may have to be altered as neem extracts decompose faster in higher temperatures.

Citronella: 30-ml Citronella oil formulated and applied following the above procedure for Neem.

Duration: From first week May to third week June (this year rains started in the third week of June) weekly spray of both Neem or Citronella in their respective farms was practised. First of May was chosen as summer is most severe during this month in western India and the need of sprinkler irrigation is essentially felt during this month. Resultant insect invasion too is significant following sprinkler irrigation.

With the onset of rains in third week of June this year on western coast the frequency of spray is increased to daily and will continue till the end of monsoon (August).

Observations

Both farms showed similar results. Plant mites, ants, and the host of other insects were equally controlled in both farms in pre-monsoon conditions as well as first 3 weeks of monsoon rains.

Conclusion:

As the experiment was carried out in a very limited area of 5 hectares for Citronella, the duration too was limited to 7 weeks pre-monsoon and only 3 weeks during monsoon rains. No conclusions can be drawn. More experiments are planned for the forthcoming season on a larger scale. Optimisation of application too will have to be experimented.

The cost effectiveness of citronella over neem oil will remain the central attraction to use citronella oil if results remain consistent. Now, can you suggest any particular parameters which we must observe during our forthcoming experiments?

Ed Note*: At this time I suggested Dr. Marshall Johnson, Entomologist at the Univ. of Hawaii, assist in the development and evaluation of practices. Suresh's access to E-mail made this possible.*

8-6-00

Dear Dr. Johnson,

Prof. Bartholomew forwarded your message in response to my query on field trials of citronella oil. At the onset let me thank you for your willingness to help us out. Here is the background information,

1. Yes primarily citronella and neem sprays were aimed at insects as mealybugs appear in our field only following appearance of ants and (may be coincidentally) both disappear simultaneously after treatment.
2. Furthermore mealy bugs are noticed only in the area where ants are present and not in the entire field, unlike other pests which are noticed almost in the entire field especially the plant mites.
3. Matter of fact ants population in the field is noticeable only after summer sprinkling of fields. And immediately after monsoon.
4. Yes removal of wild weeds from proximate area invariably follows insect invasion on the field. Typical post monsoon problems.

This also gives a good solution, we will now take all preventive measure before removing surrounding weed. Our monsoon is about to be over in September we will implement this schedule. This is likely to save our October harvest; will keep you informed.

We are settled with 30 ml Citronella oil and currently are exploring other dosages such as 10 and 20 ml oil. So far 10 ml has failed to significantly control insects. Between 20 ml and 30 ml there is no significant difference in insect control but there is significant reduction in number of burn spots. During forthcoming monsoon we will have confirmatory results on 20 ml dosage.

Regarding clarifications, our approach to plant disease is primarily of preventive nature therefore we take several preventive measures. Citronella and neem sprays both are essentially used for prevention. We are not too sure if either of them could be as effective in curative treatments. It cannot be denied that the success experienced on our field could be a result of over all preventive measures rather than any single action. Insects of our main concern are:

a. Ants & Mealybugs: We now know that they coexist and are inter-linked; hence we now treat them as a single group. Ants appear in the field towards the end of April or beginning of May. After onset of monsoon in June they disappear only to reappear in August.

b. Plant Mites: Mites are more significant during monsoon (Indian rainy season) towards the end of monsoon (August-September) they are a real menace if not controlled in time.

c. Thrips: These are generally noticed towards the end of monsoon through winter.

d. Symphylids, Millipedes, Centipedes: Rare but recently noticed in the fields in western India. Their presence may be related to porous underground red rock of western India.

e. Grasshoppers: Very rare in pineapple fields, but we are extremely sensitive to them because of their prolific destructive ability.

f. Leech: These are common in the eastern region they are more nuisance to farm workers.

Spraying citronella or neem requires a thinnest fogging. Usual care in handling of pesticides is required for both citronella and neem. Particularly in case of citronella it is found to cause burnt spots on leaves if concentrated form of oil is used.

A comparison between Citronella and Neem as noticed on our fields incldue:

Effects on Insects

Citronella

1. Repellant; effect noticed immediately after application.
2. Insecticide Action; unconfirmed but possible.
3.Time for noticeable effect; Reduction in insect population almost immediately, mostly attributed to its strong repellant action.
4. Time duration for which effect lasts; Insects usually return within 3 to 5 days.
5. Biodegradability; Biodegradable

Neem

1. Repellant; No noticeable repellant action.
2. Insecticide Action; Known insecticide action in long term application.
3. Time duration for noticeable effect; Noticeable reduction in insect population after about a week of daily application.
4. Time duration for which effect lasts; Control last 5 to 7 days, in some cases as long as 10 days.
5. Biodegradability; Biodegradable

Note: Some preventive steps currently practiced

1. Neem leaves are used as starter green fertilizer before planting.
2. Compost that is used on the farm is always sterilized before application.
3. All planting material is soaked in neem water prior to use.
4. All farm implements are washed in neem water periodically.

As insect control on our fields is more of prevention, intensified insect control measures are taken in anticipation of proliferation of insects in the beginning of insect breading season and continue through out their breading season viz. monsoon. As a result, our intensified preventive measures start from mid-May and last till mid-October. The rest of the year we spray weekly.

Due to anti-fungal and exceptionally long action of Neem, it is a superior choice to citronella. However, neem extracts are expensive so we prefer citronella as a cost-effective alternative. Results with citronella are certainly very encouraging as far as insect control is concerned. The effect of citronella is slightly faster than neem, but it is necessary to use a very dilute emulsion to prevent plant burn.

I also take this opportunity to refer to your earlier mail broadcast on the use of natural gypsum ($CaSo_4$-$2H_2O$) on pineapple. In fact we use gypsum routinely to increase sugar contents of fruit. Currently we use about 2% by weight Gypsum in compost. The result is significant on our western India fields where soil pH ranges between 4.5 and 5.5. Incidentally these fields are very proximate to iron and manganese mining areas.

Our initial attempts to grow pineapple bore highly acidic and small fruits and crowns of these fruits were particularly large. However, subsequent plants fed on gypsum-laced compost gave normal crown size, higher fruit sugar contents and normal fruit weight. This result was observed in both the varieties commonly grown in India viz. Queen and Kew (Kew is similar to Smooth Cayenne).

During our field trials from May 1998 to Dec. 2000 we observed that results with 2%, 2.5% or 3% (in compost) gypsum did not have any significant advantage, though a lower percentage of gypsum gave significantly acidic fruit.

By the way our attempts to force flowering of pineapple with apple as a source of ethylene has turned out to be a bit expensive. Though it worked commercially it may not be viable for us and we are therefore looking at other economical alternatives. This is the long and the short story of our current attempts to go organic.

Pineapple Processing Equipment for Small Canning Operations

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I noticed in the June issue (of Pineapple News) someone is looking for small pineapple processing equipment and the difficulties faced by them. The year we started our operations in India we too found it extremely difficult to source a supplier of similar equipment. In India all fruit processing units are small scale. Most fruit preparation is carried out manually. Our associate processors too were all small-scale operators. It was therefore very essential for us to find suitable size equipment to upgrade their processing.

On one hand being supplier to EU supermarkets we had to maintain quality and on other the average Indian cannery hardly had any equipment worth its name to maintain quality. To top it all there were no standard equipment manufacturers off the cuff

At the end being frustrated by the failure to find a good manufacturer, we got about developing one ourselves. We developed a range of equipment in collaboration with a local association of engineering graduates and came up with a range of canning equipment all specifically designed for small canneries who want to maintain international quality standards. All the equipment is manufactured under EU guidelines whereby all contact parts are of stainless steel, all parts such as bearings and chains that have a potential of contaminating food being processed are concealed under stainless steel sheets. Basic structural frames are of MS. Accessibility for routine maintenance is maintained by better engineering design, thus equipment down time is minimised.

Most equipment has been designed with adaptability in mind. For example a pea grader can be used as a plum grader by just a change of a small attachment. After all, small canneries have limitations in their ability to invest in equipment. A can conveyer can be changed into an inspection conveyer by changing chainlink belt to a sanitary belt. This also minimises the cost of spare parts inventories for small canneries.

Most of the equipment like the parallel Slicer is designed in such a way that they could be included in a fully automatic processing line of medium capacity. The pea grader is adaptable for other small fruits like plums, pears and peaches. A larger model is suitable for bigger fruits like mango, papaya and pineapple.

Some of basic semiautomatic pineapple fruit preparation equipment, includes:

1. Pineapple Corer cum Sizer, which removes pineapple skin and core simultaneously, and has an option of three diameters. Specifications; semiautomatic operations, all contact parts of stainless steel, pneumatically operated, capacity 10 to 12 fruits per minute.
2. Pineapple Slicer which gives parallel slices and has an option of different thicknesses. Specifications; Semiautomatic operations, all contact parts of stainless steel, spiked drum assembly.
3. Pineapple Skin Stripper which recovers flesh adhering to the pineapple skin after peeling. Specifications; semiautomatic operations, all contact part of stainless steel, slice thickness adjustable 1/8" to 1", speed 30 pineapple per minute.
4. Fruit Mill; this equipment crushes hard fruits like pineapple and was especially developed to take care of pineapple flesh recovered from pineapple peels. Damaged or odd fruits sized unsuitable for slices can be crushed with the help of this equipment. Specifications; semiautomatic operations, all contact parts of stainless steel, capacity 2 Tonnes/hour, saw-teeth edges bar chamber is driven by an electrical motor.

Currently, our processing units at three different locations in India are using these equipment and the results are excellent. All equipment is very easy to maintain and is ideal for small volume operations. Being developed in-house they are very cost effective. Further information if required can be gladly provided to any member of the Pineapple Working Group.◆

News from South Africa

Graham Petty has kindly supplied information on upcoming books that may be of interest to pineapple researchers and growers.

Tropical Fruit Pests and Pollinators; Their Biology, Economic Importance, Natural Enemies and Control Methods

This book will have been in preparation for more than 3 years when finally published in mid – 2001. It is being compiled and edited by: JE Peña (University of Florida, Homestead, Florida), J Sharp (United States Department of Agriculture, Subtropical Horticultural Research Station, Miami, Florida) and M Wysoki (Ministry of Agriculture, The Volcani Centre, Bet Dagan, Israel). The publisher is CAB International of Wallingford, England. This book will provide biological information and updates of research on pollinators and pest management systems for tropical fruit crops Contributors are from the major fruit producing areas of the world. Judging by previous publications of a similar nature, there should be more than 600 pages, well illustrated with photographs of a very high standard. Content chapters and authors include:

1. Introduction. Pest management in the Tropics; differences with temperate areas.
2. Bananas and Plantain. C. Gold (Uganda), A. Hassyim (Indonesia), JE Peña (U.S.A.), D. Smith (Australia).
3. Mango. G. Waite (Australia)
4. Papaya. A. Pantoja (Puerto Rica), P. Follett (Hawaii, USA), J Villanueva (Mexico).
5. Pineapple. GJ Petty (South Africa), GR Stirling (Australia)., D Bartholomew (Hawaii, USA).
6. Annona spp. i.e cherimola, soursop, atemoya. JE Peña & H Nadel (USA), D Smith (Australia, MJB Pereira (Brazil).
7. Avacado. M Wysoki (Israel) G Waite (Australia).
8. Guava. W Gould (USA), A. Raga (Brazil).
9. Minor Tropical Fruits, i.e. duriam, star fruit, mangosteen, acerola, rambuttan. P Oi & A Winotai (Thailand).
10. Litchi, Longan. G Waite (Australia).
11. Passion Fruit. E Menezes & E Aguiar-Menezes (Brazil), MA Soares (Brazil).
12. Quarantine Treatments for pests of Tropical Fruits. J Sharp (USA), NW Heather (Australia)

Of particular interest, of course, to readers of this newsletter is the chapter on Pineapples by Petty, Stirling and Bartholomew. This chapter outlines the importance, world-wide, and the phenology of pineapple as a commercial crop. It goes on to discuss key pineapple pest biologies and economic thresholds and the principles and practices of sampling, monitoring, and controlling these species. These include the following. Nematodes: root-knot, reniform, lesion, spiral, ring, stubby root. Arthropods: pineapple fruit mite, pineapple red mite, symphylids, onion thrips, pink pineapple mealybug, pineapple scale insect, pineapple caterpillar, white grubs/scarabaeid larvae.

Tables list all recognised pineapple pests, world-wide, giving their importance and distribution. Information for these tables has been supplied by 62 authorities in 30 countries. There are 18 figures and 175 references.

Pests and Beneficial Arthropods of Tropical and Non-Citrus subtropical Crops in South Africa

Petty, G.J., Rabie, E., Smith-Meyer, M.K.P. and Willers, P.,2001. Pineapple Pests. In: van den Berg, M.A., Joubert, P.H. and de Villers, E.A.(eds). A.R.C. Institute for Tropical and Subtropical Crops, Nelspruit.

This book deals with pests – insects, mites and nematodes – and beneficial organisms (including natural enemies of pests) of tropical and subtropical crops in South Africa. A major part of the book is devoted to chapters on the pineapple. Apart from pineapple, other chapters have been written by numerous authors, each a specialist in his/her field of expertise on crops including: avocado, banana, coffee, ginger, granadilla, litchi, mango, macadamia, pecan nut, papaya and tea. A number of lesser known crops are also included. The book comprises 525 pages and is lavishly illustrated with more than 400 colour photographs.

Nematodes are extensively dealt with, and the pineapple chapters include root-knot nematode, *Meloidogyne javanica*, lesion nematode (*Pratylenchus* spp.) and spiral nematode species. These three groups have a very wide global distribution and a major impact on pineapple production and the cost thereof.

Pineapple associated mites dealt with include the false-spider mite/flat mite/pineapple red mite, *Dolichotetranychus floridanus*, and the fruit mite/leathery pocket mite, *Steneotarsonemus ananas*. Both species are important pests in many pineapple producing countries, causing serious damage and fruit blemishes.

Chapters on insect pests include information from local research over a period of more than 30 years as well as from studies in other countries over a much longer period (121 References). The major insect pests which are dealt with in chapters of this book include the following: Pink Pineapple Mealybug (*Dysmicoccus brevipes*); Pineapple Scale Insect (*Diaspis bromeliae*); Onion Thrips (Thrips tabaci); Black Maize Beetle/Black Beetle (*Heteronychus arator*); White Grubs (*Scarabaeid* larvae). These species are dealt with in considerable detail, and almost all of them have a very wide global distribution and importance in pineapple producing countries.

Apart from the above species, a number of less important pest species are also dealt with in the book.

The content of each chapter includes the following subject matter: 1. Historical review, 2. Economic importance, 3. Biology and ecology, 4. Biological control, 5. Chemical control, 6. Integrated control, 7. Cultural control, 8. Suggested new approaches to control, 9. Monitoring populations and defining economic thresholds.

The book is suitable for farmers, extension officers researchers, students, agricultural chemical companies, and anyone with an interest in subtropical industries.◆

News From Taiwan

Tainon #19, a New Pineapple Variety

Chin Ho Lin of Botany Department, National Chung Hsing University. Taiwan

To meet the high demand for fresh pineapple, a new pineapple variety, C66-4-744 and named Tainon #19, was released in March, 2001. The new line was released by pineapple breeder Mr. Chin Chyn Chang of Chia Yi Agricultural Experiment Branch Institute, Taiwan. Line C66-4-744 was from a cross of Smooth Cayenne (F) and Rough (M). Mr. Chang started the cross and selection in 1977 and tested it in 8 production regions over the past 5 years. The plant has an average height of 87.7 cm, leaf length 82.8 cm and leaf width of 6.1 cm, and a leaf number of 36.5. The leaves have small spines at the tip but are spineless along the leaf margins. The leaf blades are dark green in color with dark purple coloration along the midrib groove. The average fruit weight is 1.61 kg with yellow skin color tinted with dark gray when mature. The fruit has a thin skin, shallow locules, and a yellow to golden yellow flesh color with fine fibers. A fruit Brix of 16.7, titratable acidity of 0.46%, and a sugar/acid ratio of 37.8 resulting in an overall fresh fruit sensory rating of fine. The optimum harvest season is between April and October.◆

News From the United States (Hawaii)

Dairy Manure as a Pre-Plant Fertilizaer for Pineapple

Adam Reinhart, Dept. of Agronomy and Soil Science, Univ. of Hawaii, Honolulu, HI 96822

Oahu relies on underground sources of water, aquifers, for its drinking water. The Pearl Harbor aquifer is the most important groundwater source on Oahu supplying more than 50% of Oahu's potable water. The land overlying this aquifer, the Pearl Harbor watershed, is a principal agricultural area on Oahu.

Nitrate, one of the principal forms of nitrogen fertilizer used in agriculture is considered a potential ground water contaminant by the EPA. Nitrate is toxic to humans, causing methemoglobinemia (blue-baby syndrome), has very complex movement though the soil into the aquifer, and is cumulative. Once nitrate enters the aquifer it does not degrade naturally but rather continues to build up over time. The EPA has placed a maximum contaminant level (MCL) of 10 mg l^{-1} nitrate-nitrogen. While this MCL has not been exceeded in the Pearl Harbor aquifer, the concentration of nitrate in some wells in the aquifer has increased on the order of approximately 1.0 mg l^{-1} per decade, since the 1960's, and is now around 6 mg l^{-1}.

An experiment was installed in a pineapple field to determine if nitrate leaching could be reduced by replacing preplant starter fertilizer with dairy manure. The treatments were 1) Control (C) - no preplant fertilizer; 2) High Manure (HM)- 191 kg ha^{-1} N; 3) Low Manure (LM)- 64 kg ha^{-1} N; 4) High Fertilizer (HF, about twice the N as in the HM treatment); and 5) Low Fertilizer (LF, about 25% more N than in the HM treatment. All plots were fertilized with more than 600 kg ha^{-1} N applied foliarly. Data collected included monthly soil solution nitrate concentrations up to forcing, which was about the time that little nitrate was detected in the soil solution, plant biomass and leaf area at 6 and 12 months after planting, and pineapple fruit mass at harvest.

Soil solution nitrate declined over time at a depth of 30 cm and was highest in the HF and LF treatments and lowest in the Control and HM and LM treatments at all sampling dates (Figure 1). These results are important because the pineapple root system is not well established until about three months after planting so the plants are unable to take up large amounts of nutrients during this period. At the 92 cm depth (Figure 2), the results were more variable, but preplant fertilizer (HF and LF) resulted in more nitrate in the soil solution than in the Control or manure treatments. Also, nitrate in the soil solution in the Control and LM and HM treatments trended strongly downwards while soil nitrate levels in the HF and LF treatments initially increased, then leveled off, and eventually decreased. This suggests that the large amount of nitrate measured at the 30 cm depth in the HF and LF treatments leached down through the soil profile, while leaching was more limited in the manure treatments.

Plant dry biomass (Figure 3) at 6 months after planting was highest in the HM treatment and lowest in the HF treatment. There was a four-fold increase in biomass between the 6-month harvest and the harvest at forcing, one year after planting. The high concentrations of

nitrate in the rooting zone of the HF and LF treatments in the first three months become approximately equal to the LM, HM, and Control treatments at between five and six months after planting. The extra N in the fertilizer treatments apparently is not available to the pineapple when their requirement is greatest, during the period of rapid growth between six and 12 months after planting.

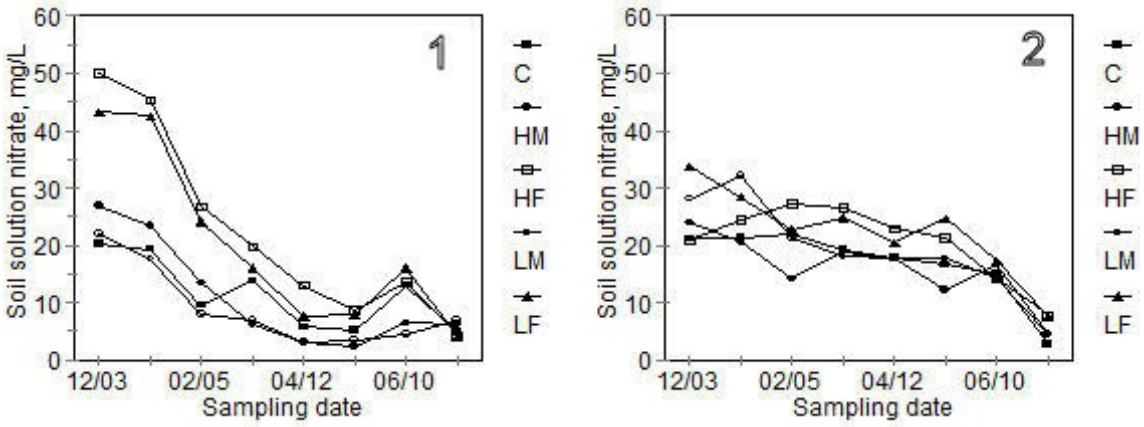

Figure 1 (left). Soil solution nitrate in control (C) and preplanting treatments high manure (HM), low manure (LM), high fertilizer (HF) and low fertilizer (LF) sampled at a depth of 30 cm.
Figure 2 (right). Figure 2. Soil solution nitrate in control (C), and preplanting treatments high manure (HM), low manure (LM), high fertilizer (HF), and low fertilizer (LF) at a depth of 92 cm.

The median pineapple fruit mass at harvest (Figure 4), a measure of fruit quality since the high value jet-fresh pineapples have strict size requirements, of the HM and LM, the LF, and the Control treatments are all within the ideal range of mass for jet-fresh pineapple. The median pineapple mass in the HF treatment was too small for jet-fresh pineapple. Estimated nitrate leached was smallest for the HM treatment and greatest for the HF treatment (Figure 4). Thus, the HM treatment produced the highest average fruit weight with the least amount of nitrate leaching of any of the treatments. Conversely, the HF treatment produced the lowest average fruit weight while leaching the most nitrate. Calculating the amount of nitrate leached required making many assumptions so the amount of nitrate leached is an estimate that likely contains considerable error. However, it is based on actual measurements such as the amount of nitrogen taken up by the pineapple plants, and the amount of nitrogen remaining in the soil after harvest. It is interesting to note that the large amount of nitrogen applied foliarly did not appear to contribute to the leaching component. The three important conclusions from this experiment are: 1) increasing the amount of nitrogen supplied by the starter fertilizer does not increase pineapple yield; 2) manure lowers the concentration of nitrate in the soil solution while simultaneously increasing median pineapple mass and total yield; 3) the use of dairy manure represents a winning scenario for pineapple growers, animal producers, and the public because it increases pineapple yields, reduces nitrate losses relative to pre-plant fertilizer, and provides a site for dairy waste disposal.

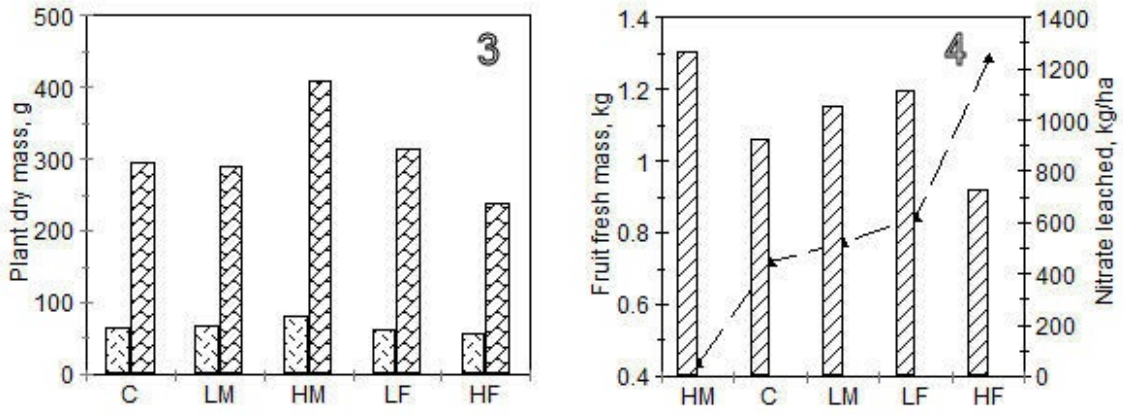

Figure 3 (left). Effects of preplanting manure (LM, HM) and fertilizer (HF, LF) on plant dry mass at 6 and 12 months after planting.
Figure 4 (right). Effects of control (C) or preplanting treatments high and low manure (HM, LM) and high and low fertilizer (HF, LF) on fruit fresh mass and estimated nitrate leached.

Sunn Hemp for Reniform Nematode Management

K.H. Wang and B.S. Sipes, Dept. of Plant and Environmental Protection, Univ. of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822

Sunn hemp 'Tropic Sun', Crotalaria juncea, is recommended as a cover crop for reniform nematode management. Reniform nematode population development were suppressed by sunn hemp as effectively as 1,3-dichloropropane (1,3-d) preplant fumigation when planted for 3 months prior to pineapple planting. Sunn hemp not only suppressed reniform nematode female development, produced the toxic compound monocrotaline after leaf incorporation, but also enhanced nematode-trapping fungi (NTF). Among the 6 pineapple field soils collected from Dole, Del Monte and Maui Pine pineapple plantations in Hawaii, sunn hemp amendment enhanced the NTF in all these soils except one that was treated with 1,3-d 2 months prior to the test. No NTF were detected in unamended soils from the same sites.

The recommendation for pineapple plantation practice is to fallow the field for 2 months after pineapple cropping, plant sunn hemp for 3 months, and then incorporate the biomass into the soil. This should be followed immediately by mulching to take advantage of the biofumigation effect of sunn hemp's monocrotaline (a nematicidal compound) and planted with pineapple 1 month later.

A New Safe Fungicide for Control of Chalara paradoxa

Glenn Taniguchi, Dept. of Plant and Environmental Protection Science, Univ. of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822; E-mail: gtaniguc@hawaii.edu.

A search is underway to find a replacement for Bayleton®, which has declined in sales over the years. Bayleton® (triadimefon) may soon be taken off the market by Bayer Corporation. Many of its uses have been replaced by Elite® (tebuconazole).

Procure® (imidazole), is a recommended fungicide from EPA's list of safer fungicides for control of *Chalara* sp. In a preliminary field screening for butt rot control, in contrast with Elite®, no plant stunting occurred with Procure®.

Current studies are concentrated on control of fruit rot caused by *C. paradoxa*. While the studies are not complete, data from two trials show Procure® to be very promising in its ability to control *C. paradoxa*. No disease was observed on fruits inoculated and treated with Procure® at 500 and 250 ppm and then held at ambient room temperature for 7 days. Controls showed 100% infection in all trials.

Update on the Control of the Big-headed Ant, Pheidole Megacephala, in Hawaii with Ant Bait Stations

Glenn Taniguchi, Dept. of Plant and Environmental Protection Science, Univ. of Hawaii at Manoa, 3190 Maile Way, Honolulu, HI 96822; E-mail: gtaniguc@hawaii.edu.

In a repeat of a previous trial, ant-infested plots were treated with Distance® (pyriproxyfen) prior to installing Amdro® (hydramethlnon) in bait stations. The study was installed at the University of Hawaii Poamoho Experiment Station. The treatments consisted of bait station spacing (7.62 by 7.62 and 15.25 by 15.25 meters) and an untreated control plot.

The results (Figure 1) were similar to those obtained in an earlier trial with the exception that ant control lasted at least up to 8 months for both spacing treatments. The duration of control was assumed to have been enhanced by the fact that this trial was installed during the winter, a period associated with relatively high rainfall, and extended into the dry summer. In contrast, the earlier trial was installed during the dry summer and extended into the wetter winter period.

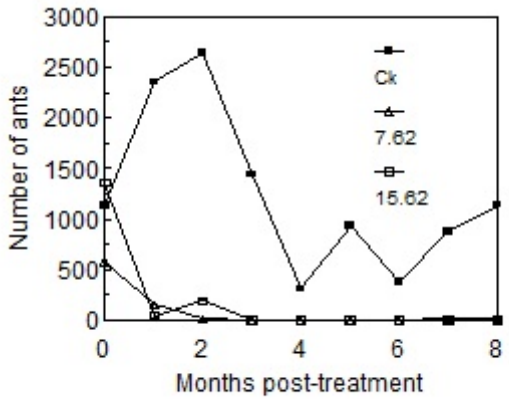

Figure 1. Effect of bait station spacing at 7.62 and 15.62 m on number of ants sampled.

Update on Recent Pineapple Mealybug Management in Hawaii

Marshall W. Johnson (mjohnson@Hawaii.edu) and Raju R. Pandey (raju@Hawaii.edu), Dept. of Plant and Environmental Protection Sciences, CTAHR, Univ. of Hawaii, Honolulu, HI 96822

Mass rearing of pink pineapple mealybug and associated parasitoid. In Hawaii, the most common mealybug attacking pineapple is the pink pineapple mealybug, *Dysmicoccus brevipes* (Cockerell). A close cousin, the gray pineapple mealybug, *Dysmicoccus neobrevipes* Beardsley, also infests plantings. The pink pineapple mealybug is often found infesting the lateral roots of the pineapple plant (just below the soil surface) and other plant hosts it infests (e.g., grasses), but it may be found on aerial plant parts also. In contrast, the gray pineapple mealybug is only found on the aerial parts of the plant. The mealybugs are often found in association with ants (e.g., the big-headed ant) that prudently oversee the mealybugs, providing protection in exchange for honeydew. Ants protect the mealybugs from their natural enemies including small wasps that parasitize the mealybugs. They also remove excess honeydew that inhibits mealybug production and dispersal if mealybugs become entangled in the accumulated feeding by-product. Ants are very important to the mealybugs' survival, and elimination of the ants using poisonous ant baits, will usually result in destruction of the mealybug colonies. Therefore, farmers routinely

use ant baits in their pineapple fields to eliminate the mealybugs' guardians. Although this is an efficient and evidently safe management system, farmers have no "backup" control systems if the ant baits suddenly become unavailable or less effective. Recently in Hawaii, control failures have occurred for unknown reasons. Additionally, due to the U.S. Food Quality Protection Act, compounds used for spot treatments (e.g., diazinon) may be lost in the near future.

Current research is focusing on the potential of augmentative releases of the mealybug parasitoid *Anagyrus ananatis* Gahan, an encyrtid wasp which develops internally as an immature in parasitized mealybugs. Parasitized mealybugs bloat and harden (referred to as the 'mummy' stage) a few days before the adult *A. ananatis* emerges. This wasp is the most effective natural enemy of the pink pineapple mealybug in Hawaii. However, it does not readily parasitize the gray pineapple mealybug. Although ants protect the mealybugs from adult female *A. ananatis* (that lay eggs), they do not kill the wasps and only interfere with them when they are in the process of parasitizing the larger sized mealybugs (3rd instars and adults). Mealybug parasitization by *A. ananatis* is reduced as much as 60% in the presence of big-headed ants. However, the wasps are able to persist and increase in pineapple plantings where ants are present. Given this, we are evaluating the potential of mass releasing (augmentation) thousands of wasps in pineapple plantings to see if the protective activities of the ants can be circumvented and the mealybug densities maintained at low levels by *A. ananatis*. To achieve this, we must first be able to mass rear the pink pineapple mealybug and the parasitic wasp.

The greatest challenge was to mass rear the pink pineapple mealybug as a food source for the parasitic wasp. In colonies, high densities of mealybugs, especially the pink pineapple mealybug, produce vast quantities of sticky honeydew which entraps small mealybug crawlers (1st instar stage) when it accumulates. Low crawler survival impedes mealybug colony production. Until recently, it was difficult to efficiently rear large numbers of the pink pineapple mealybug in the laboratory. Individuals often fell off of kabocha and butternut squash fruit used as a food source, and they often became stuck in their own honeydew because ants were not present to eliminate the honeydew. Solving these problems was simple, but contrary to logical thinking. Mealybug-infested squash were actually buried in a substrate called vermiculite, commonly used for plant propagation. It consists of light and absorbent particles that flow like sand or fine soil. An average butternut sized squash (12-16 cm long and about 0.5-1.1 kg) produced about 4,000 large third instar and adult (> 0.85 mm in size) and 2,500 2nd instar and small 3rd instar (0.5-0.85 mm in size) mealybugs, 5-7 weeks after the initial infestation with 1,000-2,000 adults. This does not include the thousand's of first-instar crawlers (dispersal stage) produced by the mealybug adults. Following initial mealybug infestation and submergence of the fruit in the vermiculite, the vermiculite has to be agitated about once weekly to reduce mold buildup and facilitate maximum elimination of the honeydew. Please note that this technique is not needed to effectively rear the gray pineapple mealybug, and will actually reduce gray pineapple mealybug colony production.

Pink pineapple mealybugs may be removed from infested squash by placing the infested host fruit under a bright light source. The mealybugs will drop off of the squash, and can be collected using a brush. Mealybugs stages may be separated by running the mealybugs through various-sized, screened sieves. Large 3rd instars and adult mealybugs may be used to maintain *A. ananatis* colonies while younger stages may be used for mealybug colony maintenance. Anywhere from 2000-5000 *A. ananatis* individuals can be produced from an average sized squash (about 500-700 g) with a good infesation of older mealybugs. This equals about 5 or more parasitoids per penny based on material costs alone and no labor. Parasitoids that are produced from mealybug hosts not permitted to feed following parasitization were significantly smaller than parasitoids reared from mealybugs left on squash hosts after parasitization. Because larger female parasitoids tend to be more fecund (higher egg production), it is preferable to allow parasitized mealybugs to feed following parasitization. Once parasitized mealybugs become mummies (bloated and hard), they may be removed from squash hosts by a brush. Currently, we are field testing augmentative releases of *A. ananatis* for management of the pink pineapple mealybug on pineapple. Additionally, we are developing a mass rearing system for the encyrtid parasitoid *Euryrhopalus propinquus* Kerrich which attacks the gray pineapple mealybug.

Use of sticky tape to monitor mealybug densities. In Hawaii, monitoring of mealybug densities on pineapple is not commonly practiced by growers. The greater focus is on the presence of ants in plantings or the appearance of mealybug wilt symptoms. Locating and counting mealybugs on pineapple plants can be quite challenging as well as destructive to plants. Efforts to develop an inexpensive and practical whole plant sampling protocol for estimating the densities of pink pineapple mealybug in pineapple plantings were initially unsuccessful. Most pink pineapple mealybugs infesting plants were found at ground level or below ground (on the roots) prior to when the pineapple plant is 'forced.' Following forcing, numbers may increase above ground on the plant stem and basal leaf areas. In the early growth stages, pineapple plants had to be removed from the ground so plants could be dissected for mealybugs counts. This procedure is unacceptable to growers because it kills the plant and numerous plants would need to be examined for an accurate count. An alternative procedure was investigated in which small strips (ca. 12 X 37 mm) of double sticky tapes (e.g., Scotch® tape, indoor carpet tape, outdoor carpet tape) were applied to different locations on pineapple leaves and left for 7 days, after which time the tapes were examined for mealybug crawlers (1st instar mealybugs). The best tape for capturing the mealybug crawlers was an outdoor carpet tape because it also captured ants on the plant. Most mealybug crawlers were captured on tapes that were in the lower and upper one thirds of the plant in contrast to the middle third.

Using the Outdoor Carpet Tape (Manco® / Ace®, manufactuer), tests were conducted in more than five pineapple plantings on several dates to determine if the numbers of crawlers captured on the tape were related to the overall numbers of mealybugs on the pineapple plant. Tapes were left on the plants for seven days and posted at low, middle and upper levels within leaf axils adjacent to the mainstem. At the end of the time, tapes were taken to the lab and numbers of mealybugs counted. Plants on which tapes were placed were completely removed from the

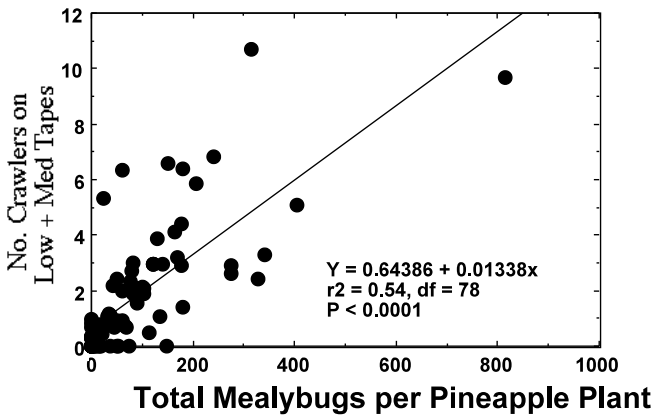

Figure 1. Relationship between mealybugs sampled with sticky tape and actual mealybugs per plant.

field and taken to the laboratory where all mealybugs on the plant were counted. Regression of the numbers of crawlers at the low and middle levels on the plant against the numbers of mealybugs per plant (Figure 1) provided the best significant fit. Although the regressions are not perfect, this sampling technique now provides us with an inexpensive and easy method to identify if mealybugs are in a pineapple planting without having to destroy whole pineapple plants in the process. Efforts are now underway to develop a grower-usable sampling protocol that will enable growers to effectively utilize this technique. The possibility of developing a sequential or presence-absence sampling technique will be investigated to reduce the efforts typically associated with fixed sampling sizes.

Control of Natural Flowering

Duane Bartholomew, NREM/TPSS, CTAHR, Univ. of Hawaii, 1910 East-West Rd., Honolulu, HI 96822.

ReTain® ((S)-trans-2-amino-4-(2-aminoethoxy)-3-butenoic acid hydrochloride, also known as amionethoxyvinylglycine or AVG) specifically inhibits the enzyme ACC synthase, which converts S-adenosylmethionine to aminocyclopropane-1-carboxylic acid, the biochemical precursor of ethylene. ReTain® is registered in many states in the U.S for use on apples and pears to increase fruit retention on the tree.

Two experiments to study the potential of ReTain® to inhibit natural induction (NI) of pineapple were installed in the fall of 2000. The treatments ranged from 62.5 to 500 ppm ReTain® applied in 150 gallons of water-0.1% organosilicone surfactant solution per acre equivalent (spray coverage to completely wet plant foliage without significant runoff). The treatments were applied twice to all plots with an interval of 3 weeks between applications. No NI occurred in one test and an average of 8% NI occurred in the other test. NI in the treatments averaged 1.0% or less, with no difference between the treatments. While the percentage of NI in control plots was low, the significant difference in NI between the treatment and control plots is encouraging. Additional studies of ReTain® are planned this fall. ReTain® is available from Valent U.S.A. Corp. (http://www.valent.com). For more information, contact Greg Venburg (greg.venburg@valent.com).

Genetic Engineering Approaches for Pineapple

David Christopher, Dept. of Molecular Biosciences and Biosystems Engineering, CTAHR, Univ. of Hawaii, Honolulu, HI 96822

Pineapple faces numerous pests and diseases and has characteristics (fruit acidity, flowering time, fruit color, vitamin content) that could be improved. However, compared with other crops, pineapple has been a difficult plant to improve via traditional breeding. The characteristic of inbreeding-induced sterility limits the establishment of a uniform genetic background to evaluate traits introduced by standard outcrossing. The end result is a large number of segregating lines each differing in various traits, some advantageous, but many undesirable. Methods of genetic engineering provide the potential to transfer selected genes into a standard variety, such as Smooth Cayenne. Successful genetic engineering of a pineapple plant requires a reproducible transformation system to deliver genes to plant cells and the availability of specific genes for desirable traits. For example, transforming pineapple with a gene for nematode resistance will reduce the need for pesticide applications. At the University of Hawaii, a collaborative pineapple genetic engineering program managed by Dr. Ken Rohrbach is tackling a variety of problems faced by pineapple growers, including nematode control. Genes encoding nematicidal compounds have been isolated from pineapple and other plants. Studies on model systems have shown that these compounds, which are found in significant levels in a variety of edible seeds and fruits, spell doom for nematodes when present at the right concentration in root cells. Technology is being developed to confine expression of these compounds in pineapple roots with no expression in fruit, to ultimately produce nematode-resistant pineapple plants of value to the industry.◆

Notices

Meetings of Interest

8th International Controlled Atmosphere Research Conference
Rotterdam, Netherlands, July 8-13, 2001. For more information contact: Conference Secretariat, Eurocongres Conference Management, Jan van Goyenkade 11, NL-1075 HP Amsterdam, The Netherlands. Phone 31-20-679-3411; Fax: 31-20-673-7306; Email: CA2001@eurocongres.com

CAM-2001: The III International CAM Congress
Coconut Beach Resort, Queensland, Australia, August 24-28, 2001. For more information contact Dr. Joe Holtum, Dept. of Tropical Plant Sciences, James Cook Univ., Townsville 4811, North Queensland, Australia. Phone: 47-81-4391; Fax: 47-25-1570; Email: joseph.holtum@jcu.edu.au.

International Symposium on Foliar Nutrition of Perennial Fruit Plants
Meran/Merano, Italy, Sept. 11-14, 2001. For more information, contact: Prof Dr. Massimo Tagliavini, Dipartim. Di Colture Arboree, Universita di Bologna, Via Filippo Re 6, 40126 Bologna, Italy (E-mail: mtaglia@agrsci.unibo.it) or W. Drahorad, Sudtiroler Beratungsring

fur Obst- und Weinbau, Kirchgasse 4, 39018 Terlan (BZ), Italy. Phone: 39-047-125-7198; Fax: 39-047-125-7800 (E-mail: beratungsring.terlan@rolmail.net).

Biotechnology of Tropical and Subtropical Species
Taipei, Taiwan, Nov. 5-9, 2001. Contact Prof. Wei-Chin Chang, Inst. Of Botany, Academia Sinica, Taipei 115, Taiwan; Phone: (886)227899590 ext. 120; Fax: (886)227827954; E-mail: wcc@wcc.sinica.edu.tw.

International Horticulture Congress
Summerland, BC, Canada, Aug. 11-17, 2002. Contact N.E. Looney, Pacific Agri-Food Research Centre, AAFC, Summerland, BC V0H 1Z0, Canada. E-mail: looneyn@em.agr.ca.

Web Sites of Possible Interest

All web sites listed below were confirmed to be working at the time of publication of the newsletter.

1. Fruits from America: An ethnobotanical inventory. Geo Coppens d'Eeckenbrugge and Dimary Libreros Ferla.
http://www.ciat.cgiar.org/ipgri/fruits_from_americas/frutales/fruits_from_america.htm
2. USDA National Organic Program (http://www.ams.usda.gov/nop/)
Organic Trade Association (http://www.ota.com/)
3. Organic Crop Improvement Association (OCIA): http://www.ocia.org/docs.html
4. A wealth of pesticide information is available on the world wide web. Hawaii has training materials for certification of applicators and back issues of a newsletter on pesticides (The Pesticide Label) at http://pestworld.stjohn.hawaii.edu/epp/pat.html; the web sites home page is at http://pestworld.stjohn.hawaii.edu/cfdocs/test/hpirs.htm
http://www.extento.hawaii.edu/IPM/Certification/Pineapple/Guidelines1.asp
5. Integrated pest management for pineapple production in hawaii at
http://www.extento.hawaii.edu/IPM/Certification/Pineapple/default.asp
6. The Agricultural Research Council, South Africa has in interesting web site with a small amount of information on pineapple at http://www.arc.agric.za/.

Commercial Services

AgroBiot S.A. Plant Tissue Culture Laboratory, located in Cartago,
Costa Rica, can supply *in vitro* plants of pineapples. For more information, contact Eng. Marco A. Cordoba, Production Manager, AgroBiot S.A., P.O.Box: 1417-2050, Cartago, Costa Rica; Phone: (506) 573-8170; Fax: (506) 573-8171; E-mail: agrobiot@racsa.co.cr ◆

References

This list includes papers published or located since the last issue of the newsletter was printed. **Please help** keep this section current by sending citations or copies of recent publications to D.P. Bartholomew. The large number of references included in this issue is due to a complete listing of publications recently received from Graham Petty, the publication of Acta Horticulturae Vol. 529, and the availability of more referencdes in on-line databases.

Reprints of many of the publications listed below can be obtained from the authors, obtainable through any research library or by writing to: Library External Services, Hamilton Library Room 112, University of Hawaii, 2550 The Mall, Honolulu, HI 96822 U.S.A. Charges are approximately $14.00 per article plus postage for the first 20 pages and $0.25 per page over 20 pages.

Abdullah, H., M.A. Rohaya, H. Rosli, and M. Mohamed Selamat 2000. Handling and Transportation Trial of Pineapple by Sea Shipment From Malaysia to the United Kingdom. 529, 317-327.

Abreu, C.M.P. de, V.D. de Carvalho, Goncalves N. Botrel, C.M.P. de Abreu, and V.D. de Carvalho 1998. Cuidados pos colheita e qualidade do abacaxi para exportacao (Post harvest conditions and quality of pineapple for export). Informe Agropecuario Belo Horizonte 19, 70-72.

Abreu, C.M.P. de, V.D. de Carvalho, C.D. dos Santos, S.J. de R. Chagas, L. Costa, C.M.P. de Abreu, V.D. de Carvalho, and C.D. dos Santos 1998. Efeito da embalagem de polietileno e da refrigeracao no escurecimento interno, na atividade da fenilalanina amonio liase (PAL) e fenolicos durante a maturacao do abacaxi cv. Smooth Cayenne (Effect of polyethylene wrapping and refrigeration on internal browning, activity of phenylalanine ammonium lyase (PAL) and phenolics during ripening of pineapple cv. Smooth Cayenne). Revista Brasileira de Fruticultura 20, 80-86.

Almeida, O.A. de 1999. Irrigação. In "O abacaxizeiro: Cultivo, agroindústria e economia" (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 203-227. EMBRAPA-SCT, Brasília, Brazil.

Ando, S., S. Meunchang, S. Thippayaraugs, P. Prasertsak, N. Matsumoto, P. Wasisirisuk, and T. Yoneyama 1999. Estimation of biological nitrogen fixation in field-grown sugarcane, cassava and pineapple in Thailand. Highlights of Collaborative Research Activities between Thai Research Organizations and JIRCAS. In "Proceedings of JIRCAS Seminar in Bangkok, 1999" (M. Suzuki and S. Ando, eds.), pp. 44-46, Bangkok, Thailand.

Ando, Shotaro, Sompong Meunchang, Preecha Vadisirisak, and Tadakatsu Yoneyama 2000. Estimation of Nitrogen Input by N2 Fixation to Field-Grown Pineapples in Thailand. 529, 203-210.

Anonymous 1997. "Annual Report of Taiwan Agricultural Research Institute.," Taiwan, Taiwan Agricultural Research Institute, Taichung; Taiwan LA: Chinese.

Anonymous 1998. "France, Centre de Cooperation Internationale en Recherche Agronomique pour le Developpement (Cooperation in plant genomics at CIRAD)," CIRAD SAR, Montpellier; France.

Anupunt, Prasert, Pornprome Chairidchai, Aporn Kongswat, Somporn Isawilanon, Suranant Subhadrabandhu, Sasithorn Vasunun, and Smarn Siripat 2000. Pineapple Industry in Thailand. 529, 99-110.

Ao, K.C., and C.M. Sarma 1999. Effect of plant growth regulators on vegetative growth of pineapple. Indian Agriculturist 43, 41-47.

Bartholomew, Duane P. 2000. The Pineapple Working Group of the International Society for Horticultural Science. 529, 27-34.
Benega, R., A. Cisneros, M. Isidron, J.A. Ramos, J. Martinez, G. Perez, E. Arias, and M. Hidalgo 1997. Obtencion y seleccion de hibridos promisorios de pina entre cayena lisa Serrana y espanola roja (Production and selection of promising hybrids between Serrana Smooth Cayenne and Red Spanish pineapples). Cultivos Tropicales 18, 72-75.
Bhatia, A.M., N. Hazarika, and R. Singha 1999. Spices and fruit for micro enterprises. A study of the potentials of ginger and pineapples in West Garo Hills, Meghalaya, India. In “MEI Case Study Series”, pp. 97 pp. International Centre for Integrated Mountain Development, Kathmandu; Nepal.
Boas, E.V. de B.V., N. Botrel, A.B. Chitarra, V.D. de Carvalho, G.H. de A. Teixeira, and V.D. de Carvalho 1998. Modificacoes de componentes da parede celular do abacaxi submetido ao tratamento com CaCl2 em diferentes temperaturas (Changes in the cell wall compounds of pineapple treated with CaCl2 solution at different temperatures). Ciencia e Agrotecnologia 22, 359-365.
Bora, G.C., and V.M. Salokhe 2000. Development of a tractor front-mounted pineapple plant dressing machine. AMA, Agricultural Mechanization in Asia, Africa and Latin America 31, 29-32.
Borras Hidalgo, O., A.P. de Matos, Cabral R. Santos, Tussel R. Tapia, M. Arzola, R. Santos, M.C. Perez, and A.P. de Matos 1998. Phytotoxic effect of culture filtrate from Fusarium subglutinans the causal agent of fusariose of pineapple (Ananas comosus (L.) Merr). Euphytica 104, 73-77.
Botella, Jose R., Antonino Cavallaro, and Christopher I. Cassonelli 2000. Towards the Production of Transgenic Pineapple to Control Flowering and Ripening. 529, 115-122.
Bueno, de Paula M., de Mesquita H. Adelande, and F.D. Nogueira 1998. Nutricao e adubacao do abacaxizeiro (Nutrition and fertilization of pineapple). Informe Agropecuario Belo Horizonte 19, 33-39.
Burch, D., and J. Goss 1999. Global sourcing and retail chains: shifting relationships of production in Australian agri foods. In “Antipodean visions: the dynamics of contemporary agri food restructuring in Australia and New Zealand”, Vol. 64, pp. 334-350.
Cabral, J.R.S., G. Coppens d'Eeckenbrugge, and A.P. de Matos 2000. Introduction of Selfing in Pineapple. 529, 165-168.
Cabral, J.R.S., F.R. Ferreira, and A.P. de Matos 1999. Caracterizacao e avaliacao de germoplasma de abacaxi (Characterization and evaluation of pineapple germplasm). Revista Brasileira de Fruticultura 21, 247-251.
Cabrera, H.A.P., H.C. de Menezes, J.J. do V. Oliveira, R.F. dos S. Batista, and H.C. de Menezes 1999. Avaliacao da concentracao de diuron e paration metilico nos sub produtos do abacaxi cv smooth cayenne processado (Evaluation of the residual levels of diuron and methyl parathion in processed pineapple cv. smooth cayenne sub products). atista, R.F.A. dos S. 21, 20-23.
Carter, Carol E., Howard Marriage, and Peter W. Goodenough 2000. Mutagenesis and kinetic studies of a plant cysteine proteinase with an unusual arrangement of acidic amino acids in and around the active site. Biochemistry 39, 11005-11013.
Carvalho, V.D. de, C.M.P. de Abreu, Goncalves N. Botrel, V.D. de Carvalho, and C.M.P. de Abreu 1998. Qualidade e industrializacao do abacaxi (Quality and industrialization of pineapple). Informe Agropecuario Belo Horizonte 19, 67-69.
Cazzonelli, C.I., A.S. Cavallaro, J.R. Botella, and D. Grierson 1999. Searching for the role of ethylene in non climacteric fruits. In “Biology and biotechnology of the plant hormone ethylene II. Proceedings of the EU TMR Euroconference Symposium, Thira (Santorini), Greece, 5 8 September, 1998” (A. K. Kanellis, C. Chang, H. Klee, A. B. Bleecker and J. C. Pech, eds.), pp. 29-30. Kluwer Academic Publishers, Dordrecht; Netherlands.
Chairidchai, Pornprome 2000. The Relationships Between Nitrate and Molybdenum Contents in Pineapple Grown on an Inceptisol Soil. 529, 211-216.
Chaiwanichsiri, S., K. Laohasongkram, C. Thunpithayakul, and S. Mekmanee 1996. Thermophysical properties of fresh and frozen pineapples. ASEAN Food Journal 11, 1-5.
Chan, Y.K. 2000. Status of the Pineapple Industry and Research and Development in Malaysia. 529, 77-84.
Chan, Y.K., and H.K. Lee 2000. Breeding for Early Fruiting in Pineapple. 529, 139-146.
Chang, ChingChyn, and C.C. Chang 1998. Effect of different types of propagule on yield and fruit shape of "Tainung No.4" pineapple. Journal of the Chinese Society for Horticultural Science 44, 64-68.
Chang, ChingChyn, and C.C. Chang 1999. Fruit characteristic of 'Tainung No.4' pineapple influenced by flower inducing chemicals. Journal of the Chinese Society for Horticultural Science 45, 217-222.
Chávez, M.A., M. Hernández, M. Márquez, G. Rodríguez, R. Santos, J. González, and C. Carvajal 1997. Proceso de Obtención de Bromelina a Partir de Tallos de Piña. Patente. Centro de Bioplantas, Cuba.
Chen, Ching-Cheng, and Robert E. Paull 2000. Changes in Sugar Content and the Activity of Sugar Metabolizing Enzymes in Pineapple Fruit Flesh During Development. 529, 191-195.
Chen, Ching-Cheng, and Robert E. Paull 2000. Sugar metabolism and pineapple flesh translucency. Journal of the American Society for Horticultural Science 125, 558-562.
Chen, LiSong, A. Nose, K. Wasano, and L.S. Chen 1998. Effects of various ions on adenosinetriphosphatase and inorganic pyrophosphatase in tonoplasts isolated from three CAM species, Ananas comosus, Kalanchoe pinnata and K. daigremontiana. In “Bulletin of the Faculty of Agriculture, Saga University”, pp. 65-73; 34.
Chen, Li-Song, and Akihiro Nose 2000. Characteristics of adenosinetriphosphatase and inorganic pyrophosphatase in tonoplasts isolated from three CAM species, Ananas comosus, Kalanchoe pinnata and K. daigremontiana. Plant Production Science 3, 24-31.
Chesney, P. 1998. Pineapple germplasm resources in Guyana. In “Tropical Fruits Newsletter”, pp. 5-8.
Chipungahelo, G.S., R. Fordham, A. Ngereza, and A.A. Mpunami 1998. Interplanting food crops under coconut palms in red sandy loams of Tanzania. In “Proceedings of the international cashew and coconut conference: trees for life the key to development, Dar es Salaam, Tanzania, 17-21 February 1997” (C. P. Topper, P. D. S. Caligari, A. K. Kullaya, S. H. Shomari, L. J. Kasuga and P. A. L. Masawe, eds.), pp. 315-319. BioHybrids International Ltd., Reading; UK.
Chitarra, A.B., J.M. da Silva, J.M. da Silva, and L. Michalczuk 1999. Effect of modified atmosphere on internal browning of 'Smooth Cayenne' pineapples. Proceedings of the international symposium on effect of preharvest and postharvest factors on storage of fruit, Warsaw, Poland, 3-7 August, 1997 485, 85-90.
Chongpraditnun, Praphasri, Pratueng Luksanawimol, Pakorn Limsmuthchaiporn, and Sasithorn Wasunun 2000. Effect of Fertilizers on the Content of Nitrate in Pineapple Fruit. 529, 217-220.
Chowdhury, D., and K.K. Deka 1997. Coconut based inter/mixed cropping under Assam conditions. Journal of Plantation Crops 25, 106-108.
Clemente, R.S., A. Baloloy, M. Collado, and J. Manguera 1999. Computer modeling of runoff/erosion and surface transport of agro chemicals at the Siniloan watershed, Philippines. Contour Jakarta 11, 12-16.
Collier, S., M. Bartlett, and T. Moody 1997. “Fruit and vegetable prices and receivals 1996/97, Flemington Markets, Sydney, Australia.,”. NSW Agriculture; Sydney; Australia.
Columba, P. 1997. Valutazioni sul commercio e sul consumo dei frutti tropicali nella Ue (Value of trade and consumption of tropical fruits within the EU). Rivista di Frutticoltura e di Ortofloricoltura 59, 19-23.
Coppens d'Eeckenbrugge, G., J.R.S. Cabral, J. Carlier, M.F. Duval, F.R. Ferreira, F. Leal, A.P. De Matos, J.L. Noyer, and Z Su rez 2000. The EU-Funded Project 'Evaluation and Utilization of Pineapple Genetic Resources From the Amazon to Breed Resistant Varieties'. 529, 169-172.
Coppens d'Eeckenbrugge, Geo, and Franck Marie 2000. Pineapple Breeding at Cirad. II. Evaluation of 'Scarlett', a New Hybrid for the Fresh Fruit Market, as Compared to 'Smooth Cayenne'. 529, 155-163.
Costa, D. da C., J.M. dos Santos, N.F. Sanches, D.C. da Costa, and J.M. dos Santos 1998. Associacao de Aorolaimus sp. (Nemata: Hoplolaiminae) com o vermelhao do abacaxizeiro na regiao de Itaberaba, Bahia (Association of Aorolaimus sp. (Nemata: Hoplolaiminae) with pineapple reddish leaf symptoms in the Itaberaba region, Bahia, Brazil). Revista Brasileira de Fruticultura 20, 119-122.
Costa, D.C. da, N.F. Sanches, J.M. dos Santos, D.C. da Costa, and J.M. dos Santos 1998. Levantamento de fitonematoides associados ao abacaxizeiro (Nematodes survey associated with pineapple). Revista Brasileira de Fruticultura 20, 392-396.
Costa, Santa Cecilia L.V., and S.M. Chalfoun 1998. Pragas e doencas que afetam o abacaxizeiro (Pests and diseases which affect pineapple). Informe Agropecuario Belo Horizonte 19, 40-57.
Craswell, E.T., A. Sajjapongse, D.J.B. Howlett, A.J. Dowling, and C.R. Latt 1998. Agroforestry in the management of sloping lands in Asia and the Pacific. Directions in agroforestry research. Adapted from selected papers presented to a symposium on tropical agroforestry organized in connection with the annual meetings of the American Society of Agronomy, 5 November 1996, Indianapolis, Indiana, USA. 38, 121-137.

Cravalho, V.D. de 1999. Composição, colheita, embalagem e transporte do fruto. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 367-388. EMBRAPA-SCT, Brasília, Brazil.
Cravalho, V.D. de, and G.A.P. da Cunha 1999. Produtos e usos. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 389-402. EMBRAPA-SCT, Brasília, Brazil.
Cunha, G.A.P. da 1999. Aspectos agroclimáticos. In “O abacaxizeiro: Cultivo, agroindústria e economia” (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 53-82. EMBRAPA-SCT, Brasília, Brazil.
Cunha, G.A.P. da 1999. Florescimento e uso de fitorreguladores. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 229-251. EMBRAPA-SCT, Brasília, Brazil.
Cunha, G.A.P. da 1999. Implantação da cultura. In “O abacaxizeiro: Cultivo, agroindústria e economia” (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 139-167. EMBRAPA-SCT, Brasília, Brazil.
Cunha, G.A.P. da, and J.R. Santos Cabral 1999. Taxonomia, espécies, cultivares e morfoligia. In “O abacaxizeiro: Cultivo, agroindústria e economia” (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 17-51. EMBRAPA-SCT, Brasília, Brazil.
Das, B.C., M.K. Sadhu, and S.K. Sen 1999. Effect of plant density and nutrition on growth and yield of pineapple cv. Giant Kew. Horticultural Journal 12, 1-11.
Das, R.K., and G. Bhowmik 1998. Some somaclonal variants in pineapple [Ananas comosus (L.) Merr.] plants obtained from different propagation techniques. International Journal of Tropical Agriculture,1997 15, 95-100.
de Matos, A.P., J. da Silva Souza, J.A. Ventura, J.A. Gomes, W.V. dos Santos, J.R. Silva, J.E.L.F. Rodrigues, R.N.B. Alves, R.S.S. Gadelha, A.C. Sampaio, D. Loeillet, J. da Silva Souza, and W.V. dos Santos 1998. Situacao atual e perspectivas da abacaxicultura (Current situation and forecasts for pineapple growing). Informe Agropecuario Belo Horizonte 19, 74-76.
Dolgov, S.V., T.V. Shushkova, A.P. Firsov, and R.A. Drew 1998. Pineapple (Ananas comosus Mess.) regeneration from leaf explants. In “Proceedings of the international symposium on biotechnology of tropical and subtropical species, part II, Brisbane, Queensland, Australia, 29 September-3 October 1997”, pp. 439-444.
Drennan, P.M., and P.S. Nobel 2000. Responses of CAM species to increasing atmospheric CO2 concentrations. Plant Cell and Environment 23, 767-781.
Duval, M.F., J.L Noyer, P. Hamon, and G. Coppens d'Eeckenbrugge 2000. Study of Variability in the Genus Ananas and Pseudananas using RFLP. 529, 123-131.
El-Tarras, A., Y.A. Hossni, and A.A. Elbanna 1999. Application of RAPD analysis for identification and genetic analysis of somaclonal variation in Ananas comous variegatum. Egyptian Journal of Horticulture 26, 97-108.
Escalona, M., J.C. Lorenzo, B. Gonzalez, M. Daquinta, Z. Fundora, C.G. Borroto, P. Espinosa, D. Espinosa, E. Arias, and M.E. Aspiolea 1998. New system for in vitro propagation of pineapple (Ananas comosus (L.) Merr). In “Tropical Fruits Newsletter”, pp. 3-5.
Feng, RongYang, EnYi Liang, R.Y. Feng, and E.Y. Liang 1998. The occurrence regularity and control of pineapple powdery scale. South China Fruits 27, 28-29.
Ferreira, F.R., and J.R.. Santos Cabral 1998. Melhoramento genetico do Abacaxizeiro (Breeding pineapple). Informe Agropecuario Belo Horizonte 19, 24-28.
Francis, D. 1999. Trade challenges for non-traditional fruits. IICA Quarterly Newsletter 5, 4-9.
Freiman, L.O., and A.U.O.S. Srur 1999. Determinacao de proteina total e escore de aminoacidos de bromelinas extraidas dos residuos do abacaxizeiro (Ananas comosus, (L.) Merril) (Determination of total protein and amino acid composition of bromelain extracted from pineapple plant residues (Ananas comosus, (L.) Merril)). Ciencia e Tecnologia de Alimentos 19, 170-173.
Geesink, Arango H., and Calderon M.E. Montero 1998. Mechanical damage resistance of Golden Extra Sweet pineapples grown in Costa Rica. In “ASAE Annual International Meeting, Orlando, Florida, USA, 12-16 July, 1998”, pp. 1 pp. ASAE Paper no. 986101. American Society of Agricultural Engineers (ASAE), St Joseph; USA.
Gnonhouri, P.G., A. Ouya, B. Assienan, and Y. Atse 2000. Resistance et tolerance de Ananas comosus vis-a-vis du nematode Pratylenchus brachyurus en Cote d'Ivoire (Resistance and tolerance of Ananas comosus to Pratylenchus brachyurus in Ivory Coast). Cahiers Agricultures 9, 145-147.
Goburdhun, D., and B. Jhuree 1997. Reducing post-harvest losses of fresh pineapple in Mauritius. Revue Agricole et Sucriere de l'Ile Maurice 76, 23-33.
Gogoi, M. 1997. Adoption behaviour of pineapple growers in Kamrup district of Assam. Journal of the Agricultural Science Society of North East India 10, 290 292.
Goncalves, Gervasio R. de C.R., and Cecilia L.V.C. Santa 1999. Teores foliares de compostos fenolicos em abacaxizeiro em funcao da murcha, da cultivar e do ciclo da planta (Foliar contents of phenolic compounds in pineapple as affected by wilt, cultivar and plant cycle). Revista Brasileira de Fruticultura 21, 232-234.
Gonçalves, N.B. 2000. “Abacaxi. Pós-colheita. (Pineapple. Post-harvest),” Embrapa Comunicação para Transferência de Tecnologia, Brasília, DF.
Gonzalez, Arnao Maria Teresa, Ravelo Manfred Marquez, Villavicencio Caridad Urra, Montero Marcos Martinez, and Florent Engelmann 1998. Cryopreservation of pineapple (Ananas comosus) apices. Cryo Letters 19, 375-382.
Graham, Michael, Lien Ko, Vanessa Hardy, Simon Robinson, Brett Sawyer, Tim O'Hare, Marcelle Jobin, Janelle Dahler, Steven Underhill, and Mike Smith 2000. The Development of Blackheart Resistant Pineapples Through Genetic Engineering. 529, 133-136.
Guerra, M.P., L.L. dal Vesco, R. Pescador, A.R. Schuelter, and R.O. Nodari 1999. Estabelecimento de um protocolo regenerativo para a micropropagacao do abacaxizeiro (Establishment of a regenerative protocol for pineapple micropropagation). Pesquisa Agropecuaria Brasileira 34, 1557-1563.
Guerra, N.B., and A.V.S. Livera 1999. Correlacao entre o perfil sensorial e determinacoes fisicas e quimicas do abacaxi cv. Perola (Correlations between the sensorial profile and physical and chemical analysis of pineapple cv. Perola). Revista Brasileira de Fruticultura 21, 32-35.
Guillemin, J.P., S. Gianinazzi, and A. Trouvelot 1992. Screening of arbuscular endomycorrhizal fungi for establishment of micropropagated pineapple plants. Agronomie 12, 831-836.
Hatano, K.I., M. Tanokura, and K. Takahashi 1998. The amino acid sequences of isoforms of the bromelain inhibitor from pineapple stem. Journal of Biochemistry Tokyo 124, 457-461.
Heredia, J.B., J.H. Siller, M.A. Baez, E. Araiza, T. Portillo, R. Garcia, and M.D. Muy 1998. Cambios en la calidad y el contenido de carbohidratos en frutas tropicales y subtropicales a nivel supermercado (Changes in the quality and content of carbohydrates in tropical and subtropical fruits at the supermarket level). In “Proceedings of the Interamerican Society for Tropical Horticulture. 1997”, Vol. 41, pp. 104-109.
Ishihara, M., M. Hasegawa, T. Taira, and S. Toyama 2000. Isolation and antimicrobial activity of feruloyl oligosaccharide ester from pineapple stem residues. Nippon Shokuhin Kagaku Kogaku Kaishi (Journal of the Japanese Society for Food Science and Technology) 47, 23-29; 19.
Islam, M.S., and T.K. Paul 1997. Performance of brinjal, mukhikachu and pineapple intercropped with coconut. Annals of Bangladesh Agriculture,1995 5, 139-141.
Jose, J.O., C.T. Radha, and K. Aravindakshan 1996. In vitro multiplication of pineapple through enhanced release of axillary buds. Journal of Applied Horticulture Navsari 2, 82-85.
Kadir, S.A., E. Sutanto, Y. Desvia, A. Niswati, Dermiyati, and M. Kimura 1999. Activities of soil enzymes in fields continuously cultivated with cassava, sugarcane, and pineapple in middle terrace areas of Lampung Province, South Sumatra, Indonesia. Soil Science and Plant Nutrition 45, 803-809.
Karunaratne, A.M., and M.V.A. Dharmawanse 1999. Potentially toxigenic fungi and potential biocontrol microorganisms in some ingredients used in processed foods. Ceylon Journal of Science, Biological Sciences 27, 1-8.
Keetch, D.P., G.J. Petty, and E.R. Dalldorf 1980. Incompatibility of spray materials in pineapple cultivation. Farming in South Africa H.23, 3pp.
Kruger, F., E. Rabie, K. Wesson, and H. Tustin 1998. The fight against blackheart in 'Queens'. In “Neltropika Bulletin”, pp. 18-20.
Kruger, F.J., and M. Bezuidenhout 1998. Progress in the development of a postharvest treatment to combat blackheart in 'Queen' pineapples. In “Neltropika Bulletin”, pp. 27-29.
Kruger, F.J., and E.C. Rabie 2000. Development of a Postharvest Procedure for Sea Export of 'Queen Victoria' Pineapples From South Africa to Europe. 529, 329-336.
Kruger, F.J., L. Tait, M. Kritzinger, M. Bezuidenhout, V. Claassens, and L. Michalczuk 1999. Postharvest browning in South African subtropical export fruits. In “Proceedings of the international symposium on effect of preharvest and postharvest factors on storage of fruit, Warsaw, Poland, 3-7 August, 1997”, pp. 225-229.
Latha, A.K.B., S.R. Nair, and P.C.S. Varma 1996. Staggering of fruit production in pineapple var. Mauritius. Journal of Tropical Agriculture 34, 103-107.

Latha, A.K.B., P.C.S. Varma, and S.R. Nair 1997. Influence of time of planting and application of growth regulator on the quality of pineapple. South Indian Horticulture 45, 274-276.
Leal, F., and L. Avilan 1997. Situacion de la fruticultura en Venezuela: un analisis (Situation of fruit cultivation in Venezuela: an analysis). Revista de la Facultad de Agronomia, Universidad Central de Venezuela. 23, 1-30.
Leal, F., and E. Sergent 1996. Situacion actual de la pina en Venezuela: epitome (Current situation of pineapple in Venezuela: epitome). Revista de la Facultad de Agronomia, Universidad Central de Venezuela (V Congreso nacional de frutales, Maracay, Venezuela, 1994) 50, 35-39.
Lin, Chin Ho, and Chyn-Ching Chang 2000. Pineapple Production and Industry in Taiwan. 529, 93-98.
Lin, MingTse, MingTzu Fu, ChuianFu Ken, ChiTsai Lin, M.T. Lin, M.T. Fu, C.F. Ken, and C.T. Lin 2000. Plant Gene Register PGR 00 021. Cloning and characterization of a cDNA encoding for Cu/Zn superoxide dismutase from pineapple (accession no. AJ250667). Plant Physiology 122, 619.
Lopez, Laura, M.I., Cynthia Sequeiros, Claudia L. Natalucci, Adriana Brullo, Bruno Maras, Donatella Barra, and Nestor O. Caffini 2000. Purification and characterization of macrodontain I, a cysteine peptidase from unripe fruits of Pseudananas macrodontes (Morr.) Harms (Bromeliaceae). Protein Expression and Purification 18, 133-140.
Lorenzato, D., E.C. Chouene, J. Medeiros, A.E.C. Rodrigues, and R.C.D. Pederzolli 1997. Ocorrencia e controle da broca do fruto do abacaxi Thecla basalides (Geyer, 1837) (Occurrence and control of the pineapple fruit borer Thecla basalides (Geyer, 1837)). Pesquisa Agropecuaria Gaucha 3, 15-19.
Lovato, P., J.P. Guillemin, and S. Gianinazzi 1992. Application of commercial arbuscular endomycorrhizal fungal inoculants to the establishment of microporpagated grapevine rootstock and pineapple plants. Agronomie 12, 873-880.
Lu, YouMing, FuFa Lai, Y.M. Lu, and F.F. Lai 1999. An effective method for control of pineapple powdery scales. South China Fruits 28, 33.
Luo, HuiHua, ShaoZong Zhong, H.H. Luo, and S.Z. Zhong 1998. Effects of black inhibitor for controlling black heart disease in pineapple. Journal of Guangxi Agricultural University 17, 233-240.
Mac, Inegite, O' Bagaiye O.K. Jose, and Olumuyiwa A. Owolabi 1998. Changes in thiamine, riboflavin and niacin content of fruits during ripening. Indian Journal of Nutrition and Dietetics 35, 4-8.
Maibangsa, S., and F. Ahmed 2000. Effect of post flowering spray with NAA and GA3 on ratoon pineapple. Annals of Agricultural Research 21, 133-134.
Malezieux, Eric 2000. Global Network for Pineapple Research. 529, 35-48.
Manjunath, B.L., M.S. Balbatti, D.G. Dhandar, and K.K. Thomas 1998. Intercropping in coconut for higher monetary returns. In “Developments in plantation crops research. Proceedings of the 12th Symposium on Plantation Crops, PLACROSYM XII, Kottayam, India, 27 29 November 1996” (N. M. Mathew, J. C. Kuruvilla, J. Licy, T. Joseph and J. R. Meenattoor, eds.), pp. 199-202. Allied Publishers Ltd., New Delhi, India.
Marie, F., E. Mal,zieux, J. Marchal, and X. Perrier 2000. On-Farm Approach of Pineapple Fruitlet Core Rot Disease in Martinique. 529, 261-263.
Marie, Franck, Geo Coppens d'Eeckenbrugge, and B. Bernasconi 2000. Pineapple Breeding at CIRAD. I. Evaluation and Selection of 'Smooth Cayenne' x 'Manzana' Hybrids. 529, 147-153.
Marinho, F.J.L., P.D. Fernandes, and H.R. Gheyi 1998. Desenvolvimento inicial do abacaxizeiro, cv. Smooth Cayenne, sob diferentes condicoes de salinidade da agua (Initial growth of pineapple cv. Smooth Cayenne under different water salinity conditions). Revista Brasileira de Engenharia Agricola e Ambiental 2, 1-5.
Martelleto, L.A.P., A.M.C. Castilho, A. de Goes, and A. de Goes 1998. Influencia da temperatura de incubacao no crescimento micelial, na esporulacao e na patogenicidade de Fusarium subglutinans, agente causal da fusariose do abacaxizeiro (Influence of incubation temperature on mycelial growth, sporulation and pathogenicity of Fusarium subglutinans, the causing agent of Fusarium wilt in the pineapple plant). Summa Phytopathologica 24, 242-246.
Martinez, de Carvalho A. 1998. Irrigacao no abacaxizeiro (Irrigation of pineapples). . Informe Agropecuario Belo Horizonte 19, 58-61.
Matos, A.P. de 1999. Doenças e seu controle. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 269-305. EMBRAPA-SCT, Brasília, Brazil.
Matos, Aristoteles Pires de, Jose Renato, Santos Cabral, Nilton Fritzon Sanches, and Ranulfo Correa Caldas 2000. Effect of Temperature and Rainfall on the Incidence of *Fusarium subglutinans* on Pineapple Fruits. 529, 265-272.
Mayak, S., T. Tirosh, A. Ilan, A. Duvdevani, E. Khayat, and R.A. Drew 1998. Growth and development of pineapple (Ananas comosus L.) plantlets cultured in vitro at enriched and ambient CO2 environments. In “Proceedings of the international symposium on biotechnology of tropical and subtropical species, part II, Brisbane, Queensland, Australia, 29 September -3 October 1997”, pp. 225-229.
Medrano, Sanchez C., and E. Sergent 1996. Control de malezas en frutales (Weed control in fruit trees). V Congreso nacional de frutales, Maracay, Venezuela, 1994 50, 131-140.
Melzer, M. J., A. V. Karasev, D. M. Sether, and J. S. Hu 2001. Nucleotide sequence, genome organization, and phylogenetic analysis of pineapple mealybug wilt-associated virus-2. J. General Virology 82, 1-7.
Meunchang, S., B. Tangchum, P. Wadisirisuk, and S. Ando 1999. Isolation and characterization of nitrogen-fixing endophytic bacteria in pineapple. Highlights of Collaborative Research Activities between Thai Research Organizations and JIRCAS. In “Proceedings of JIRCAS Seminar in Bangkok, 1999” (M. Suzuki and S. Ando, eds.), pp. 47-48, Bangkok, Thailand.
Michel, P. 1998. Nouveaux produits au Columa 1998: onze nouvelles molecules herbicides (New products at Columa 1998: eleven new herbicide molecules). In “Phytoma”, pp. 5-6.
Miller, P. 1999. Tin in canned pineapples. In “Food Surveillance Information Sheet”, pp. 0-13 pp. HMSO Publications Centre, London; UK.
Montigaud, J.C., and J. Weerts 2000. Globalisation process and adaptation of fresh produce commodity systems: the case of Compagnie Fruitiere. Proceedings of the XXV International Horticultural Congress. Part 14. Horticultural economics at micro and macro level, international trade and marketing, international cooperative programs, relations between research, development, extension and education, Brussels, Belgium, 2-7 August, 1998
Acta-Horticulturae 524, 181-189.
Moody, T. 1998. “Fruit and vegetable prices and receivals, cut flower prices 1997/98.,” NSW Agriculture, Sydney; Australia.
Morroni, de Paiva B., and de Andrade Resende L. Morais 1998. Aspectos economicos da producao e comercializacao do abacaxi (Economic aspects of the production and trade of pineapples). Informe Agropecuario Belo Horizonte 19, 7-11.
Murachi, T. 1970. Bromelain enzymes. In “Methods in Enzymology”, Vol. 19, pp. 273-283.
Murray, David A., and J.E. Hoffman 2000. To Ascertain the Ideal Combinations of Atrizine and/or Diuron with Thiazopyr (Visor) in Order That Acceptable Broad Spectrum Pre-Emergent Weed Control in Pineapples is Achieved. 529, 289-292.
Mwaiko, W., and A.A. Mpunami 1998. Role of Oecophylla longinoda (Formicidae) and Amdro (hydramethlynon) ant bait in the integrated pest management of Pseudotheraptus wayi (Coreidae) on coconuts in Tanzania. In “Proceedings of the international cashew and coconut conference: trees for life the key to development, Dar es Salaam, Tanzania, 17-21 February 1997” (C. P. Topper, P. D. S. Caligari, A. K. Kullaya, S. H. Shomari, L. J. Kasuga and P. A. L. Masawe, eds.), pp. 452-455. BioHybrids International Ltd., Reading; UK.
Nanayakkara, K.P.G.A., H.M.W. Herath, and Y.D.A. Senanayake 1997. Effects of some pre-harvest treatments of potassium and hormones on fruit core tissue deterioration and internal browning of pineapple under cold storage. Tropical Agricultural Research 9, 90-95.
Nascimento, A.R., Filho F. Ferreira, Filho J.E. Mouchrek, and F.B. Cantanhede 1999. Perfil microbiologico das polpas de acerola (Malpighia glaba L) e abacaxi (Ananas comosus), produzidas e comercializadas na Ilha de Sao Luis, MA (Microbiological profiles of acerola (Malpighia glaba L.) and pineapple (Ananas comosus) pulps commercially produced in Sao Luis, Maranhaoo). Higiene Alimentar 13, 44-47.
Nath, R.C., B. Mukherjee, and M.K. Dasgupta 1998. Population dynamics of plant parasitic nematodes in a pineapple plantation of Tripura, India. International Journal of Nematology 8, 185-190.
Nigam, J.N. 2000. Continuous ethanol production from pineapple cannery waste using immobilized yeast cells. Journal of Biotechnology 80, 189-193.
Nirenberg, H.I., and K. O' Donnell 1998. New Fusarium species and combinations within the Gibberella fujikuroi species complex. Mycologia 90, 434-458.
Nose, A., A. Miyata, K. Kobayashi, K. Wasano, and G. Garab 1998. Temperature and pH responses of phosphofructokinase from three CAM plants, Ananas comosus, Kalanchoe pinnata, and K. daigremontiana. In “Photosynthesis: mechanisms and effects. Volume V. Proceedings of the XIth International Congress on Photosynthesis, Budapest, Hungary, 17-22 August, 1998”, pp. 3599-3602. Kluwer Academic Publishers, Dordrecht; Netherlands.
Paiva, P.D. de O., M. del B. Mayer, M.I. Kawamura, M. Pasqual, and R. Paiva 1999. Efeito de BAP, thidiazuron e sulfato de adenina na propagacao in vitro de abacaxi (Effect of BAP, thidiazuron and adenine sulfate on in vitro propagation of pineapple). Revista Ceres 46, 231-237.

Pandey, R.M., R. Palaniappan, M.E. Raja, and K.S. Gajbhiye 1998. Suitability of red and lateritic soil landscapes for fruit crops. In “Red and lateritic soils. Volume 1: Managing red and lateritic soils for sustainable agriculture” (J. Sehgal and W. E. Blum, eds.), pp. 191-201. A.A. Balkema; Rotterdam; Netherlands.
Pasqual, M., M.A. Moreira, Sobrinho A. dos Anjos, and Sobrinho A. dos Anjos 1998. Biotecnologia aplicada a producao de mudas de abacaxi (Application of biotechnology to production of pineapple cuttings). Informe Agropecuario Belo Horizonte 19, 20-23.
Paula, M.B. de, F.S.R. Holanda, H.A. Mesquita, V.D. de Carvalho, M.B. de Paula, and V.D. de Carvalho 1999. Uso da vinhaca no abacaxizeiro em solo de baixo potencial de producao (Use of vinasse in pineapple cultivation on soil with low yield potential). Pesquisa Agropecuaria Brasileira 34, 1217-1222.
Peng, FangRen, BaoLong Huang, T. Juhana, L. Nam, F.R. Peng, and B.L. Huang 1998. Nutrient cycling in coconut pineapple intercropping. Journal of Nanjing Forestry University 22, 9-12.
Peng, FangRen, BaoLong Huang, T. Juhana, F.R. Peng, and B.L. Huang 1999. Productivity and nutrient cycling in an agroforestry ecosystem for interplant[ing] of pineapple and coconut. Journal of Forestry Research 10, 163-167.
Perez, de C.M., L. Laskowski, J. Zambrano, and J. Pina 1997. Comportamiento poscosecha de frutos de pina (Ananas comosus) tratados con retardantes de la maduracion almacenados a diferentes temperatures (Postharvest behaviour of pineapple (Ananas comosus) fruits treated with ripening retardants stored at different temperatures). Revista de la Facultad de Agronomia, Universidad del Zulia 14, 393-398.
Perez, de C.M., J. Zambrano, J. Manzano, and E. Sergent 1996. Relacion entre el color de los frutos de pina cv. Espanola Roja y su estado de madurez (Relationship between the colour of pineapple cv. Red Spanish fruits and maturity). In “V Congreso nacional de frutales, Maracay, Venezuela, 1994. Revista de la Facultad de Agronomia, Universidad Central de Venezuela.” (F. Leal, ed.), Vol. 50, pp. 89-95.
Petty, G. 1984. Methyl bromide sterilisation of pineapple plants. Citrus Subtrop Fruit Res Inst Information Bulletin 147, 5.
Petty, G. 1985. Ant control in pineapple lands. Citrus Subtrop Fruit Res Inst Information Bulletin 155, 4-5.
Petty, G.J. 1973. New pests of Subtropical Crops - Lepidopteran larvae on pineapples. C.S.F.R.I. Information Bulletin 15, 1-2.
Petty, G.J. 1976. Leathery Pocket in pineapples. Farming in South Africa H.2, 3pp.
Petty, G.J. 1976. The pineapple mealybug. Farming in South Africa H.15, 8pp.
Petty, G.J. 1976. Pineapple Pests : Black Maize Beetle. Farming in South Africa H.13, 4 pp.
Petty, G.J. 1976. White Grubs in pineapples. Farming in South Africa H.12, 4pp.
Petty, G.J. 1977. Army worm attacks pineapples. C.S.F.R.I. Information Bulletin 60, 11-12.
Petty, G.J. 1977. Continueing white grub damage in Eastern Cape. C.S.F.R.I. Information Bulletin 56, 10-11.
Petty, G.J. 1977. White grub rears head in Eastern Cape. C.S.F.R.I. Information Bulletin 53, 1-2.
Petty, G.J. 1978. False Spider Mite of pineapples. C.S.F.R.I. Information Bulletin 75, 8.
Petty, G.J. 1978. Mealybug infestation of pineapples (Wolluisplaag by pynappels). C.S.F.R.I. Information Bulletin 65, 3-4.
Petty, G.J. 1978. Pineapple insects and mites: pineapple mealybugs. C.S.F.R.I. Information Bulletin 74, 15-16.
Petty, G.J. 1978. Pineapple Mites. Farming in South Africa H.16, 4pp. .
Petty, G.J. 1978. Pineapple Scale Insects. Farming in South Africa H.14, 4pp.
Petty, G.J. 1978. Pineapple Thrips. Farming in South Africa H.17, 8 pp.
Petty, G.J. 1979. The marketing of pineapples in South Africa. Farming in South Africa J.1, 8 pp.
Petty, G.J. 1979. Minor pests of pineapples. Farming in South Africa H. 22, 7 pp.
Petty, G.J. 1985. The pineapple mealybug. Farming in South Africa H.15, 7pp.
Petty, G.J. 1986. New large beetle in Eastern Cape Pineapples. C.S.F.R.I. Information Bulletin 168, 10
Petty, G.J. 1986. Pineapples : Black Maize Beetle Warning. C.S.F.R.I. Information Bulletin 172, 8.
Petty, G.J. 1987. Army Worm. In “Crop pests in southern Africa, 2: Citrus and other Subtropicals, Bulletin 411” (A. C. Myberg, ed.), pp. 118 pp. Perskor for Govt. Printer.
Petty, G.J. 1987. Black Maize Beetle. In “Crop pests in southern Africa, 2 : Citrus and other Subtropicals, Bulletin 411” (A. C. Myberg, ed.), pp. 118 pp. Perskor for Govt. Printer.
Petty, G.J. 1987. Control of mealybugs and scale on pineapples by methyl bromide fumigation of planting material. Phytophylactica. 19, 255-258.
Petty, G.J. 1987. Leathery pocket mite. In “Crop pests in southern Africa, 2 : Citrus and other Subtropicals, Bulletin 411” (A. C. Myberg, ed.), pp. 118 pp. Perskor for Govt. Printer.
Petty, G.J. 1987. pH and the pineapple farmer. C.S.F.R.I. Information Bulletin 180, 12.
Petty, G.J. 1987. pH and the pineapple farmer. Citrus Journal 639, 5.
Petty, G.J. 1987. Pineapple Flat Mite. In “Crop pests in southern Africa, 2 : Citrus and other Subtropicals, Bulletin 411” (A. C. Myberg, ed.), pp. 118 pp. Perskor for Govt. Printer.
Petty, G.J. 1987. Pineapple Mealybugs. In “Crop pests in southern Africa, 2 : Citrus and other Subtropicals, Bulletin 411” (A. C. Myberg, ed.), pp. 118pp. Perskor for Govt. Printer.
Petty, G.J. 1987. Pineapple Thrips. In “Crop pests in southern Africa, 2 : Citrus and other Subtropicals, Bulletin 411” (A. C. Myberg, ed.), pp. 118pp. Perskor for Govt Printer.
Petty, G.J. 1987. Sanitised pineapple planting material a must for Hluhluwe. C.S.F.R.I. Information Bulletin 178, 5.
Petty, G.J. 1988. Methods for monitoring pineapple insects and mites. C.S.F.R.I. Information Bulletin 188, 2,4,5.
Petty, G.J. 1989. Endosulfan sprays control Black Spot and Leathery Pocket in pineapples. C.S.F.R.I. Information Bulletin 205, 10.
Petty, G.J. 1989. Penicillium a problematic pineapple pathogen. Subtropica 10, 14-16.
Petty, G.J. 1990. Black Maize Beetle in pineapples. Farming in South Africa H. 13, 2pp.
Petty, G.J. 1990. Black Spot in pineapples. Farming in South Africa H. 1, 2 pp.
Petty, G.J. 1990. The Brown House ant (Pheidole megacephala): Importance of control in pineapples. C.S.F.R.I. Information Bulletin 216, 2. .
Petty, G.J. 1990. Control of ants and mealybugs. Landbounuus / Agricultural News 47, 6-7.
Petty, G.J. 1990. Leathery Pocket in pineapples. Farming in South Africa H. 2, 2 pp.
Petty, G.J. 1990. The marketing of pineapples in South Africa. In “Farming in South Africa
J. 1”, pp. 3 pp. Department of Agricultural Development, Pretoria.
Petty, G.J. 1990. Mier wortel van pynappelprobleem. Landbouweekblad 656, 90-93.
Petty, G.J. 1990. Minor pests of pineapples. Farming in South Africa H. 18, 2 pp.
Petty, G.J. 1990. New registration of remedy for ant control. C.S.F.R.I. Information Bulletin 210, 4- 5.
Petty, G.J. 1990. The Pineapple Mealybug. Farming in South Africa H. 15, 4 pp.
Petty, G.J. 1990. Pineapple Mites. Farming in South Africa H 16, 4 pp.
Petty, G.J. 1990. Pineapple Scale. Farming in South Africa H. 14, 2 pp.
Petty, G.J. 1990. Thrips in pineapples. Farming in South Africa H. 17, 4 pp.
Petty, G.J. 1990. Use of unregistered pesticides in pineapples. C.S.F.R.I. Information Bulletin 214, 14.
Petty, G.J. 1990. White Grubs in pineapples. Farming in South Africa H. 12, 2 pp.
Petty, G.J. 1990. Yeasty Fermentation in pineapples. Farming in South Africa H. 10, 1 pp.
Petty, G.J. 1990. Yellow Spot in pineapples. Farming in South Africa H. 5, 2 pp.
Petty, G.J. 1991. One of the world's smallest insects in S.A. pineapples. C.S.F.R.I. Information Bulletin 221, 6.
Petty, G.J. 1991. Pineapple Bud Moth : A new pineapple pest at Hluhluwe. C.S.F.R.I. Information Bulletin 221, 4-5.
Petty, G.J. 1991. Pineapple spraying : Get the mix right. Farmers Weekly 81040, 32 34.
Petty, G.J. 1992. Beat pineapple black spot. Farmers Weekly 82003, 33-34.
Petty, G.J. 1992. Beroking klop witluis, rooimyt goedkoop uit. Landbouweekblad 759, 46-48.
Petty, G.J. 1992. Important problems for research and extension in the pineapple industry. I.T.S.C. Information Bulletin 237, 19-20.
Petty, G.J. 1992. Leathery pocket mite : Distribution on pineapple plants. I.T.S.C. Information Bulletin 244, 6.
Petty, G.J. 1993. Brown House Ant Control with Amdro. I.T.S.C. Information Bulletin 251, 6.

Petty, G.J. 1993. Control of nematodes and soil insect pests in Eastern Cape pineapples. I.T.S.C. Information Bulletin 252, 3.
Petty, G.J. 1993. Dimethoate-Bromacil incompatibility in pineapples. I.T.S.C. Information Bulletin 252, 4.
Petty, G.J. 1993. Interrelationship of ants, pineapple mealybugs and mealybug wilt disease. I.T.S.C. Information Bulletin 253, 4-5.
Petty, G.J. 1993. Skietgoed teen pynappelplaag. Landbouweekblad 786, 42-43.
Petty, G.J. 1993. Swaziland pineapple production. I.T.S.C. Information Bulletin 245, 9.
Petty, G.J. 1993. Use of Miral in pineapples. I.T.S.C. Information Bulletin 252, 1.
Petty, G.J. 1994. The Pineapple Mealybug. Farming in South Africa Leaflet series H. 15, 4 pp.
Petty, G.J. 1994. White grubs in pineapples : An alternative prevention strategy. I.T.S.C. Information Bulletin 265, 11-12.
Petty, G.J. 1996. Victoria pineapple in South Africa. Fruitrop 30, 4.
Petty, G.J., and E.R. Dalldorf 1990. Incompatibility of spray materials in pineapple cultivation. Farming in South Africa H. 19, 2 pp.
Petty, G.J., and B.Q. Manicom 1995. Control of the big-headed ant, Pheidole megacephala, in pineapple plantations with the proprietary bait Amdro. Fruits 50, 343-346.
Petty, G.J., and D.N.A. Murray 1996. Bathurst - a new beginning for pineapple research. I.T.S.C. Information Bulletin 287, 1-3.
Petty, G.J., and A.A. Van Der Westhuizen 1992. Fumigation of pineapple planting material with methyl bromide. C.S.F.R.I. Information Bulletin 233, 12-13.
Petty, G.J., and A.A. Van Der Westhuizen 1992. Integration of chemical remedies for the control of insect and mite pests in pineapples. Subtropica 13, 33-42.
Petty, G.J., and A.A. van der Westhuizen 1997. New soil pest control products evaluated for pineapples. Neltropika 298, 20-23.
Petty, G.J., and G.S. Webster 1981. Importance of pineapple mealybug, Dysmicoccus brevipes (Ck11) and its distribution on the pineapple plant. Subtropica 2, 7-8.
Petty, G.J., P. Willers, and G. Smart 1991. Methyl bromide fumigation of pineapple planting material. Subtropica 12, 20-24.
Pinto, da Cunha G.A. 1998. Controle da epoca de producao do abacaxizeiro (Control of time of production of pineapple). Informe Agropecuario Belo Horizonte 19, 29-32.
Pitaksa, Chamnan, Anuwat Chantarasuwan, and Auranuj Kongkanjana 2000. Ant Control in Pineapple Field. 529, 309-314.
Poudel, D.D., D.J. Midmore, and L.T. West 1999. Erosion and productivity of vegetable systems on sloping volcanic ash-derived Philippine soils. Soil Science Society of America Journal 63, 1366-1376.
Poudel, D.D., D.J. Midmore, and L.T. West 2000. Farmer participatory research to minimize soil erosion on steepland vegetable systems in the Philippines. Agriculture Ecosystems and Environment 79, 113-127.
Pouzet, D., P.F. Chabalier, and P. Legier 1997. “Diagnostic de fertilite des sols et conseils en fertilisation des principales cultures reunionnaises (Analysis of soil fertility and fertilizer recommendations for the main crops grown in Reunion),”.
Pouzet, D., P.F. Chabalier, and P. Legier 1998. “Fertilite des sols et conseil en fertilisation: Systeme expert d'interpretation des analyses chimiques des sols reunionnais (Soil fertility and advice on fertilization. Expert system of interpretation of chemical analyses of Reunion soils),”. CIRAD SAR, Montpellier; France.
Prasanta, Das, Hazarika Binita, P. Das, and B. Hazarika 1999. Effect of black polythene and rice husk mulch on chemical composition of pineapple. Journal of Applied Horticulture Lucknow 1, 125-127.
Putthacharoen, S., R.H. Howeler, S. Jantawat, and V. Vichukit 1998. Nutrient uptake and soil erosion losses in cassava and six other crops in a Psamment in eastern Thailand. Field Crops Research 57, 113-126.
Quesada, M., and R. Barboza 1999. Distribucion espacial de Helicotylenchus spp. en suelo de una plantacion de pina (Ananas comosus) en la zona norte de Costa Rica (Spatial distribution of Helicotylenchus spp. in soil of a pineapple (Ananas comosus) plantation in the northern region of Costa Rica). Agronomia Costarricense 23, 97-103.
Rabie, E.C., H.A. Tustin, and K.T. Wesson 2000. Inhibition of Natural Flowering Occurring During the Winter Months in Queen Pineapple in Kwazulu-Natal, South Africa. 529, 175-184.
Radha, T., and K.L. Chadha 1996. Effect of plant densities and nitrogen on the yield and quality of Kew pineapple. Journal of Tropical Agriculture 34, 108-111.
Radha, T., and K.L. Chadha 1997. Influence of plant densities and applied nitrogen on the production of slips and suckers in pineapple. South Indian Horticulture 45, 83-87.
Rama, K., and M.K. Dasgupta 1998. Population ecology and community structure of plant parasitic nematodes associated with ginger in West Bengal. Indian Journal of Nematology 28, 10-14.
Ramkhelawan, E., and N. Baksh 1997. Stem multiplication of Smooth Cayenne pineapple suckers and container grown fruits in Trinidad. In “Tropical Fruits Newsletter”, pp. 3-5.
Rattanapanone, Nithiya, Chansuda Chongsawat, and Soungsuda Chaiteep 2000. Fresh-cut fruits in Thailand. Hortscience 35, 543-546.
Rawal, R.D., and S.M.P. Khurana 1998. Major fungal diseases of some tropical fruits. In “Pathological problems of economic crop plants and their management”, pp. 379-414. Scientific Publishers, Jodhpur; India.
Razzaque, A.H.M., Hanafi Musa Mohamed, Abd Rahim Anuar, and Husni M.H. Ahmad 2000. Pineapple response to nitrogen application on tropical peat: I. Effect of N on plant growth, N uptake and recovery. Fruits 55, 135-140.
Rebolledo, M..A., D.E.A. Uriza, and M. L. Rebolledo 2000. Rates of Fruitone CPA in Different Applications Number During Day Versus Night to Flowering Inhibition in Pineapple. 529, 185-190.
Rebolledo, M.A., D.E.A. Uriza, and M.L. Rebolledo 2000. The Pineapple in Mexico: Current Status and Prospects. 529, 85-88.
Reinhardt, D. H., V. P. de Lima, and J. A. Costa 2000. “Desbaste de mudas tipo filhote na cultura do abacaxi (Slips thinning in pineapple crop),” Rep. No. ISSN 1516-5744. Embrapa Mandioca e Fruticultura. Comunicado Técnico,67, Cruz das Almas, BA.
Reinhardt, D.H, and J. da S . Souza 2000. Pineapple Industry and Research in Brazil. 529, 57-72.
Reinhardt, D.H., L.F. da S. Souza, and J.R.S. Cabral 2000. “Abacaxi. Produção: Aspectos técnicos (Pineapple. Production. Technical Aspects),” Embrapa Comunicação para Transferência de Tecnologia, Brasília, DF.
Reinhardt, D.H.R.C., and G.A.P. da Cunha 1999. Métodos de propagação. In “O abacaxizeiro: Cultivo, agroindústria e economia” (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 105-138. EMBRAPA-SCT, Brasília, Brazil.
Reinhardt, D.H.R.C., and G.A.P. da Cunha 1999. Plantas daninhas e seu controle. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 253-268. EMBRAPA-SCT, Brasília, Brazil.
Reinhart, A. 2000. Assessment of and potential to reduce nitrate leaching in the Pearl Harbor watershed. PhD, University of Hawaii, Honolulu.
Robbs, C.F. 2000. Sobrevivencia e disseminacao de bacterias patogenicas a plantas frutiferas no Brasil (Survival and dissemination of pathogenic bacteria of fruit plants in Brazil). Summa Phytopathologica 26, 172-174.
Rohrbach, Kenneth G. 2000. The Hawaiian Pineapple Industry. 529, 73-76.
Rohrbach, Kenneth G., David Christopher, John Hu, Robert Paull, Brent Sipes, Chifumi Nagai, Paul Moore, Mike McPherson, Howard Atkinson, Aurora Levesley, Calvin Oda, Herve Fleisch, and Mike McLean 2000. Management of a Multiple Goal Pineapple Genetic Engineering Program. 529, 111-114.
Rooyen, C.J. van, D. Esterhuizen, O.T. Doyer, C.J. van-Rooyen, and P.J.P. Zuurbier 2000. How competitive is agribusiness in the South African food commodity chain? In “Chain management in agribusiness and the food industry. Proceedings of the Fourth International Conference Wageningen, 25-26 May 2000” (J. H. Trienekens, ed.), pp. 543-551. Wageningen Pers., Wageningen; Netherlands.
Roy, P., V.M. Salokhe, and Roy Poritosh 1999. Development of a power tiller drawn pineapple plant dressing machine. AMA, Agricultural Mechanization in Asia, Africa and Latin America 30, 59-62.
Sairam, C.V., P. Gopalasundaram, D.V.S. Reddy, P. Subramanian, L. Umamaheswari, and M.R. Hegde 1999. Cash flow analysis of coconut based high density multi-species cropping system, a case study. Journal of Plantation Crops 27, 39-44.
Salokhe, V.M., and G.C. Bora 1997. Field testing of a tractor front mounted pineapple plant dressing machine. In “XXXIII Annual Convention of the Indian Society of Agricultural Engineers”, Rahuri, India.

Sampaio, A.C., T. de F. Fumis, and V.A. de N. Hernandes 1998. Acido alfanaftaleno acetico (ANA) no controle da diferenciacao floral natural do abacaxizeiro cv. Smooth Cayenne (Alphanaphthalene acetic acid (ANA) on the control of natural flowering differentiation of the pineapple plant cv. Smooth Cayenne). Revista Brasileira de Fruticultura 20, 353-358.
Sanches, N.F. 1999. Pragas e seu controle. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 307-341. EMBRAPA-SCT, Brasília, Brazil.
Sanches, N.F., and A.P. de Matos 1999. Murcha associada à chchonilha Dysmicoccus brevipes (Cockerell, 1893). In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 343-366. EMBRAPA-SCT, Brasília, Brazil.
Sanewski, G., and C. Scott 2000. The Australian Pinapple Industry. 529, 53-56.
Santos Cabral, J.R. 1999. Melhorament genético. In “O abacaxizeiro: Cultivo, agroindústria e economia” (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 83-103. EMBRAPA-SCT, Brasília, Brazil.
Sarma, R., and G. Medhi 1997. Relative efficacy of different mulches on weed control in pineapple (Ananas comosus L Merr.). Journal of the Agricultural Science Society of North East India 10, 145-149.
Selvarajah, S., and H.M.W. Herath 1997. Effect of an edible coating on some quality and physico-chemical parameters of pineapple during cold storage. Tropical Agricultural Research 9, 77-89; 18.
Selvarajah, S., H.M.W. Herath, and D.C. Bandara 1998. Physiological effects of pre heat treatment on pineapple fruit stored at low temperatures. Tropical Agricultural Research 10, 417-419.
Selvarajah, S., H.M.W. Herath, and D.C. Bandara 1999. Basal application of fused magnesium phosphate (FMP) on the incidence of post-harvest internal browning of Mauritius pineapple. Tropical Agricultural Research 11, 432-437.
Selvarajah, S., H.M.W. Herath, D.C. Bandara, and D.M.G.A. Banda 1998. Effect of pre-harvest calcium treatment on post-harvest quality of pineapple. Tropical Agricultural Research 10, 214-224.
Selvarajah, S., H.M.W. Herath, and K.K. Liyanage 1997. Effect of modified atmospheric storage on internal browning development in pineapple. Tropical Agricultural Research 9, 388-391.
Sether, D. M., and J. S. Hu 2001. The impact of pineapple mealybug wilt-associated virus and reduced irrigation on pineapple yield. Australasian Plant Pathology (inpress).
Shen, ZhaoMin, YinGuo Li, Z.M. Shen, and Y.G. Li 1998. On the status of fruit industry in the red, yellow soil areas in China and the technical strategy. South China Fruits 27, 52-53.
Silva, J.R. 1998. O adensamento como forma de aumentar a produtividade do abacaxi (Density increase as a method of augmenting pineapple productivity). Informe Agropecuario Belo Horizonte 19, 62 64.
Silva, J.R., W.V. dos Santos, and W.V. dos Santos 1998. Mecanizacao da cultura do abacaxi (Mechanization of pineapple culture). Informe Agropecuario Belo Horizonte 19, 65-66.
Silva, R.B.Q. da, A.F.S.L. de Veiga, R.B.Q. da Silva, and A.F.S.L. de Veiga 1998. Patogenicidade de Beauveria bassiana (Bals.) e Metarhizium anisopliae (Metsch.) Sorok sobre Castnia icarus (Cramer, 1775) (Pathogenicity of Beauveria bassiana (Bals.) and Metarhizium anisopliae (Metsch.) Sorok on Castnia icarus (Cramer, 1775)). Revista de Agricultura Piracicaba 73, 119-128.
Singh, D.B., and B.L. Attri 1999. Standardization of flower induction time in pineapple var. 'Kew'. Horticultural Journal 12, 27-31.
Singh, D.B., Singh Vijai, and A.K. Bandyopadhyay 1998. Effect of planting time and size of sucker on year round pineapple production. Journal of the Andaman Science Association 14, 7-15.
Sipes, B. S., and D. P. Schmitt 2000. Rotylenchulus reniformis Damage Thresholds on Pineapple. 529, 239-245.
Sison, Chesed M. 2000. Sulfentrazone for Preplant Weed Control in Pineapple. 529, 303-307.
Smith, B.G., P.J. Harris, L.D. Melton, and R.H. Newman 1998. The range of mobility of the non cellulosic polysaccharides is similar in primary cell walls with different polysaccharide compositions. Physiologia Plantarum 103, 233 246.
Sornsrivichai, J., J. Yantarasri, and K. Kalayanamitra 2000. Nondestructive Techniques for Quality Evaluation of Pineapple Fruits. 529, 337-341.
Souto, R.F., O.A. de Almeida, L.F. da S. Souza, R.C. Caldas, and F.H. de S. Faria 1998. Niveis de umidade do solo e de adubacao para o abacaxizeiro 'Perola' no norte de Minas Gerais (Soil humidity and fertilizer levels for 'Perola' pineapple in the north of Minas Gerais state). Revista Brasileira de Fruticultura 20, 332-342.
Souza, J. da S., C.E.L. Cardoso, and P.T. Filho 1999. Situação da cultura no mundo e no Brasil e importância econômica. In “O abacaxizeiro: Cultivo, agroindústria e economia” (G. A. P. d. Cunha, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 403-428. EMBRAPA-SCT, Brasília, Brazil.
Souza, L.F. da S. 1999. Correção de acidez e adubação. In “O abacaxizeiro: Cultivo, agroindústria e economia” (d. C. G. A. Pinto, J. R. Santos Cabral and L. F. d. S. Souza, eds.), pp. 169-202. EMBRAPA-SCT, Brasília, Brazil.
Srihari, .K, and A.K. Chakravarthy 1998. Ecological approaches for the management of vertebrate pests in western ghats region of Karnataka. Indian Journal of Ecology 25, 55-61.
Sulaiman, S.F.M. 2000. Effect of Pesticidal Pre-treatments of Pineapple Plants on the Incidence of the Mealybug Wilt Disease. 529, 273-288.
Sulaiman, S.F.M. 2000. Implications of the Use of Excess Coir Dust Mulch in Pineapple Cultivation on the Mealybug Wilt Disease of Pineapple. 529, 221-235.
Sulaiman, S.F.M. 2000. Pineapple Production and Research in Sri Lanka. 529, 89-92.
Sundararaju, P., Banu Gulsar, K. Ratnakaran, and G. Banu 1999. Effect of various plant extracts on mortality of Radopholus similis. Indian Journal of Nematology 29, 99-101.
Suwanarak, Kleopan, Sermsiri Kongsaengdao, and Sasithorn. Vasunun 2000. Efficiency of Pre-planting Herbicides on Weed Control and Growth of No-Tillage Pineapple (Ananas comosus L.). 529, 293-301.
Talandier, M. 1999. Les achats de fruits en hiver et au printemps 1999 (Fruit purchases in winter and spring 1999). In “Infos Paris”, pp. 24-28.
Tanaka, Maria A. de S., A. Spironello, Walter J. Siqueira, Filho Jose A. Usberti, Sobrinho Joaquim Teofilo, and N. Bortoletto 2000. A survey of fusariosis on pineapple germplasm of the Instituto Agronomico de Campinas. Summa Phytopathologica 26, 271-275.
Tapia, Hernandez A., Cristales M.R. Bustillos, Salgado T. Jimenez, Mellado J. Caballero, and Ramirez L.E. Fuentes 2000. Natural endophytic occurrence of Acetobacter diazotrophicus in pineapple plants. Microbial Ecology 39, 49-55.
Tapia, R., R. Santos, M. Quincose, L.M. Pena, O. Borras, B. Companioni, M.A. Blanco, and J.L. Gonzalez 1998. Estandarizacion del proceso para la obtencion de metabolitos de Fusarium subglutinans y su efecto en callos de pina (Standardization of the process for obtaining Fusarium subglutinans metabolites and its effect on pineapple calluses). Cultivos Tropicales 19, 51-55.
Taylor, M., and P. Thorpe 1999. Micropropagation of agricultural crops. In “Proceedings of the Regional Tissue Culture Workshop, Apia, Samoa, 5 13 June 1997. PRAP Report Pacific Regional Agricultural Programme” (M. B. Taylor and I. Powaseu, eds.), pp. 37-42.
Teisson, C., and D.. Alvard 1995. A New Concept of plant in vitro Cultivation Liquid Medium: Temporary Immersion. In “Current Issues in Plant Molecular and Cellular Biology” (M. Terzi and e. al., eds.), pp. 105-110. Kluwer Academic Publishers.
Thamsurakul, S., O. Nopamornbodi, S. Charoensook, and S. Roenrungroeng 2000. Increasing Pineapple Yield by Using VA Mycorrhizal Fungi. 529, 199-202.
Ti, T.C. 2000. The Global Pineapple Economy. 529, 49-50.
Triratanasirichai, K., S. Wongpichet, V.M. Salokhe, Triratanasirichai Kittichai, e Wongpichet Sere, and Z. Jianxia 1998. Design and development of a pineapple planter. In “Proceedings of the International Agricultural Engineering Conference, Bangkok, Thailand, December 7 10, 1998” (V. M. Salokhe, ed.), pp. 233-245. Asian Institute of Technology, Bangkok; Thailand.
Turnbull, C.G.N., E.R. Sinclair, K.L. Anderson, R.J. Nissen, A.J. Shorter, and T.E. Lanham 1999. Routes of ethephon uptake in pineapple (Ananas comosus) and reasons for failure of flower induction. Journal of Plant Growth Regulation 18, 145-152.
Vargas, H., W.O. Martinez, and R.G. Corchuelo 1998. Reguladores de crecimiento y sustratos naturales para la aclimatacion de vitro plantulas de pina Ananas comosus (L.) Merr. (Growth regulators and natural substrates for acclimatization of pineapple vitro plants Ananas comosus (L.) Merr.). Agronomia Colombiana 15, 163-171.
WanCheng, Liao 1997. A manual on the prevention of damage to fruit trees by extreme environmental conditions. In “Special Publication Taichung District Agricultural Improvement Station”, pp. 162pp., Tatsuen; Taiwan.

Wang, K. H., and B. S. Sipes 2000. Suppression of Renifrom Nematode, Rotylenchulus reniformis on Pineapple With Tropical Cover Crops. 529, 247-260.
Winter, H.L. 1990. On the Pharmacology of Bromelain: An Update with Special Regard to Animal Studies on Dose-Dependent Effects. Planta Med 56, 249-253.
Wongpichet, S., V.M. Salokhe, K. Triratanasirichai, and Z. Jianxia 1998. The ergonomic study for designing of pineapple transplanter. In "Proceedings of the International Agricultural Engineering Conference, Bangkok, Thailand, December 7 10, 1998" (V. M. Salokhe, ed.), pp. 44-52. Asian Institute of Technology, Bangkok; Thailand.
Yahia, E.M. 1998. Modified and controlled atmospheres for tropical fruits. Horticultural Reviews 22, 123-183.
Yang, RongYang, Chang Zhou, R.Y. Yang, and C. Zhou 1998. Study on the control of pineapple heart rot disease by sunning the propagation materials. South China Fruits 27, 35.
Yu, B., C.A.A. Ciesiolka, C.W. Rose, and K.J. Coughlan 2000. A validation test of WEPP to predict runoff and soil loss from a pineapple farm on a sandy soil in subtropical Queensland, Australia. Australian Journal of Soil Research 38, 537-554.
Zhuang, Hong, M.M. Barth, D.F. Hildebrand, H. Zhuang, and D.B. Min 1998. Fatty acid oxidation in plant tissues. In "Food lipids: chemistry, nutrition, and biotechnology. Food Science and Technology Series 88" (C. C. Akoh, ed.), pp. 333-375. Marcel Dekker Inc., New York; USA.◆

Directory of Professionals

This listing is maintained as a convenience for those seeking the assistance of professionals with experience in pineapple production and processing. If you have such expertise and wish to have your name listed here in a future issue, please send your name, address, Email address, and a brief resume to D.P. Bartholomew (duaneb@hawaii.edu).

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