Pineapple News

Newsletter of the Workgroup Pineapple, International Society for Horticultural Science
Issue No. 24, July, 2017

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Pineapple Working Group News

From the Editor:

Help with Pineapple News

I am very pleased to welcome Dr. Chesed Sison, formerly Research Manager, Del Monte Philippines (DMPI), to the Pineapple News production team of two. Chesed spent almost her entire professional career with DMPI and recently retired after 30 years with the company. A few months ago Chesed wrote that although retired she wanted to continue to remain engaged with the scientific community and asked if she could help with the production of Pineapple News in her spare time. I am delighted with her offer of help and hope she will help to keep Pineapple News going into the future.

New's about IX International Pineapple Symposium (IX IPS)

It has been the policy of the ISHS Workgroup Pineapple to hold each symposium in different regions of the world where pineapples are grown. It was agreed at the Workgroup Pineapple meeting during VIII IPS to return to the Americas for the next symposium. Costa Rica was the first choice of the Workgroup and EARTH University initially agreed to host IX IPS. However, their plan was blocked by the country's banana industry because of concerns that participants from areas where *Fusarium oxysporum* f. var. cubense, also known as Tropical Race 4 or TR4 (http://www.promusa.org/Tropical+race+4+-+TR4) is known to occur might carry the disease to the country. Colombia, which has a relatively small but growing pineapple industry, was asked if they would be able to host IX IPS and their banana industry, which is more than twice the size of the pineapple industry, also opposed hosting of the symposium in the country. It was late in 2016 when the Workgroup agreed to ask Cuban researchers if they would be able to host IX IPS. By now all on the Pineapple News mailing list will know that Cuba has agreed to host IX International Pineapple Symposium in Havana, Cuba from October 15 to 19, 2017. Thanks are due to the organizing group in Cuba for taking on this organizational task on such short notice. Best wishes to all for a successful IX International Pineapple Symposium in Havana.

Download digital editions of the books by Py et al., 1984 and 1987

The following books by Py, C., Lacoeuilhe, J.J., and Teisson, C. are now available as digital editions.
Py, C., Lacoeuilhe, J.J. & Teisson, C. (1984) L'Ananas Sa Culture, Ses Proudits, Paris, Editions G.-P. Maisonneuv, and Py, C., Lacoeuilhe, J.J. & Teisson, C. (1987) The pineapple. Cultivation and uses, Paris, Editions G.-P. Maisonneuve.

Copies of both books are available at https://evols.library.manoa.hawaii.edu/handle/10524/55419.

A special thanks for this effort goes to Prof. Robert Paull and the University of Hawaii's Hamilton Library which did the scanning and optical character recognition. According to Prof. Paull, the publisher went out of business so the copyright reverted to the authors. Special thanks also goes to Dr. Claude Teisson, now retired, the only author still living, who agreed to give up his copyright so the books could be digitized.

This book is a wonderful resource for pineapple researchers and growers because it was painstakingly researched and contains details not found in any other publication on pineapple. Another great benefit is that the entire text can be searched by computer making details difficult to fine in the index easily accessible.

Pineapple News archives

All back copies of Pineapple News can be found at the two links below.
http://www.ishs.org/pineapple/pineapple-newsletters
https://scholarspace.manoa.hawaii.edu/handle/10125/41067

A searchable table of contents of all issues of Pineapple News can be viewed at the link below. The author and title index is in a publicly available google sheets spreadsheet, which also provides a direct link to the Pineapple News issue of interest.

https://docs.google.com/spreadsheets/d/1ePrvbOxZK_fAetf5dDG9KSJ-iI3TGbWEuVPqNWSIC1k/edit#gid=1754861927

Pineapple cultivar listing by country. Additions and corrections welcomed.
https://docs.google.com/spreadsheets/d/1NDr9v3FSZLP8W3m9rYhScErrxed8vEc7f8meDyLXEmg/edit?usp=sharing

The above google spreadsheet provides a searchable cultivar list that is alphabetized by country and by cultivars within each country where the various cultivars are found. The list also includes any colloquial name used in the country, other relevant comments and the first published mention found of the cultivar in each country.

In addition to documenting the presence of cultivars within a country, the list can used to identify the pineapple cultivar in papers that often only cite the colloquial (local) name of the cultivar. Some colloquial names, Sugarloaf and Sugar loaf being examples, are used to name more than one cultivar, which makes papers on the cultivar relatively inaccessible. It is hoped that the list will help expand access of researchers to published research on the cultivars grown in various countries and encourage researchers to link there research publications to the body of literature on a given cultivar by identifying the colloquial and cultivar name in their papers.

News from Australia

The Effect of Cations on Natural Flower Initiation in Pineapple

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Abstract

The effect of the cations calcium, potassium, magnesium and boron on the incidence of natural flower initiation in the cultivar CO-2 were tested in sub-tropical Australia. Applications of magnesium + potassium reduced NI from 7% in the control treatment to 3%. A change in leaf nutrient levels was not demonstrated. The significance of the NI response to treatments was considered marginal and further work is needed to make conclusive recommendations.

INTRODUCTION

In Australia, natural flower initiation (NI) is a significant industry problem in the fresh market pineapple cultivars MD-2 and CO-2 (73-50). NI results in disruptions to production schedules and substantial loss of yield.

Pineapple is classified as a quantitative, short-day plant and flower initiation can occur when days are short and temperatures low (Friend and Lydon, 1979; Py et al, 1987; Bartholomew and Malezieux, 1994). In Australia, it usually occurs in May to June. To date there has been no universally satisfactory means of preventing NI.

Shortening days and low temperatures are thought to give rise to increased ethylene production in the basal white leaf tissue and stem apex of pineapple plants which in turn stimulates flowering (Van-Overbeek and Cruzado, 1948; Friend, 1981; Millar-Watt, 1981; Min & Bartholomew, 1993). Exogenous application of ethylene, auxins or compounds that generate ethylene have long been used to initiate flowering in pineapple (Py et al, 1987; Turnbull et al, 1993). It is expected if endogenous ethylene production that is associated with NI can be prevented, then NI will also be prevented. Most efforts have concentrated on testing the efficacy of various chemicals. Studies in Australia (Scott, 1993), Hawaii (Min and Bartholomew, 1996), Mexico (Rebolledo et al, 1998) and South Africa (Rabie et al, 1998) indicate the synthetic auxin 2(3-cholophenoxy) propionic acid (CPA) can inhibit NI to a substantial degree. It must however be applied several times during the period when NI is expected (Min and Bartholomew, 1996) and is expensive. Likewise studies on aviglycine (AVG or ReTain®), a known inhibitor of ACC synthase, can prevent NI (Kuan et al, 2005; Rabie et al, 2011; Tsai and Kuan, 2013; Venburg et al, 2008; Wang et al, 2007; Bartholomew et al, 2011) but is expensive, especially when considering the best time for application is not known with accuracy.

There are no published reports of studies specifically examining the effect of nutrient levels on NI in pineapple but there are reported associations which include low nitrogen reduces NI (Page, 1968) and low potassium reduces NI (Jorgensen, 1969) and high potassium reduces NI (Sanford et al, 1961). Work in other crops suggests a link between ethylene production and calcium. Calcium has been demonstrated to improve shelf-life of many fruits and it is thought this is primarily through improved cell wall cohesion and reduced ethylene production (Aghdam et al., 2012). Calcium has been shown to reduce ethylene production in papaya (Babak et al., 2014), apple (Kittemann et al., 2010) and muskmelon fruit (LuShuangShuang et al., 2009). Quality of stored peach has been improved by postharvest treatment with calcium (Manganaris et al., 2007). Field sprays of calcium compounds were shown to improve the structural integrity of the middle lamella of persimmon fruit (Moon et al., 2002). Similarly, pre-harvest field sprays of calcium to apple improved cell-to-cell adhesion as indicated by better preservation of the middle lamella and higher contents of bound pectins (Ortiz et al., 2011). Further work with apple demonstrated correlations between post-harvest calcium application, reduced pectin degradation and greater fruit firmness (Ortiz et al., 2012).

Calcium relies on the movement of water through the plant for uptake and distribution. Experiments by many researchers using several plant species have shown calcium only moves in the xylem (Peterburgskii and Sidorova, 1955; Bell, 1963; Sakaguchi, 1964; Zavalloni et al, 2001). Calcium is mainly absorbed by root tips as it cannot move across the Casparian strip formed in the endodermis immediately behind the root tip (McConigle and Grant, 2015). Good uptake will therefore require a healthy root system. It is not absorbed through the leaf to much extent (Norton and Wittwer, 1963). Where responses to calcium sprays are seen, as in apples, this is thought to be variety dependent and associated with fruit cuticular and epidermal cracks. Trials in pineapple (Sanford, 1959) have shown leaf calcium levels are not increased much by foliar sprays. Calcium mobility in the plant, including pineapple, is very limited, usually only moving upwards with xylem flow. Tissues that do not receive a steady water stream receive less calcium. Bromeliaceae are however known to absorb water and some nutrients through the leaf bases, trichome stalks and aerial roots. This ability is more developed in extremely xerophytic relatives of pineapple, the Tillandsias (Benzing and Burt, 1970). Tillandsia, which do not possess highly developed roots, are known to absorb high amounts of calcium through the leaf blade but other species of Bromeliads less so (Benzing et al, 1976). Specific studies in pineapple have shown calcium and potassium in particular are not absorbed much through these mechanisms (Sanford, 1959; Page, 1971.). Transpiration (evaporation through the plant) is needed to maintain water, and hence calcium, uptake. High humidity, cold and cloudy weather might result in low transpiration and low calcium. Most transpiration is from exposed leaf surfaces. Plant tissues such as fruit that usually have a low transpiration rate are more likely to experience low calcium. Calcium movement into fruit is very dependent on that cultivar's ability to maintain functionality of xylem vessels. The concentration of calcium in phloem sap is usually extremely low. Rapidly growing plant tissues with a low transpiration rate, such as shaded tissues (unfolded leaves, growing points) will suffer calcium deficiency first. Very high temperature and high sunshine can also cause reduced calcium over time if the plant experiences wilting (Olle et al, 2009). Calcium deficiency in plants usually results in the collapse of cell walls in subapical cells (Ozgen et al., 2011).

Even where high rates of root absorption of calcium and transpiration exist, the level of available calcium in the xylem flow can be reduced through binding to xylem vessel walls and complexing with organic acids such as oxalic, citric and malate acids (Kumar et al, 2015). Oxalates in particular are a known binding agent of calcium but the level of oxalates in pineapple is low (Clark, 1939).

Calcium is best applied to the soil although responses to fruit sprays have been recorded for pineapple (Sanford et al, 1961). As in apples, it is likely entry into the fruit is via lenticels or small cracks in the fruit epidermis.

Other soil cations such as potassium can reduce calcium uptake by pineapple (Watson, 1970; Sideris and Young, 1945; Sanford et al, 1961). In general, potassium uptake from the soil is not restricted to root tips and it is more readily redistributed throughout the plant than calcium (Karley and White, 2009). Ammonia fertilisers such as sulphate of ammonia, a competing cation, will also suppress calcium uptake by pineapple (Sideris and Young, 1945).

Pineapple has a low transpiration rate (Joshi et al., 1965) with most transpiration probably occurs at night although this is very dependent on relative day and night temperatures (Ekern, 1965, Yoder, 1969). There are no studies examining the significance of root pressure (and hence daytime movement of water) in pineapple varieties.

Calcium application has been associated with reduced translucency and blackheart severity in pineapple (Sideris and Young, 1954; Paull and Chen, 2015; Silva et al, 2006; Uthairatanakii et al, 2015). Both disorders are expected to be associated with dysfunctional cell membranes or cell walls (Paull and Chen, 2015, Youryon and Wongs-Aree, 2015, Youryon et al., 2013). Application of potassium has been associated with increased translucency in pineapple (Pengrin et al., 2014) suggesting antagonism with calcium utilisation. Many pineapple soils in the main southern growing district of Queensland, Australia are acidic and generally lacking in potassium, calcium and magnesium but high in sodium. The imperative to maintain a low pH in pineapple soils for Phytophthora control means liming with calcium has not been a regular practice. Consequently, basal D-leaf calcium levels are often very low in pineapple. In addition, leaf calcium levels usually decline as winter approaches at/or near differentiation, particularly if there is a high K level (Sanford, 1959). The pineapple hybrid CO-2 absorbs more potassium from the soil than Smooth Cayenne. The ability to absorb and accumulate 'luxury amounts' of some nutrients is often a feature of plants adapted to low nutrient environments (Benzing, 1973). It is unclear if this is the case with pineapple cultivars like CO-2 or if it has a higher requirement. It is also unclear what effect a higher K level (luxury level) in this cultivar has on the level of other cations including calcium.

It was hypothesised by the authors that a low calcium level in the growing point of pineapple as it enters winter might make the plant more prone to NI through membrane dysfunction and higher endogenous ethylene. A preliminary trial was therefore established to examine the effect of cations, in particular calcium, on NI in CO-2.

MATERIALS AND METHOD

A trial was imposed on a commercial field of CO-2 on 13 January, 2015. The field had already been planted in June, 2014 at a plant density of approximately 55,250 plants/ha. The trial design was a Latin square with eight replications of eight treatments (Table 1).

Table 1. Treatment compounds and concentrations.

Compound	Company	Active concentration	Application concentration
Magnesium Sulphate		10% magnesium	1 g/L
Potassium Sulphate		42% potassium	10 g/L
Magnesium Sulphate + Potassium Sulphate		10% magnesium + 42% potassium	1 g/L + 10 g/L
Optical Ag ®	Agrichem	Calcium acetate with 6% calcium	10 mL/L
Optical Ag ® + Solubor		Solubor contains 22% boron.	10 mL/L + [1 g/L or 0.5 g/L].
Optical Ag + Verde Cal G ®	Verde Cal G - www.aquaaid.com	Verde Cal G is "advanced activated gypsum" with 22% calcium.	10 mL/L + soil application at 5 kg/ 100 m^2. (450 g/ plot).
Cal-Tech ®	http://www.growthproducts	13.4 % Calcium glucoheptonate (chelated calcium nitrate). Contains 9% calcium and 6% nitrogen.	10 mL/L
Water (ambient temp)		0	

All treatments except Verde Cal G ® were foliar applications at a rate equivalent to 4,000 L/ha (3.6 L/plot). Seven foliar applications were made from 12 February to 21 April, 2015 at approximately 1-2 week intervals. The first two applications of Solubor were at the 1 g/L rate and the other five applications were at 0.5 g/L. Three soil application of Verde Cal G ® granules were applied, one each in January, February and March. The field was also fertilised by the grower using an overhead boom-spray as per the standard agronomic practices.

A soil sample, the D leaves of 40 plants and the apices of 10 plants were collected from plants in the same field but immediately adjacent to the trial on 28 January, before any treatments were applied. The length, weight and area of the D leaves were recorded before the basal white tissue of 10 leaves were removed, washed and dried at 60 ^oC for nutrient analysis. The plant apices were also dried for analysis and it was assumed these analyses (Table 2) are representative of the entire field. The leaves had a mean fresh weight of 35 g, a length of 69 cm and an area of 266 cm^2.

The D leaves from five plants in each plot were collected on 28 April, 2015 after treatment applications were completed. Data included D leaf weight and length was collected on all leaves before the plot treatment samples were bulked to give one sample for each treatment for nutrient analysis. Leaf data is shown in table 3 and leaf nutrient analyses in table 4.

The number of plants that flowered was counted for each plot on 1 Sept, 2015. The field was treated with ethephon some time after NI counts were made. The mean number of plants that flowered (NI) in each treatment is shown in table 5.

Table 2. Leaf base and stem apex nutrient levels on a dry weight basis (10 leaves bulked for analyses) of 6 month old plants of the variety CO-2 before treatments were applied.

Nutrient	D Leaf base	Stem Apex
N%	1.3	3.5
P%	0.19	0.38
K%	6.43	5.38
Ca%	0.08	1.36
Mg%	0.19	1.34
Na%	0.01	0.03
S%	0.17	2.2
Zn ppm	56	240
Fe ppm	450	130
Cu ppm	43	11
Mn ppm	33	190
B ppm	12	14
Mo ppm	0.10	0.11

RESULTS AND DISCUSSION

While the leaf nutrient analysis data were insufficient for statistical analysis, there were few obvious trends (Table 3). There were no differences between treatments in their effect on D leaf major nutrient levels. D leaf Ca appeared to be very low and all nutrient levels were mostly unaltered compared to pre-trial levels. Basal D leaf levels of the major cations magnesium, potassium and calcium appeared unaffected by treatments. The leaf analysis conducted before the commencement of the trial indicated large differences between leaf and apices levels of some elements particularly calcium, magnesium, sulphur, manganese and zinc, with the apex being much higher, particularly calcium and sulphur. Potassium appeared to be at a similar level in the D leaf and growing point. Calcium in particular is well known to be higher (2-6 times) in the stem compared to the leaf suggesting a low rate of translocation from the apex to the leaf (Sideris and Young, 1945). Sideris et al (1943) indicated most calcium in pineapple plants was located in the stele and apex of the stem but is depleted with flowering. They reasoned that calcium moves only slowly through the meristematic tissues because these tissues, which include the stem apex and new leaf bases, lack well-formed tracheids.

Table 3. Basal D leaf nutrient levels (dry weight basis) after seven treatment applications. Data are based on the bulked basal white tissue from 40 D leaves.

Element	Optimum	MgSO4	K2SO4	Mg+K	Ca	Ca+B	Ca+Verde	Cal-Tech	Water
N%	-	1.4	1.4	1.4	1.4	1.3	1.3	1.4	1.3
P%	0.14-0.35	0.18	0.18	0.19	0.19	0.18	0.17	0.17	0.18
K%	4.3-6.4	5.27	5.19	5.33	5.4	4.99	4.96	4.76	4.91
Ca%	0.22-0.4	0.08	0.09	0.08	0.08	0.07	0.09	0.09	0.08
Mg%	0.41-0.57	0.17	0.18	0.17	0.17	0.16	0.15	0.15	0.16
Na%	0.004-0.015	0.01	0.01	<0.01	<0.01	<0.01	0.01	<0.01	0.01
S%	-	0.30	0.30	0.31	0.32	0.30	0.29	0.28	0.28
Zn ppm	15-70	12	5.5	9.8	3.9	5.4	6.1	3.5	9.4
Fe ppm	80-150	140	120	100	100	81	92	96	190
Cu ppm	10-50	6.1	5.7	6.0	5.5	4.9	5.3	5.0	7
Mn ppm	150-400	23	23	21	24	19	22	20	19
B ppm	-	11	14	10	9.8	9.5	10	19	10
Mo ppm	-	<0.01	0.01	0.05	<0.01	0.15	0.14	<0.01	0.05

From table 3, pre-trial and post-trial (control) levels of Ca, Mg, Zn, Cu and Mn appeared low but in most cases not low enough to be associated with deficiency symptoms. No deficiency symptoms were observed in any plants. Sanford et al. (1961) indicates deficiency levels of Ca <0.003%; Mg < 0.009%; Zn < 4ppm in the stem apex; and Mn 0.006%. In their study the stem apex was found to be the only reliable indicator of zinc levels.

It is unclear from the data collected in our study if a change in plant uptake of cations was achieved despite application of nutrients over an extended period. It appears in our study that the leaves were not a strong sink during this period or the applications were insufficient. It is possible that a change in stem apex levels might have been achieved without a change in D leaf levels, particularly if little development of new D leaves had occurred over the treatment period.

The plot data for the number of plants that flowered and D leaf data are shown in Table 4. The flowering data were transformed to % then arcsin. Both the transformed and normal data are shown. From table 4, magnesium + potassium produced less NI than the control, magnesium and Optical® + boron. Magnesium produced more NI than Optical®, magnesium + potassium, potassium and Cal Tech®.

From the D leaf data in table 4, magnesium and magnesium + potassium produced very slightly larger leaves than the control (water) and Optical® + boron. Optical® + boron produced slightly smaller leaves than magnesium + potassium, magnesium, potassium, Optical® and Optical® + Verde Cal G®. The differences were not large. It is possible that magnesium alone had a very slight beneficial effect on plant growth. It is also likely that the boron in the Optical® + boron treatment had a negative effect on growth.

While the plants appeared healthy, the low levels of some nutrients may have affected the incidence of NI and the treatment response. The treatment effects on NI were relatively small. Calcium products had no effect. Magnesium and potassium had no effect on their own.

It appears from this study that cation levels, in this case magnesium + potassium, might reduce the incidence of NI although the effect might not be great. The relationship in this trial was not high and was complicated by the failure of treatment applications to alter leaf nutrient levels. The work does indicate further work is necessary to investigate the effect of cation levels with a greater emphasis on soil application and analysis of the growing point rather than the D leaf. Applications of calcium both to the plant and soil did not influence NI despite the plants showing a very low leaf calcium level. It is likely from this work that calcium does not influence NI to any substantial extent but further work is needed on potassium and magnesium.

Table 4. Treatment means for incidence of NI in 50 plants and D leaf length.

Treatment	NI (Arcsin %)	% NI plants	Mean D leaf length (cm)
Cal Tech®	11.48 ^{cd}	4	82.5 ^{ab}
Potassium	11.37 ^{cd}	4	83.7 ^{bc}
Magnesium	17.28 ^{a}	9	86.3 ^{cd}
Magnesium + Potassium	9.96 ^{d}	3	87.0 ^{d}
Optical®	11.90 ^{bcd}	4	83.7 ^{bc}
Optical®+ boron	16.98 ^{ab}	9	79.4 ^{a}
Optical® + Verde Cal®	13.79 ^{abcd}	6	82.7 ^{b}
Water	15.34 ^{abc}	7	81.4 ^{ab}
l.s.d	5.18		3.2

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News from Brazil

Evaluation of bait for integrated pest management (IPM) of ants associated with mealybugs and mealybug wilt disease of pineapple in Espírito Santo, Brazil, 2016-2017

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Keywords: *Dysmicoccus brevipes* (Hemiptera: Pseudococcidae), abamectin, Formicidae

Abstract

Research is being conducted in Espírito Santo, Brazil to evaluate the use of bait containing abamectin for control of ants associated with mealybugs that infest pineapple to reduce mealybug populations and mealybug wilt disease of pineapple. Results indicate that granular bait containing abamectin (0.01%) may be useful for control of ants in pineapple fields.

INTRODUCTION

As a vector of pineapple mealybug wilt-associated virus (PMWaV) and co-factor in development of mealybug wilt disease, the pineapple mealybug (*Dysmicoccus brevipes*) is a major pest of pineapple throughout the world. Research in various regions indicates that use of baits containing insecticides to control of ants symbiotically associated with mealybug pests in pineapple and other crops may be effective in reducing ant and associated mealybug pest populations (Taniguchi et al., 2005; Daane et al., 2008). Based on initial tests of several bait treatments in pineapple and other crops in Espírito Santo, Brazil, we concluded that further evaluation of bait containing abamectin for management of ants in such crops is warranted (Culik et al. 2016). Therefore, we are currently conducting experiments to evaluate effects of bait containing abamectin for control of ants and associated mealybugs on pineapple and several other crops in Espírito Santo as part of continued development of integrated pest management (IPM) in this region, and report initial experimental results here.

MATERIALS AND METHODS

Ongoing experiments (November 2016 – April 2017)

Experiments to evaluate the effectiveness of a bait containing the insecticide abamectin for control of ants in pineapple fields and other crops (coffee and cocoa) are being conducted at the Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural (Incaper) Experiment Farm in Sooretama, and in Linhares, Espírito Santo.

The pineapple study site consists of an established field being used for production of planting material. The experiment has a randomized complete block design with three replications consisting of 10 X 10 m plots separated by 15 m. Each block contained one treated plot with bait, and one untreated, control plot without bait (experiments in coffee and cocoa have a similar design and methods). A granular bait for the experiments was prepared with the active ingredient (AI) abamectin (0.01%). At the start of the test, bait (35 g) containing the AI was placed in a bait station (Perimeter Patrol) located at the base of one plant located at each corner of the treated experimental plots. Additional bait (35 g) was added after 2 weeks, and in January, March, and April for experiments in pineapple and coffee, and February, March, and April for the experiment in cocoa.

.To evaluate the effects of the bait on ants, ant activity was monitored at the start of the experiment (pre-treatment), 2 weeks following the initial bait application, and at 4 week intervals thereafter, as follows: two open 50 ml plastic centrifuge tubes with untreated bait (5 ml) were placed in each plot and after approximately 1.5 hour the tubes, with ants attracted to the bait inside, were closed and collected for transport to the laboratory for examination. The ants captured in the tubes were subsequently counted and preserved for identification and reference. Because the ant activity data was not normally distributed a Box-Cox transformation was applied to the data for each crop and ANOVA was conducted using Assistat (Silva and Azevedo 2016).

RESULTS AND DISCUSSION

The mean number of ants was significantly lower in abamectin treated plots compared to untreated controls in the pineapple (2.6 vs. 29.7) and in coffee (0.4 vs. 20.1) (Tukey's HSD, ***P***<0.05). Similar results were observed in cocoa but the difference was not statistically significant. Because this research is ongoing results are limited at present. However, based on our initial observations abamectin appears to be effective in reducing ant populations in pineapple and coffee compared to the control with no bait treatment (Figure 1).

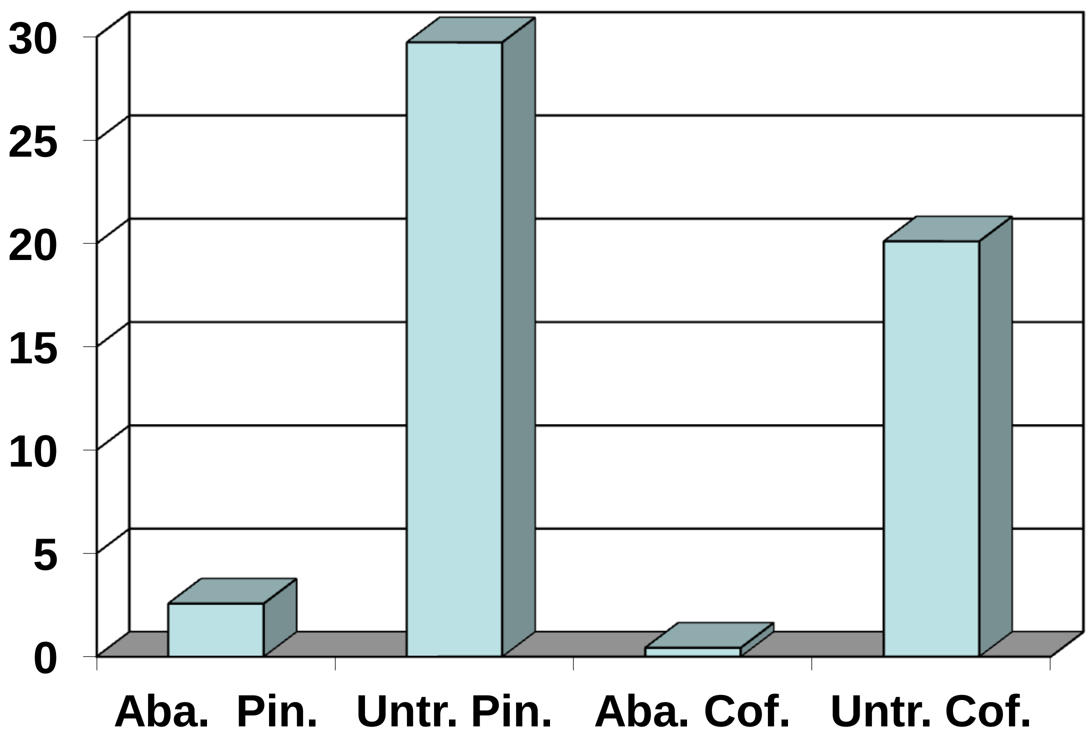

Figure 1. Effect of bait treatment containing abamectin (Aba.) on ants (y-axis = mean number of ants/monitoring tube, 2, 6, 10, 14 and 20 weeks after initial bait application, n = 30) compared to untreated control (Untr.) in pineapple (Pin.) and coffee (Cof.) fields, Espírito Santo Brazil (Experiment 1, Nov 2016- Apr 2017).

CONCLUSIONS

Preliminary results indicate that 0.01% abamectin granular bait application at approximately monthly intervals and 10 m between baits was effective in reducing ant activity in pineapple and coffee crops tested. This experiment is ongoing until May 2017 and similar studies will be conducted during the 2017-2018 crop season to verify these initial results and evaluate effects of the bait treatment on other factors such as ant and mealybug infestation levels on plants and natural enemy activity.

ACKNOWLEDGEMENTS

This research is supported by the Fundação de Amparo à Pesquisa e Inovação do Espírito Santo (Fapes), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), and the Instituto Capixaba de Pesquisa, Assistência Técnica e Extensão Rural Incaper). We thank T. Barreto, Syngenta, for providing an AI sample, A. Gwara, B&G Equipment Company, for bait stations for testing, and C. A. S. Souza, Comissão Executiva do Plano da Lavoura Cacaueira (Ceplac), for enabling our research at the Ceplac Filogônio Peixoto Experiment Station, Linhares. We also thank G. Taniguchi and K. Daane for information and reprints concerning research on use of baits for ant control and pineapple pest management, and Clair Barbosa for excellent help in the field.

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Inhibition of Natural Flowering of Pineapple with the Use of 1-MCP

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Poster presented at the 12th International Symposium on Plant Bioregulators in Fruit Production. Orlando, Florida, USA 28 July – August 1, 2013.

INTRODUCTION

Brazil is the second tartest producer of pineapple (*Ananas comosus* var. *Comosus*), with a planted area of 62,481 hectares and production of 2.3 million tons. Natural flowering of pineapple is a complex process that depends primarily on the physiological and nutritional state of the plant and the day length and temperature, with short days and a minimum range of temperature between day and night required to induce natural flowering. The problem presents several drawbacks affecting the management of the crop and the harvesting and marketing of fruits and can cause great losses.

OBJECTIVES

The aim of the study was to determine the effect of 1-methylcyclopropene (1-MCP), which blocks ethylene active sites, on natural flowering of pineapple.

MATERIALS AND METHODS

The experiment was conducted in a randomized block design with four replications and a split-plot, with five 1-MCP treatments in the plot and three pineapple cultivars ('Pérola', 'IAC Fántastico' and 'Vitória') as subplots. The 1-MCP treatments were: control (cont); 37.5 mg L^{-1} with eight weekly applications (37.5-8); 75 mg L^{-1} with four applications every 14 days and eight weekly applications (75-4; 75-8); 150 mg L^{-1} with four applications every 14 days (150-4). Treatments with 1-MCP were conducted from June 1, 2011, when the plants were 11 months old and were repeated on June 1,2012. From the application of the treatments, it was monthly assessed the percentage of plants with natural flowering. The percentage of natural flowering observed in the second year of assessment and the percentage of global natural flowering showed significant reduction compared to the control treatment (37.4%) when plants were treated with 75 mg L ' 1-MCP with eight weekly applications (14.6%).

RESULTS

Natural flowering in Janaúba. MG (532 m elevation and Latitude 15º43'98"S) is a significant problem in the area (Figure 1). Note that Pérola seems to be much more susceptible to NF than are the other two cultivars and that is confirmed by the results (Table 1).

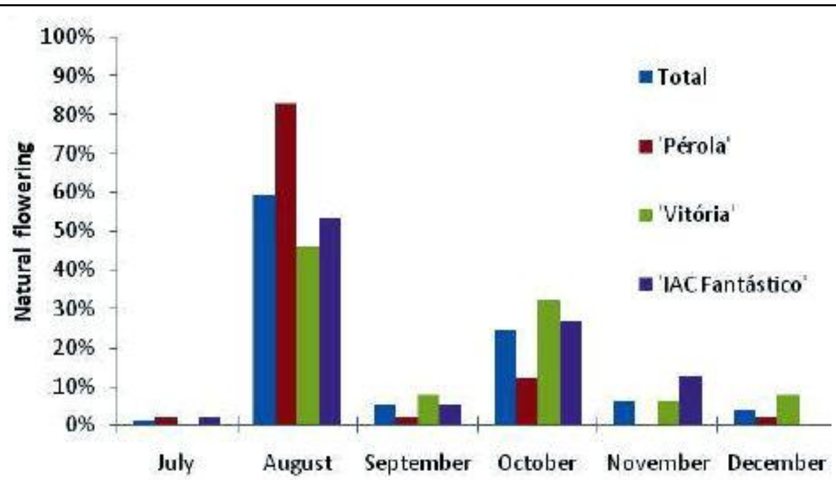

Figure 1. Percentage of natural flowering of three pineapple cultivars in Janauba, MG. Data are the averages for two years.

The percentage of natural flowering was significantly reduced by eight weekly treatments with 75 mg L^{-1} 1-MCP (Table 1). While 1-MCP can significantly decrease NF, it is a difficult material to handle because it is a gas that is quickly released when the product is mixed with water.

Table 1. Means of natural flowering (NF) in the first year of assessment (NF1), in the second year of assessment (NF2), the total NF in the first and second years, and the mortality of pineapple in the treatments and for the cultivars.

Treatment	**NF-1, %**	**NF-2, %**	**NF- avg, %**	**Mortality, %**
Control	14.2 a	27.7 a	36.7 a	12.1 a
37.5-8	11.3 a	19.0 ab	28.3 ab	11.7 a
75-4	9.2 a	18.5 ab	25.4 ab	12.5 a
75-8	7.1 a	7.9 b	14.6 b	15.8 a
150-4	7.1 a	17.7 ab	23.3 ab	8.3 a
Cultivars				
Pérola	29.3 a	22.4 a	43.0 a	3.3 c
Vitória	0 b	17.3 a	17.3 b	12.0 b
IAC Fantástico	0 b	21.0 a	16.8 b	16.8 a

Means followed by the same letter do not differ at 5% significance by Tukey test.

CONCLUSIONS

The percentage of natural flowering in the second year of assessment and the percentage of global natural flowering show significant reduction (14.6%) compared to the control treatment (37.4%) when plants were treated with eight weekly applications of 75 mg L^{-1} of 1-MCP.

News from Cuba

Bioproductivity and Climatic Changes: Pineapple Plants Treated with Jasmonates

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Summary

The biological and economic productivities, and therefore the relationship between them, will depend on the physical, biological, chemical, and general environmental conditions in which the plants are grown, and especially the characteristics of each specie or variety, since each has different photosynthetic capacity. It is inferred then that the purpose of this paper is gross primary productivity, to make it more efficient with higher CO_2 fixation with less water loss, increasing biomass production.

INTRODUCTION

One of the effects of global climate change is the destruction of ecosystems. The increase in greenhouse gases is not only causing drastic changes in the atmosphere, which is wreaking havoc all over the planet, thus affecting the supply of water, clean air and with them agriculture, resource-based energy sources. Plants and animals die or move to other (non-native) habitats when the ecosystems they depend on to survive are threatened by warming of the ecosystem temperature and water shortages.

The economy of a country is directly related to the consequences of climate change. Natural disasters such as floods or hurricanes are costly. The global crisis is leading to an increase in energy and food costs, and economic tensions over raw materials control make them increasingly expensive (Fisher *et al*., 2012). Therefore, scientific applications are imposed as part of the measures to mitigate these effects, some of them related to biotechnological processes related to the main impacts of two climatic variables: temperature and precipitation (Lobell, 2007; Lobell and Burke, 2008; Fishman, 2016).

The objective of this paper is the gross primary productivity (Roxburg *et al*., 2005), to make it more efficient with greater CO_2 fixation with less water loss, increasing biomass production, and water recovery in the face of the crisis of its existence in the planet. With the use of micropropagation phases and a biotechnological product with recognized anti-stressing action, the biochemical and physiological behavior of plants grown in vitro as a function of gaseous exchange, the main source of energetic fluxes of primary productivity is studied.

MATERIALS AND METHODS

As a basis for net primary productivity the behavior of photosynthesis and transpiration as the essence of the gas exchange of the plants as primary producers was studied as summarized below. As material, pineapple plants (*Ananas comosus* (L.) Merr.) cv. MD-2 were micropropagated according to the protocol proposed by Daquinta and Benegas (1997). The culture chambers were lighted with a 40-60 μmol $m^{-2}s^{-1}$ photosynthetically active photon flux (FFF), 16 h photoperiod and 8 h dark period and a temperature of 23 ± 1.2 °C during 45 days of culture. In the last *in vitro* phase Biojas® medium, a mixture of jasmonates produced by fungi *Botryodiplodia theobromae* and registered as a product of the Cuban biotechnology industry was added to a group of plants . The dose used (1 mg L^{-1}) was selected according to results previously obtained by González-Olmedo *et al*. (2006).

In the *ex vitro* acclimatization phase, the two groups of vitroplants (90 plants per group), from the control medium and the medium with the jasmonic acid, were planted in containers with 190 cm^3 of a substrate composed of a mixture of Zeolite + cachaza (1: 1) (v: v) in a completely randomized design. The average acclimatization conditions maintained during 42 days were a temperature of 28 ± 2 °C, a relative humidity of 70-80%, an atmospheric CO_2 concentration of 375-400 μmol mol^{-1} and light intensity of 450 μmol $m^{-2}s^{-1}$ and a natural light / dark photo period.

Physiological evaluations were performed at the beginning of the acclimatization phase and after 42 days. As indicators of physiological variables, net photosynthesis (μmol CO_2 $m^{-2}s^{-1}$) and total transpiration (mmol H_2O $m^{-2}s^{-1}$) were measured. Measurements of these variables were performed with the CIRAS-2 Portable Photosynthesis System (PP Systems, U.K.) coupled to a universal cuvette (PLC6 of 2.5 cm^2). The area of the cuvette was covered with at least two leaves (2.5 cm^2) and these were evaluated in the optimal light where photosynthesis was maximum and stable (FFF 600 μmol $m^{-2}s^{-1}$). The carbon dioxide concentration and the relative humidity (RH) were ambient values (375-400 μmol mol^{-1} CO_2 and 70-80% RH). Measurements of these variables were always performed in the hours of 9-10 am. Four (most representative) plants were considered per treatment with 10 replicates each for a total of 40 values. The efficiency of water use, which is the relationship between net photosynthesis and total transpiration, was calculated from the values of these variables (Cernusak *et al*., 2007).

At both times, the variables length of the D leaf (cm) were evaluated, being the representative organ where the gas exchange is developed based on the bioproductivity, as well as the masses, fresh and dry (g), related to the biomass. Survival was also evaluated as an indicator of the abiotic anti-stress effect caused by the change of *in vitro-ex vitro* environments.

RESULTS AND DISCUSSION

The gaseous exchange variables for control and Biojas® treated plants (Table 1) show that with an approximately ten-fold increase in FFF the rate of photosynthesis approximately doubled between day 0 and day 42. The main effect of Biojas® was a significant decrease in transpiation and an increase in wáter use efficiency at day 0.

Table1. Behavior of gaseous exchange variables in pineapple plants (*Ananas comosus* (L.) Merr.) 'MD-2' micropropagated, effects of Biojas®

Variables / Treatments	0 day T 23±1.2 ^{0}C	42 day T 28±2 ^{0}C	E
Photosynthesis (μmol CO_2 $m^{-2}s^{-1}$) Control	3.1 b	6.30 a	
with Biojas®(1 mg L^{-1})	3.2 b	6.20 a	.12
Transpiration (mmol H_2O $m^{-2}s^{-1}$) Control	4.0 a	1.10 c	
with Biojas®(1 mg L^{-1})	2.2 b	1.10 c	.06
Water use efficiency Control	0.61 c	14.35 a	
with Biojas®(1 mg L^{-1})	1.44 b	14.60 a	.15

Date with different letters indicate significance (ANOVA, Tukey test p≤ 0.05). Each data represents the mean for n = 40.

It is an important result for Biojas® because it is sometimes reported to decrease photosynthetic activity (Ananiev and Ananieva, 1999). The most favorable effect consisted in the reduction of transpiration during the transition to external environments with a temperature increase of 5 ^oC, lower RH and greater light intensity. Such low water loss demonstrates the anti-stress action of Biojas® by improving water relations efficiency, as well as the effectiveness of in vitro environmental management (González-Olmedo *et al*., 2005; Nievola *et al*., 2005). This assumes better stomatal control induced by Biojas® as previously reported for other jasmonic acid and jasmonate formulations (Creelman and Mullet, 1997; Evans, 2003; Dombrowski and Bergey, 2007).

In terms of primary productivity the application of Biojas® attenuates adverse manifestations in the plants that occur aftger a change to less favorable environments, an example being that the capture of CO_2 is not limited, and water loss is reduced. It is known that the total productivity of the biosphere depends on the photosynthesis and the subsequent capacity of assimilation of the organisms that form the next trophic level. The first is a limiting factor of global productivity, while it determines the rate of conversion of solar energy into chemical energy, which quantitatively is barely 1%.

The high levels of survival recorded satisfy the efficiency of the established methodology for this species with a background in the technique reported by Yanes *et al*. (2000). However, seedlings treated with Biojas® attenuated the fall of this indicator so that the losses caused in those 42 days in the houses of cultivation (96% of survival) were inferior to the control plants, with 2% of plantlets saved when previously treated with the bioproduct (Table 2), thanks to the better management of their water relations (Table 1).

Table 2. Effects of the Biojas® on the survival of micropropagated pineapple (*Ananas comosus* (L.) Merr.) MD-2 plants during the *in vitro-ex vitro* transition and the morphological variables in acclimatization.

Variables / Treatments	**0 day T 23±1.2 ^{0}C**	**42 day T 28±2 ^{0}C**	**SE**
Survival (%) Control	100 a	94 c	
with Biojas®(1 mg L^{-1})	100 a	96 b	0.5
Length leaf ¨D¨ (cm) Control	7.6 b	7.7 b	
with Biojas®(1 mg L^{-1})	7.0 c	8.0 a	0.09
Fresh Mass (g) Control	2.20 b	11.30 a	
with Biojas®(1 mg L^{-1})	2.21 b	11.55 a	0.2
Dry Mass (g) Control	0.28 c	1.65 b	
with Biojas®(1 mg L^{-1})	0.29 c	1.76 a	0.04

Date with different letters indicate significance (ANOVA, Tukey test p≤ 0.05). Survival data were transformed according to y'= 2arcsin (y / 100) $^{0.5}$. Each data represents the mean for n = 90.

According to Swiatek *et al*. (2002), jasmonic acid exerts inhibitory effects on the growth and development of diverse forms; reducing nucleic acid and protein synthesis, or inhibiting cell division in Arabidopsis. This may be the reason why the D leaves of the treated plants were the smallest at day 0. However, in the warmer environments, D leaves were significantly longer and plant dry mass was significantly greater than those of control plants on day 42, without doubt due to the greater wáter use efficiency of the treated plants (Table 1). Thus, the inhibitory action can be moderated with the concentration used or the species' own responses, as may have occurred on this occasion.

The influence of temperature on the production of plants can be direct, on the growth of the plant altering its physiology, or indirectly by varying the humidity, the quantities of minerals absorbed by the plant and its transport. Whatever the influence of the thermal increase in this transit, the results of the application of Biojas® favored the relationships of the metabolic processes (perhaps as demonstrated in other thermal management Cejas *et al*., 2012) required to improve productivity in new climatic scenarios, it would then be a tool to apply to predictive studies (Lobell and Asseng, 2017).

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News from France

ANANABIO : A Project To Design Organic Pineapple Cropping Systems Through A Participative Approach Between Research And Producers.

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ABSTRACT

ANANABIO is a multi-partnership project (2016-2018) associating Research (CIRAD) with a technical institute (ARMEFLHOR) on Reunion Island (Indian Ocean) to design innovative practices for environmental-friendly organic pineapple cropping systems. Other partners of the project are the local administrative support to farmers (Agriculture Chamber and agricultural training school), professional organizations of farmers and independent farmers as well. Pineapple produced under the French Organic production specifications are marketed with the label 'Agriculture Biologique' (AB) of the French Ministry of Agriculture. The project proposes through a participatory approach to encourage farmers to co-design cropping systems with agronomists and to evaluate their performances. As far as cultural practices are concerned, ANANABIO focuses on the destruction of old crops and mechanized planting, organic fertilizer application, the pest and weeds management, and production of disease-free planting material. These cropping systems should also follow the Agroecology concept that promotes an agriculture that respects and protects man in his environment.

INTRODUCTION

Pineapple is the first diversification crop on Reunion Island with 16,000 tons produced on 360 ha, the main crop being sugar cane. Pineapple represents 75% of the fruits exported from the country towards the international markets. Pollution by pesticides and chemical fertilizers are critical issues in small insular territories. Thus, there is an increasing societal demand for better management of environmental risks and health protection in our country. Agroecology and more specifically organic production may provide the answer to this demand. Therefore, producers are looking for new ways to produce pineapple that are respectful of the environment and that could be better valorized economically. The evolution of the intensive cropping systems towards agroecological production and here towards organic production will be globally beneficial for a small country like the Reunion Island that is recognized as a hot spot of biodiversity and classified as a World Patrimony by UNESCO since 2010.

To obtain high quality agricultural products, farmers are forced to innovate their cropping systems with environmental-friendly and organic practices. These have to be re-designed to restore ecological processes and ecosystemic functions as for example the regulation of populations of soil microorganisms. Many functions provided by the agrosystems have been lost in the classical intensive monocultures. However, introduced biodiversity can restore some of these functions through rotation and/or association with selected plants. The characteristics of these plants may help to restore different services provided through the agrosystems: to reduce the impact of weeds, to reduce soil pathogen populations, to increase the populations of beneficial organisms (bacteria, mycorrhiza), to increase the natural regulations between beneficial organisms (auxiliaries) and pathogens, and as green manure to increase soil organic matter and fertility.

The project ANANABIO will develop cultural practices on four main issues: 1) Mechanization, particularly the destruction of the old plots after harvest but also mechanized planting, 2) organic fertilization, 3) weed management and 4) pest management. Agronomists, elaborating and evaluating innovative practices, will design new cropping systems. In addition, a participatory approach with farmers to evaluate the new cropping systems with their own indicators should enhance the adoptability by the industry. The project is divided into six specific work packages: management of the overall project, conception and implementation of the participatory approach, organic fertilization, mechanization, weed control, pest management, and finally transfer of the technical information to the industry.

PARTICIPATORY APPROACH, TECHNICAL EVALUATION AND SELF-EVALUATION OF THE CROPPING SYSTEMS BY THE FARMERS

This work package must develop different issues about the participatory approach to design and to evaluate the innovative cropping systems. These systems designed according to the agro-ecological concept will be evaluated with specific indicators of performance in three domains, agronomy, economy and environment.

For an agronomic evaluation, we selected different indicators: Rate of mineralization of different types of organic fertilizer; Efficiency of cover crops for weed management; Dynamics of nematode and symphylid populations under cover crops; Microorganisms activity in soil; Root system establishment and other classical indicators of pineapple growth (D leaf) and yield. Some of these indicators are not easy to measure at the experimental level so simulation tools and models have been used to select economically and environmentally beneficial cropping systems under a wide range of conditions (Sterk et al., 2007, Colbach, 2010). However, in most methodologies, the farmers play only a consultant role or are not consulted at all. Consequently, they rarely adopt the innovative cropping systems proposed by agronomists.

With the participatory approach proposed in this project, the hypothesis was that farmers have different contexts and objectives and so different ways to evaluate their systems with their own indicators. According to their economic and environmental objectives, farmers have to make compromises between their practices and their specific constraints to optimize performances and sustainability. Thus, pineapple producers with a wide range of contexts of production were previously surveyed to identify agroclimatic contexts and strategies of production and commercialization (Cambournac, 2013, Pissonnier, 2014) and to identify the strategies for the ecological transition of the farms (Dupré et al., 2017). Workshops were organized to identify the indicators that the farmers are using to self-evaluate their cropping systems. Thus, in order to ensure their adoption by farmers, a new organic pineapple cropping system must show efficient performance and be well adapted to the farmers' constraints.

Surprisingly, the farmers proposed many indicators on the agronomic, economic and environment domains of evaluation also proposed by the agronomists, although their methods and indicators were more empirical. This indicates that the farmers are fully part of the societal demand to reduce environmental problems and health risks. Finally, after aggregating and evaluating the different innovative practices, the organic cropping systems will be designed taking into account the agronomic expertise of farmers and agronomists.

The recently developed SIMPIÑA model for 'Queen' (Dorey et al., 2015, Dorey, 2014) will be used to match cropping practices to the various environments of pineapple farms in Reunion. Pineapple is grown in most areas in la Réunion at elevations from 50 m to 900 m resulting in a wide range of climatic conditions. Large farms can be found on low and relatively flat lands in the southern, western and northern parts of la Réunion. Most of the smaller farms with different management practices are established on sloping lands (300 to 700 m elevation) in eastern and northern areas with sometimes very steep slopes. There is a high diversity of soils on which pineapple farms are established. The soils are mostly more or less weathered andic soils (East, South and higher areas in the West) including black soils (Mid elevation in the West). In the drier western area of the island, some pineapple farms are established on very difficult black clayey soils. The eldest soils are ferrallitic (mainly in the North East of the island).

ORGANIC FERTILIZATION

Most of the fertilizers used in conventional systems of production comply with the requirements of the organic production except for nitrogen (N). Natural sources of K and P are authorized for organic production. Therefore, the work package on organic fertilization has first to identify known or possible local sources of organic N that could supply the quantity of N required for a pineapple crop in Reunion, about 350 kg.ha^{-1} (pineapple residue, blood & bone meal, legume cover crops, composts, etc). Then, with the available sources of N, controlled and field experiments would determine if the N needed for pineapple growth and production is theoretically and actually available to meet that requirement with the appropriate timing during the cycle.

Possible sources of Nitrogen in la Réunion:

The pineapple residue after harvest may provide a large amount of N as the amount of fresh organic matter after harvest in pineapple may reach up to 200 tons fresh weight.ha^{-1} on varieties like Smooth Cayenne (Py et al., 1987). In la Réunion, the mother plants and the remaining suckers are picked out and placed in windrows either to be destroyed with a slasher or to push them away on the edges of the plots, especially if they are highly contaminated by parasites, or when the plots are too stony for a mechanized destruction. In the experimental plots of the project, the mother plants are slashed into very tiny pieces (see hereafter the section Mechanization). Thus, we could evaluate amounts of residue ranging from 20 to 40 tons of dry matter per ha in different fields of conventional producers, being a potential source of nitrogen ranging from 170 to 320 kg.ha^{-1}. But the quick mineralization of the pineapple leaves cannot meet the requirement of growing plants during the 9 or 10 months of the pineapple vegetative growth. Part of this organic matter will contribute to restore the soil organic statute and will contribute to the growth of the cover crops that can be used in rotation systems with pineapple.

The cover crops as green manure are also investigated as an optional N source. Different cover crops and their biomass produced will be evaluated in the project without forgetting that some of these plants are also used for weed management (see section Weed Management) and to reduce soil borne pathogens (see section on Pest Management). The first plants selected for these experiments were crotalaria species, *C. juncea* and *C. spectabilis* (but others as *C. ochroleuca* will be studied), and mix planting of Crotalaria and Pearl Millet as well. The first results observed in our conditions showed large variations of biomasses produced between crotalaria species but also according to the date of sowing (warm or cool season). Preliminary results showed relatively low biomass productions during the warm season in la Réunion (10 tons DM ha^{-1}) when compared with Martinique (40 tons DM ha^{-1}) corresponding respectively to ~300 kg N.ha^{-1} vs ~1200 kg N.ha^{-1} incorporated into the soil with *C. juncea* as a green manure.

There are not many commercially available organic plant nutrient sources that comply with the organic production requirements. The only one available is a blood and bone meal from slaughterhouses, with a high content in N (~14%) and a fast mineralization. However, mixed incorporations of blood and bone meal and *Crotalaria* spp biomass before planting are also under evaluation.

Another solution is Ramial Chipped Wood (RCW; chipped branches <7.0 cm in diameter) but in the project it was used first for a different purpose. The RCW was used as a dead mulch to cover the soil and to control weeds. Nevertheless, this fresh material is also a source of nitrogen and was developed first in Canada, however, it is now a wide spread technique around the world, including for small private horticulture gardens. Unfortunately in our case, it also induces a strong proliferation of ant nests and mealybugs. Moreover, the main source for this material (roadside maintenance) is not appropriate for organic production, thus the use of RCW has not been investigated more deeply in this project as a Nitrogen source. Composts would have also been an interesting solution to be explored. They have been used in Ghana in large Organic farms for example self-produced composts from banana and pineapple residue of the farm mixed with large amounts of aquatic grasses collected from the Volta River (Soler, 2007). In la Réunion, the composts locally produced do not meet the specifications for organic production.

Experimental evaluation of different sources of Nitrogen:

The selection of organic compounds or cover crops will rely on analyses based on previous published works on methods to evaluate the mineral forms of N (NH_4^+, NO_3^-) and CO_2 released by the natural mineralization process and the carbon-to-nitrogen ratio C/N ratio. The C/N is an indicator to evaluate the ability of organic matter to decompose more (low C/N ratio) or less (high C/N ratio) rapidly in the soil

These researches intended to establish predictions of mineralization characteristics for C and N for exogenous organic matters (including industrial sludges, composts, animal wastes, mulches, cover crops used as green manure and fertilizers) incorporated into the soil from their biochemical characteristics in controlled systems but also in experimental fields (Lashermes et al., 2009, Lashermes et al., 2010, Fernandes et al., 2010).

In addition, the amount of nitrates lost by leaching at field level as well as the CO_2 and the ammoniacal N released will be measured. The data will allow calculating the equivalent amounts of organic fertilizer to replace the chemical ones. Then fertilizing procedures should be proposed to the farmers. Nevertheless, a strong challenge appears for N fertilization as most of the farmers are using classical plastic or organic mulch. So, to elaborate a schedule of applications of organic N during vegetative growth will be complicated as most of the N, available in solid form, would be applied before planting by the incorporation of the cover crops biomass, mixed or not, with other organic compounds. The contribution of organic matter, including green manure with cover crops, to soil fertility is well known (Jama et al., 2000, Pieri, 1989, Pichot, 1975). The mineralization characteristics of the cover crops may play an important role by releasing N slowly enough to maintain an equilibrated access for K and N to the pineapple plants throughout the vegetative growth period. In addition, in Reunion Island, there is no industry that produces organic composts or fertilizers and to import such fertilizers will not be economically sustainable.

. Similarly the C/N ratio of plants or different organic matter sources may help in evaluating the impact of soil C/N and the speed of their mineralization when incorporated into the soil (Giroux and Audesse, 2004). It is considered that in a soil with a C/N <15 there is a strong production of nitrogen, maximized at a C/N ~10, and the rate of decomposition increases as the C/N decreases. *C. juncea* has a C/N ratio of about 16.7, as is the case for many other Fabaceae. Due to their nitrogen-fixing capabilities they contain more N ~3% vs C ~50% than Poaceae spp, N ~0.8% vs C ~49% (Van Soest et al., 1991). Nevertheless, there is a large variability of the C/N in plants and organic matter in soils and the speed of the mineralization does not depend only on this ratio as for example the availability of nutrients for bacterial populations in the soil. The experiments in this project will help in evaluating not only the total amount of N actually available for the plants, but also the timing of release during the cycle for the blood and bone meal, the crotalaria and a mix of both sources.

MECHANIZATION

The work package ‘Mechanization’ has two objectives, the planting and the destruction of the old plants into very tiny pieces.

The mechanization of planting is a critical issue because of the high cost of labor in European territories and both organic and conventional productions are concerned. To determine the needs of the farmers is a complex task because of the high diversity of contexts (Cambournac, 2013). Most farms are mechanized to some extent as the cost of labour is very high in French territories, but the biggest equipment, for example a planting machine, must be shared through the cooperatives. In the project, the next step will be to design, build and test the equipment while relying on the direct participation of the farmers in technical workshops and field tests.

To shred old plants and particularly the stems into very tiny pieces, the project needs to identify and test commercially available equipment. The objective is to limit further development of small shoots from large pieces of stems as they could interfere with field operations in the planted crop and maintain populations of soil borne parasites and mealybugs, jeopardizing the establishment of the new pineapple crop. This practice is part of the integrated pest management but it also accelerates the mineralization of the organic matter. The most efficient tools identified to obtain the desired particle size belong to two categories: First, modified “wood chippers” normally used to destroy tree branches; Second, modified “rotary slashers” with heavy chains as the crushing system. The first ones are commercially available machines that need only slight adaptations. Rotary slashers need deeper modifications that for safety reasons can only be done by specialized companies. The first option is under evaluation in the project and the first results are good in terms of destruction but, as expected, relatively time consuming when compared to the classical pineapple slashers with articulated hammers rotating at high velocity.

WEED MANAGEMENT

In the work package on ‘Weed management’, different options are under investigation The weed control should be done using several techniques that will not interfere with pineapple growth, with pest management or other proposed practices. A diagnostic survey identified the agronomic and economic constraints linked to weed management. Thus, a specific frame of constraints was designed before selecting the plants and the farmers could aggregate their point of view to the frame of constraints. One of the main constraints is the cost of weed control, as chemicals are not allowed anymore. Another strong constraint is the omnipresence of weeds vegetatively multiplied by a mechanical destruction and that frequently damages the plastic mulch growing through it, as for example *Cyperus species* (*C. rotondus* in lower areas and *C. esculentus* above 500 m). Other weeds vegetatively multiplied are *Phalaris arundinacea* and *Raphanus raphanistrum* (both in higher lands), and *Oxalis* sp. (Perret and Dorel, 1999). A more exhaustive floristic survey must be done to identify the main weeds present in pineapple fields in la Réunion and the possible evolution of the flora using cover crops for weed management.

The weed control should not consist in a simple elimination of the weeds by hoeing or using only mechanized systems because it may result in strong erosion problems. The andic soils are particularly fragile in some areas of production subjected to heavy rains but there is also a tendency to over-mechanize some of these practices enhancing the deleterious consequences on the soil integrity. Finally, the optional techniques under investigation include mechanized weeding of inter-rows for some areas, natural mulch, dead (wood chips) or live mulches (cover crops that need to be cut or rolled down before they compete for light with pineapple). Nevertheless, as the soil borne parasites on pineapple are not hosted by pineapple only, the selection of the plants must take into account the pest management that is also partly based on the use of the same plants.

The project will assess different techniques mentioned above in experimental fields in organic farms. Beside the impact of the techniques on weed control, different parameters must be evaluated at the same time as the populations of soil borne parasites. We also decided to introduce *Crotalaria* before pineapple as it should induce a selection among the weeds and reduce the amount of seeds in the soil.

As far as cover crops are concerned, some specific constraints appeared including the commercial availability of seeds, certification for organic production, or taking into account the risk of introduction of invading species severely controlled by local authorities.

PRODUCTION OF DISEASE-FREE PLANTING MATERIAL AND PEST MANAGEMENT WITH ROTATION CROPS

The work package on pest management focuses on the production of disease-free planting material and on the selection of cover crops (also called in this case servicing plants (Table 1, Soler et al., 2016)) that have the potential to reduce the inocula of soil borne parasites. It is also expected that these servicing plants help to restore some natural regulations between beneficial and pathogenic microbial populations. Doing so, they contribute to establish stronger below– aboveground interactions for the crops. These interactions are believed to be a driving force for a healthy growth and which account for better yields in environmentally friendly agrosystems (Laksmanan et al., 2014, Orrell and Bennett, 2013). Other ecosystemic services can be provided by the agrosystems when servicing plants are used in a rotation and/or association with pineapple. They can improve the organic matter content of the soil, contribute to improvement of soil structure, contribute to the weed management (see previous section), and improve the quantitative and dynamic bioavailability of nutrients through their redistribution from deeper to upper layers of the soil. The table 1 summarizes expected ecosystemic services provided by the agrosystems with the corresponding plant traits that may help to restore the services.

Table 1 Expected ecosystemic services provided by the agrosystems and related traits of cover crops integrated in rotation or association with pineapple.

Expected ecosystemic services	Related cover crop traits
Clearing the soil of nematodes and symphylans before pineapple is planted	Host unfavorable to pathogens, Allelopathy, Biofumigation after incorporation
Cleansing the soil to the depth at which symphylans can be found	The root system should be capable of exploring the soil profile beyond the depth usually explored by the pineapple root system (30-40 cm).
Enhancing the suppressive effect of soil on pests (balance between microflora and microfauna communities, increased mycorhization potential)	Plant capable of mycorhization, Satisfactory biomass production, Quality of organic matter
Controlling weeds (many plants host soil borne parasites)	Cover crop, Allelopathy
Improving the soil structure and organic matter content	Appropriate root system, Satisfactory biomass production
Improving the quantitative and dynamic bioavailability of nutrients	Satisfactory biomass production, Quality of organic matter, Ability to fix nitrogen, Appropriate root system
Control of aerial parasites of pineapple or associated cash crops	Attraction of auxiliaries Repulsive effect on aerial parasites

A preliminary diagnostic survey in the different areas of production showed the presence of several pathogenic nematodes including *R reniformis, P brachyurus* and *Meloidogynae spp*, but also of symphylans and strong development of wilt disease with the associated mealybugs. A more exhaustive survey will be undertaken.

Production of planting material "free of diseases"

In Reunion Island, farmers harvest all the suckers in one shot, 4 to 6 months after fruit harvest by pulling the whole plant out of the soil. Then, they select few suckers with the correct size from the numerous ones produced by Victoria ('Queen'). This practice tends to give contaminated suckers, especially by mealybugs but also by symphylans and nematodes, if the suckers are not correctly prepared by removing old dry leaves and remaining roots. The frequent exchanges of planting material between farms is a common practice responsible for a rapid extension of contaminated areas (no possibility of disinfection).

The production of disease-free material through tissue-cultured techniques is well-known but it is not economically feasible as a regular source of plants in Reunion. For this project, the plan is to establish a supply of 'second generation' plants after the production of a reduced number of tissue-cultured plants. After acclimation, the tissue-cultured plants will be multiplied using 2 classical methods, first at field, level castration of the plant after forcing, and second in greenhouse, early destruction of the apex of young tissue culture plantlet (Soler and Dole, 2006) and distributed to growers when sufficient supplies are available. Economical sustainability is expected in both cases because of the high rate of production of suckers by the Victoria ('Queen'). They normally should replace the classical production of suckers after fruit harvest, at least until the populations of parasites decrease to reasonable levels.

Selection and evaluation of cover crops to sanitize the system

The preliminary diagnostic survey showed the diversity of pathogenic nematodes on pineapple that the servicing plants should help to control in addition of the symphylans. The diversity of the conditions of production (soil, rain and temperature), requires a more exhaustive diagnostic taking into account the seasonal impact on the growth of parasites populations.

The servicing plants are selected among the germplasm available in Reunion Island. The main criteria in this case is that the plants should not allow the increase of soil borne parasites. Nevertheless, as indicated in Table 1, other services are expected from the characteristic of these plants (fertility and organic status of the soil, natural regulation with the increase of beneficial population of microorganisms, weed control, and more).

First, we need to determine which of the plants are unfavorable hosts of pineapple parasites. This will be done under controlled conditions with inoculations of monospecific populations of local parasites. Other characteristics will be evaluated in experimental plots (particularly the biomass produced in different areas of production at different seasons, the potential of mineralization and the improvement of several soil characteristics). Then, the plants will be integrated and evaluated in pineapple cropping systems as rotation crops and/or cover crops as well. The evaluation will encompass agronomic, economic and environmental efficiency from both the perspectives of farmers and scientists.

The first plants tested in experimental fields are *Crotalaria* species (*C. juncea and C. spectabilis*) because of the practical experience already acquired in Martinique for *R. reniformis* (main pathogenic nematode on pineapple in Martinique) and previous publications on the topic (Wang et al., 2003, Wang et al., 2002). These plant species are already present in la Réunion but several issues must be investigated. First, the *Crotalaria* sp. are short-day plants flowering after 1 or 2 months during winter period. Therefore, the plants need to be incorporated into the soil after 4 months, meanwhile during the warm season the plants can be maintained up 6-7 months before destruction. The nodulation has been shown to be a critical point for production of toxic alkaloids by the *Crotalaria* sp. (Irmer et al., 2015) and although the nodulation occurs early after germination even in the cold season, the length of the cycle may have an impact for the production of the toxic pyrrolizidines and the management of soil borne parasites. The second point to be investigated for *Crotalaria* sp. is their impact on the different pathogenic nematodes. We need to verify if the local strain of *R. reniformis* is efficiently controlled by the *Crotalaria* sp. Then, the nematode *Pratylenchus brachyurus* has been also identified as one of the aggressive pathogenic nematodes for pineapple in la Réunion, meanwhile they are not in Martinique. Wang et al. (2002) have indicated that *Crotalaria juncea* does not control the *Pratylenchus* sp. Nevertheless, Machado et al. (2007) showed that *C. spectabilis* and *C. breviflora* can efficiently control the nematode *Pratylenchus brachyurus*. So, another alternative that is tested on experimental fields is to mix Crotalaria species (*C juncea* and *C. spectabilis*) and *C. juncea* with Pearl Millet as the latter plant may also control some species of *Pratylenchus*. Finally, *Crotalaria* sp. have their own pathogens very aggressive, in Martinique, it is the *Utetheisa ornathrix* caterpillar but in la Réunion, it is a bug from Miridae family. Both of them may require a management as they reduce considerably the growth of the plants.

ADDITIONAL ISSUES DEVELOPED FOR THE ORGANIC PRODUCTION

Forcing technique for organic pineapple:

The traditional forcing techniques (application of ethylene or ethephon in water) are not acceptable under the French organic production standards. Nevertheless, a technique using dry activated charcoal charged with small amounts of ethylene exists already (Soler et al., 2006), the project is looking for an administrative authorization to use it for pineapple because in French territories the use of ethylene is not authorized in open air.

Analysis of existing distribution channels for pineapple organically produced:

The objective here was to acquire a global vision of the different distribution channels of organic fruits and vegetables in Reunion Island. Organic farming is still not very widespread (170 producers in 2015 grow fruit and vegetables on 316 ha) and supply does not meet demand. Although, 9 different distribution channels were identified for organic fruits and vegetables, the majority of producers prefer direct or short-sale marketing. The long circuits cover professional organizations and cooperatives as well as export sales. The different channels are described as follows: Direct sale, short or long channels, then farms profiles and their economic strategies, importance of fruits and vegetables in the channels, advantages and disadvantages of the channel for the producer, media for marketing and success factors.

Transfer of the technical information

The objective of the last work package is to design training tools and technical sheets to transfer the techniques developed by the project to agricultural schools, to the farmers and to the technicians of the professional organizations. This technical information includes many prophylactic measures already known but very often abandoned by the farmers because of the efficiency and easy use of the pesticides. The prophylactic measures sometimes require much labor and close monitoring of the pest and disease development.

CONCLUSION

The objective of the ANANABIO project in Reunion Island is to propose to the pineapple producers cropping systems that comply with the French organic production specifications. The farms will be certified and fruit marketed under the label 'Agriculture Biologique' (AB) of the French Ministry of Agriculture. A complete review of the conventional and intensive systems of production is necessary. To do so, the project brings together the resources from research and technical institutes, professional organizations and farmers. The new cropping systems must follow the concept of Agroecology for health and environment protection. Practices including the destruction of old crops, fertilizer applications, pest and weed management, and the production of disease-free planting material, and forcing, are the focus for the technical innovations. Many of the technologies will be useful for conventional production as well. The participatory approach developed in this project with farmers from the conception to the evaluation of new practices and cropping systems should facilitate their adoption by the industry.

Project organization: ARMEFLHOR: Financial management, CIRAD: Scientific & technical management. Work packages & Team leaders: Cell management of the project, [2]Soler A. and [1]Nurbel T., Participatory approach and integrative actions: [2]Dorey E. & [2]Darnaudery M. assisted by[2] Lebellec F, [2]Michels T. & [2]Danflous J.P., Organic fertilization: [2]Thuries L., Mechanization: [1]Hoarau I., Weed management: [1]Tisserand G., Production of disease-free planting material and Pest management with rotation crops: [2]Soler A., Forcing: [1]Graindorge R., Transfer of the technical information (Chambre d'Agriculture, EPLEFPA).

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Other partners : AROPFL, Chambre d'agriculture, EPLEFPA (Agricultural school).

Financial support: Ministry of Agriculture, Europe, Réunion Dpt, Réunion Region.

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News from the Philippines

Trimming 'MD-2' Mother Plants for the Production of Planting Materials

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INTRODUCTION

'MD-2' is currently the variety of choice for the fresh pineapple market worldwide. Since the fruits are usually sold with their crowns on, sustainable production must necessarily rely on planting materials other than crowns. Harvesting suckers and slips after plant crop harvest is an alternative method of producing planting materials from pineapple varieties destined for the fresh market like 'MD-2'. It is considered cheaper than either macrosectioning or tissue culture but requires a large initial population of mother plants and big land area to be able to generate a significant quantity of planting material.

Trimming mother plants was believed to enhance the production of suckers from 'MD-2'. This test was therefore conducted to determine the effect of trimming of 'MD-2' mother plants after plant crop harvest on the number of suckers that can be produced per unit area.

MATERIALS AND METHODS

One month after plant crop harvest of a commercial planting of 'MD-2' in Manolo Fortich, Bukidnon, Philippines, the mother plants were defoliated either by slashing the leaves with a sharp machete or by cutting them, including the stump, with a power scythe down to 10-15 cm above ground level (Figure 1). Uncut or untrimmed plots were maintained as controls. Treatments were applied on July 27, 2002 at 19 months after planting. The experimental area was applied with foliar fertilizers following the standard commercial practice for a ratoon crop.

Two months later in September 2002, and every two months thereafter, suckers >28 cm long were stripped and sorted by size as follows: medium – 28.1 to 35.6 cm; large – 35.7 to 43.2 cm. Suckers less than 28 cm in length were left behind. The experiment was terminated after six rounds of sucker collection in July 2003 when the field had to be chopped in preparation for the next cycle.

Plot size was 7.9 m x 6.1 m (= 48.3 m^2) and there were three replicates per treatment laid out according to a randomized complete block design. The experimental area was planted on December 27, 2001 at 77,236 plants/hectare.

RESULTS AND DISCUSSION

Under the soil, weather, and farming conditions in Bukidnon, Philippines for the duration of this study, defoliation of the mother plants, whether by slashing or trimming with a power scythe, consistently resulted in fewer and smaller suckers collected over a 12-month period after plant crop harvest (Table 1). Over this 12-month period, the total number of regular + ground suckers collected from the experimental area averaged 193,420 per hectare when the plants were trimmed or slashed; 293,980 per hectare when the mother plants were left intact. The numbers indicated sucker production rates of 2.50 suckers per plant when plants were trimmed or slashed; 3.81 suckers per plant when the mother plants were left intact.

Trimming part of the stumps together with the leaves apparently reduced the number of axillary buds available for sucker production, which led to the reduction in number of suckers collected from the trimmed plants. Trimming, however, was not necessary for sucker emergence as the release of the axillary buds from apical dominance was accomplished by the development of the fruit at the shoot apex of the mother plant as it is in many other herbaceous plants (Shimizu-Sato and Mori, 2001).

The data also demonstrated the importance of intact mother plants in nourishing the suckers that arose from them. This was supported by the clear shift in the size distribution of the collected suckers to more medium and fewer large when the mother plants were severely trimmed (Table 1). The reduction of the plant crop biomass, mostly leaves, as a result of severe trimming apparently led to the production of smaller suckers. Clark (1936) reported reserves of carbohydrate and organic N increased in plant crop stumps following fruit harvest. Subsequent growth of suckers must have been totally dependent at first on food reserves mobilized from the mother plants. Dependence gradually receded until such time that the suckers were able to produce food on their own.

Table 1. Effect of slashing MD-2 mother plants after plant crop harvest (July 27, 2002) on the number and size distribution of suckers collected every two months from September 2002 until July, 2003 (six harvests).

	Suckers collected, 000/ha			Size distribution, %		
Treatment	Medium 28.1 to 35.6 cm	Large 35.7 to 43.2 cm	Total	Medium 28.1 to 35.6 cm	Large 35.7 to 43.2 cm	Total
Power scythe or slashing	82.07	111.35	193.42	42.43%	57.57%	100%
No trimming	68.61	225.37	293.98	23.34%	76.66%	100%

CONCLUSION

Under the soil, weather, and farming conditions in Bukidnon, Philippines for the duration of this study, mother plants are best left intact when sourcing them for sucker planting materials. The healthier and longer-lived they are, the more and bigger the suckers that can be collected from them.

ACKNOWLEDGMENT

The author gratefully acknowledges the support and consent of Del Monte Philippines Inc. in allowing the publication of this work.

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Figure 1. Severity of trimming of the mother plants using a power scythe.

ALOHA Pineapple Model to be Resurrected

Reynato Umali, Dole Philippines, Polomolok, South Cotabato, Philippines and Duane P. Bartholomew

The process-oriented ALOHA Pineapple model V. 2.1, which was developed with extensive data sets for 'Smooth Cayenne' pineapple from Cote d'Ivore and Hawaii and supplemented with data from Queensland and Thailand, appeared in 1997 (Zhang et al., 1997). The model included simulation of soil-water balance and incorporated the improved fruit maturity simulation described by Malézieux et al. (1994). The model was integrated into early versions of Decision Support System for Agrotechnology Transfer (DSSAT), but was dropped due to lack of support from pineapple growers.

Under the leadership of Andrew Brooke-Smith and Dr. Reynato Umali, Dole implemented a graphical information system, referred to as the Pineapple Plantation Information System (PPIS), to help ensure long term sustainability of production and to maintain the best possible quality of fresh fruit produced (Jung-Rothenhaeusler et al, 2016). With the objective of expanding the use of information technology, under the leadership of Dr. R. Umali Dole Philippines contracted with Dr. G. Hoogenboom and the University of Florida to update and modularize ALOHA Pineapple and merge it with the current Cropping System Model (CSM) similar to all other crops that are a part of DSSAT 4.6. DSSAT 4.6 is open source and and can be downloaded from the DSSAT web site. It is expected that the updated model will be available with DSSAT by December, 2017.

We expect that normalized difference vegetation index (NDVI) for biomass assessment and the updated ALOHA Pineapple model will be integrated in Dole's Plantation Analysis and Management System) (UAV-PAMS). When combined with the production and research databases, we expect a lot of commercial applications in the future. Yield and volume estimate would be the priority for the production side while simulation trials would give research headways for quick evaluation of cultural recommendations.

To learn more about DSSAT, please see http://dssat.net/about. DSSAT training workshops are held annually and the next, 2018, workshop will be held at the University of Georgia – Griffin Campus from May 14-19, 2018.

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Services

The listings below are provided as a convenience to readers and should in no way be construed as an endorsement of those providing commercial or professional services. Those offering specialized services to pineapple growers or researchers are invited to contact the editor for possible inclusion in the listings below.

Commercial Services

Maintain CF 125 continues to be available for use in pineapple plant propagation anywhere in the world. Supplies can be obtained from N. Bhushan Mandava, Repar Corporation, 8070 Georgia Ave., Suite 209, Silver Spring, MD 20910. Tel: (301) 562 – 7330; Fax: (202) 223 – 0141; On the web at www.reparcorp.com; E-Mail: mandava@compuserve.com.

Professional Services

Mark P. Culik, PhD. Incaper CRDR-CN, Rodovia BR 101 Norte, Km 151, C.P. 62, CEP 29915-140, Linhares, ES, Brasil. http://www.incaper.es.gov.br. Email: markculik3@yahoo.com
Experience: PhD in Plant and Soil Sciences with more than 25 years of agricultural pest management experience in crops ranging from apples to papaya and pineapple, identification of pests and beneficial arthropods ranging from mites to fruit flies, and current work on scale insects, including pineapple mealybugs. Areas of specialization: Entomology, Insect and Pest Identification, Integrated Pest Management. Culik Traduções, Português – Inglês; Culik Translations, Portuguese – English; English and Biological Editing Service.

Dr. Herve Fleisch. Interested in consulting on most agronomic and managerial aspects of production operations. See online profile at http://www.linkedin.com/pub/herve-fleisch/28/536/21a

Ing. Jhonny Vasquez Jimenez, MSc. San Carlos, Costa Rica. E-mail: jvasquez@proagrocr.com, Phone: (506) 89103878, (506) 24756795. Advice on the agricultural management of pineapple crop. Analysis and improvement of pineapple crop systems for producer companies (environment and productive potential, nutrition, control pathology, crop management). For Agrochemical Companies, designing and conducting researches for new production technologies in the area of nutrition, plant pathology, weeds and other disorders.

Book Reviews and Web Sites

Book Reviews

No reviews were provided for this issue.

Web Sites of Possible Interest

New References on Pineapple

The list below includes papers related to various aspects of pineapple culture, physiology, processing, preservation or byproducts that were published or located for the period since the last issue up to about March 31, 2013. Some papers may seem relatively unrelated to pineapple but the list follows the principle of inclusion to provide the widest possible content. Often, abstracts of the papers listed below can be found on-line. I suggest searching using the paper title. Of course all abstracts of papers published in Acta Horticulturae are available from info@ishs.org. For a larger view, adjust the magnification in Adobe Reader.

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