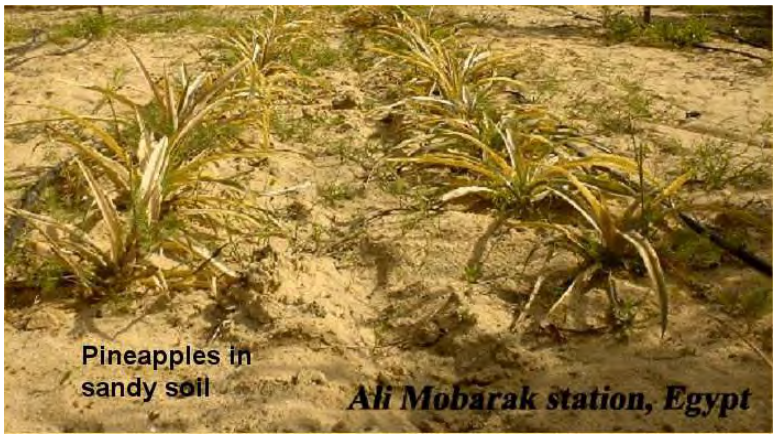
projected for 18 months later in September.

In December, an unexpected obstacle emerged. The winter season caused cold damage on the plants being grown at Ali Mobark and Sids Stations. Initially mature leaves turned red in color due to anthocyanin formation but continued exposure to cold stress produced white leaves. The leaves also became narrow and smooth and no or slow growth also was observed during the winter season. However, intercropping of pineapple plants under banana plantings at Kanater Station was effective in preventing cold stress (Photo B). Under banana plants, the mature leaves of pineapple remained green and healthy. It seems that the big leaves of banana protect pineapple plants from low temperature. The mean temperatures at night ranged from 8 to 13 ºC through the winter season but on some nights in some areas the temperature reached 5.5 ºC. The outer leaves of banana will be safely removed to allow direct lighting in the next summer.



When planting pineapple plants in the field, plants were placed on the two edges of terraces. Plants obtained their nutrients from usual fertilization of banana. The intercropping of pineapple with banana is expected to save a lot of costs for fertilization. No interaction was observed in water requirements between the needs of both crops.

The cultivation of pineapple in the open field in Egypt is economical and very important. Cold stress in the winter season was the big problem but intercropping under banana overcame this problem. Other means that could be used to overcome cold stress include the cultivation of pineapples under low plastic tunnels, which could be easily anchored in sandy soils (See photo), intercropping with maize, and covering the surface of the soil with rice straw. Rice straw from rice cultivation is considered as waste in Egypt and it is cheap and easy to use. Covering the surface of the soil could help keep the root environment warm and thus help to reduce cold stress.

This experimental work was done at the Sids station (Beni-Sweef governorate), which is located beside the Nile river where the relative humidity ranges from 40 to 60 % and the temperature in summer ranges between 30 and 35 ºC. Finally, research to overcome cold stress using different techniques was carried out in different areas of the country. Overcoming other obstacles to spread pineapples in Egypt is our target in near future.

News From France

Pineapple Multiplication: Practical Techniques for Small Farms

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Introduction

Selecting and multiplying pineapple plants for fruit quality and yield, vigor of the plants, fast sucker production or introducing new varieties, require fast multiplication of planting material. This may be a major constraint for small farmers or small organizations of producers. All techniques described below rely on the development of buds in leaf axils (just above the point of leaf attachment). Even though each leaf covers a bud that potentially may give a new plant, the buds are dormant due to strong apical dominance (Py et al, 1984). Nevertheless, different techniques based on vegetative multiplication exist with advantages and drawbacks for each of them. (For an extensive review see Py, 1979).

The modern technique of micro propagation is the ultimate technology for fast expansion and introduction of new varieties, but it is not very convenient for small farmers. With this technique, it is possible to produce thousands of plants (generally for pineapple a correct multiplication factor is 1:1000) from very few original plants. And even with the recent improvements that have been brought to this technique (González-Olmedo et al, 2005), it still has several drawbacks. These include a time-lag of one year between the beginning of the tissue culture and the production of the first in vitro plants as well as an additional 6 months for hardening and growth before plantlets are ready to be transplanted into the field. The cost is relatively high for small amounts of plants. Finally, several genetic variations such as spiny leaves or multiple slips at the base of the fruits inducing deformations, may appear during the first generations of plants.

Another common technique used is the application of phytohormons (like chlorfurenol) mixed with ethephon at forcing or just after. This technique, first developed by Sanford (1973), allows a rapid production of slips on the peduncle of the fruit or the

transformation of the fruitlets into small crowns. The plantlets obtained need to be grown in beds before they are transplanted into the fields. The results in terms of type of plantlets and size are not very consistent and difficult to control. Nevertheless this technique is the basis for rapid pineapple propagation in many countries while in others it is not allowed because of the restrictions about the use of phytochemicals in pineapple cultivation.

Practical techniques for small farms in French West Indies

All of the techniques but the first one described below are used in French West Indies and other Caribbean islands for expansion of new varieties. Table 1 below provides a comparison of the timing and production of the different propagation techniques.

1) Removal of the flowers: Two months after flower induction on young plants (4 to 6 months old), the young inflorescence is broken off (castration), which destroys apical dominance and boosts sucker production. Additional cultural practices such as cutting off the old leaves and applying fertilizers will also promote faster growth. Six to seven suckers per plant may be harvested during the following 12 months depending on the size of suckers the producer is looking for. The plant density may be increased up to 100,000 plants/ha resulting in the production of 500,000 plants/ha in 18 months, which includes the time required for growth of mother plants. But this technique requires a previous multiplication for new varieties or for multiplication of selected plants. Finally the technique is very similar to the classical production of suckers after harvesting fruit.

2) Crown leaf budding: This technique has been used for many years and many alterations of the original technique have been tested (K.K.Seow *et al.*, 1970; C.K.Lee *et al.*, 1978; H.C.Dass *et al.*, 1984). Each crown leaf in the pineapple plant covers a bud on the stem at its base. The first step is to remove and discard the base of the crown and any dry leaves. Each green leaf of the crown can then be carefully removed along with a small piece of the stem just under the bud (Figure 1A). The top portion of the crown with associated leaves is too soft to permit the removal of single buds so the whole top is just split vertically into four pieces. The cuttings are then dipped into a sodium hypochlorite solution followed by a fungicide dip to protect against rotting and then planted into flats containing moistened sand, a mixture of black soil and peat (Figure 1B), or agarose (agar medium). One month after the transfer to the growing medium the buds develop into plantlets. The stages of development can be seen in Figure 1D. No fertilizer application is required at this stage.

After two to three months of growth, the plantlets are transferred into propagation trays (sheet pots) Figure 1D) or into beds in a greenhouse. The growing media used at this stage consists of 45% black peat, 40% white peat, 15% clay and 4 kg Osmocote 10-11-18+2 per m^3 (Osmocote may be replaced by other fertilizer compounds). The propagation trays are installed under shade (40%) and irrigated with small sprinklers just to maintain the soil wet (Figure 1E). After three additional months of growth under light shade, i.e. when they are five to six months old, they are ready to be transplanted into the field. One crown can give up to sixty plantlets depending on the variety of pineapple.

3) Young plant or crown apex destruction: Destroying the apex of young plants or crowns by gouging (Figure 2A) allows for the fast development (3 months) of 10 to 15 plantlets even directly in the field. The apex is destroyed manually and then disinfected with a fungicide (Aliette for example). Young plants must be about 25-30 cm high before gouging as the stem is very small and it is difficult to remove the apex correctly. The stems of crowns are much larger so gouging is much more easily done, even on a small crown. After disinfection, the plants or crowns are planted and grown as usual but at a density of 75,000 plants/ha. Plastic mulch reduces contamination of the new plantlets by soil. In three months, about 10 to 15 plantlets can be removed from the mother plants (Figure 2B) and grown separately in propagation trays or in beds under shade to accelerate emergence of the new plantlets with the same fertilizer applications and irrigation as described for crown leaf budding.
They also can be left in place to grow up to the size suitable for transplanting into the field (Figure 2C). If the plantlets are kept on the "mother" plant until they reach a size allowing transplantation into the field, the number of plantlets will be reduced to 5 or 6 per crown. Development of the plantlet is promoted as described above for crown leaf budding, either in sheet pots or in beds under shade (Figure 1E).

4) Stem splitting: The stems of mature plants can be prepared for fast multiplication after harvest of the fruit and of one or two suckers. This classical technique allows the production of 20 to 40 plantlets per stem. The old leaves must be removed from the stem after which it is split in half (Figure 3A) or cut into slices 1 cm thick. After being disinfected (insecticide and fungicide dips), stem halves are laid over a medium of perlite + vermiculite (50% each) and irrigated by misting three times a day for 2 minutes. A sand bed also works fine. Too much moisture leads to stem rotting, so accurate control of irrigation is needed. The plantlets are grown under shade (same device as for leaf budding or even simple tunnels under shading tissue (Figure 3E) may be sufficient). Foliar applications of fertilizer mixed with insecticide every 2 weeks promote more rapid growth. Buds start developing into small plantlets after 2-3 weeks (Figure 3B). The stronger the shading the more plantlets while more light results in fewer but much more vigorous plantlets. The plantlets (Figure 3C, 3D) may be transplanted into sheet pots as explained for leaf budding or left on the stem until they reach a size suitable for transplanting into the field (about 3-4 months). In the latter case, the emergence of new plantlets will be delayed. The main drawback of the technique is that it is time consuming for the preparation of the stems. An optimization of the method has been developed in Antigua (M.A.SIROY, 1996).

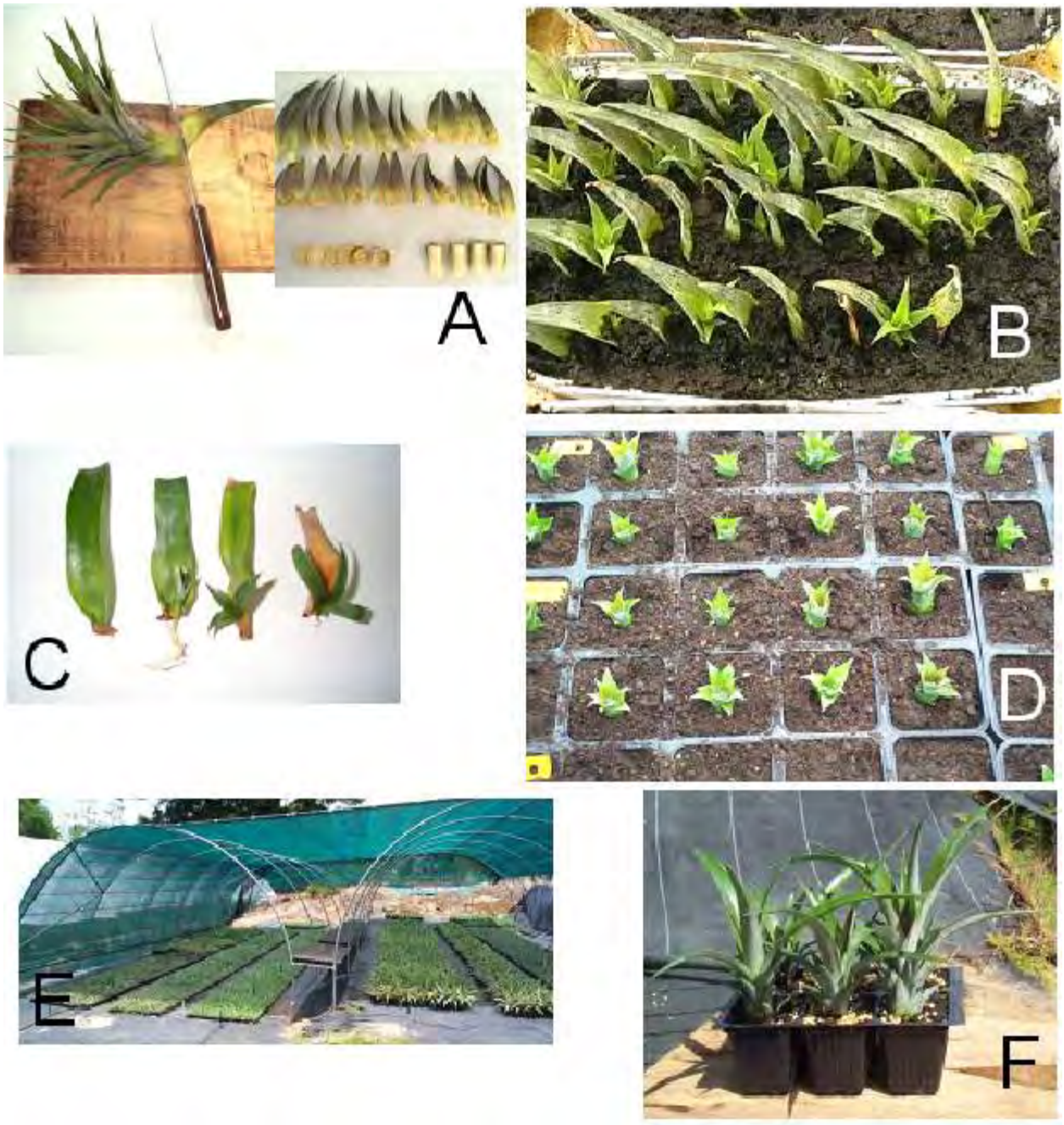

Figure 1. Crown leaf budding. A. Separating leaf buds from the crown. B. Leaves growing in the planting medium. C. Four stages of bud development. D. Plantlets transferred into small pots. E. Plantlets under shade and irrigated with small sprinklers. F. Plantlets ready to be transferred to the field.

Figure 2. A. Destruction of the stem apex by gouging. B. Plantlets produced by gouging. C. Plantlets left on the mother plant (crown.

Table 1. Timing and production of plantlets for different propagation techniques to obtain 50 000 plants for 1 ha.

Method	Mutliplier	Initial material	Mother plant growth†	Plantlet production	Plantlet growth	Total growth
Tissue culture	1000	50	-	12	6	18
Chlorfurenol	10	5000	6	6	6	18
Plant castration	5	10000	6		12	18
Leaf budding	50	1000	-	3	5	8
Stem splitting	25	2000	-	3	5	8

†This and other columns to the right are time in months. The "Total" column is considered to be the minimum time.

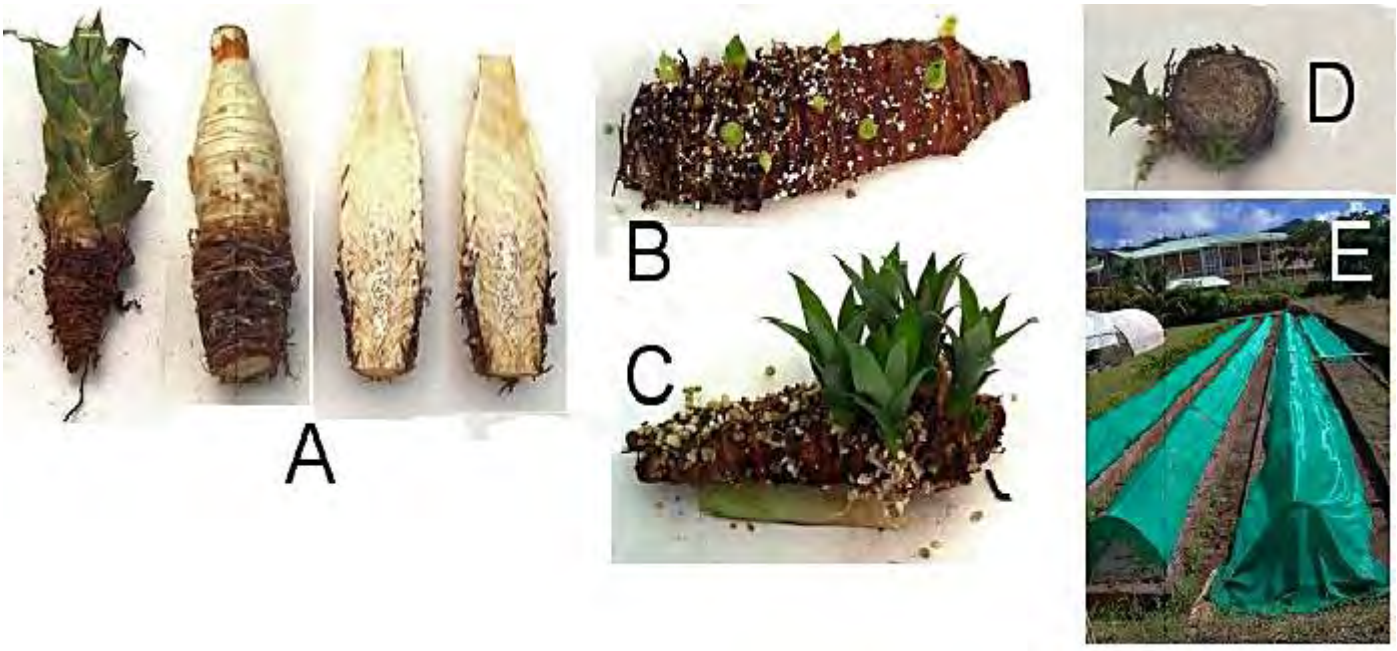

Figure 3. A. Stems cleaned and split into halves prior to disinfection. B. Stem half with growing buds. C. Stem with plantlets ready to be picked. D. Stem slice with growing plantlet. E. Stems in sand beds covered by shade cloth.

Conclusion

Multiplication factors and timing of plant production depend on environmental conditions and varieties. The 3 propagation techniques described as more practical techniques must be adapted to local conditions, particularly manpower cost, availability of greenhouses or similar structures or even availability of chemicals. The choice for a particular technique depends on the goal of the producers. The techniques showing the higher multiplication factors are more sophisticated and may require special infra-structures with higher costs and so they are useful for development of new varieties or multiplication of specifically selected plants. With the others, the classical infra-structures of production are sufficient, and so are more convenient for farm expansion.

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Forcing in Pineapples: What is New ?

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Introduction

Successful forcing is a key point for economical sustainability for pineapple farms. Ethylene, the natural hormone controlling pineapple flowering, is the best forcing agent. On that basis, the following different techniques have been developed and are still in use.

- Gaseous ethylene injected into water with activated charcoal is the most widely-used technique on large scale farms with a high level of mechanization (Py et al., 1984). Night applications are required as the pineapple stomata through which the plant absorbs the gas are closed during the day.
- Calcium carbide after contact with water produces acetylene, a gas with a chemical structure very close to ethylene (Abeles, 1973) that can force pineapple (Py et al., 1984). The explosive nature of acetylene limits this efficient technique to smaller farms with manual application of a water-saturated solution (Abutiate, 1977). The technique also requires night application.
- Ethephon, an ethylene releasing agent, has become the most popular technique over the world as it may be used by large or small farms and the chemical can be applied during the day, ethylene being released slowly in the plant (Cooke et al., 1968). The main limitation of this technique is poor efficiency during hot climatic conditions (season or equatorial areas).
- Cold water (5˚C) has been used on organic farms as other methods were prohibited. The technique gives results only on plants very susceptible to natural induction such as plants under stress (nutritional or mechanical stresses); the stresses enhance the natural production of ethylene by the plants. The results are very low and this method is scarcely used.

Recently European regulation (CE 1138/2005 as a complement of Annex II regulation CEE N° 2092/91) and following the US regulation (http://www.ams.usda.gov/nop/NationalList/FinalRule.html, § 205.601 Synthetic substances allowed for use in organic crop production; (k) As plant growth regulators, Ethylene - for regulation of pineapple flowering) allows the use of ethylene, and ethylene only, as a forcing agent for organic pineapple production. This alteration of the European regulation may be considered as a good opportunity for many small farmers, the main suppliers of organically produced pineapple on the markets,