

Applying Calcium Carbide to Induce Flowering in Pineapple

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Pineapple, *Ananas comosus* L., is both a lucrative and flexible crop. It requires good drainage and grows well on coarse textured soils. We get the best results in dark loamy sands that have some organic matter present, but it will grow even in coarse sand with almost no fertility, where few other crops grow. While the pineapples are smaller, they are still acceptable to farmers here. Pineapple is also drought-resistant.

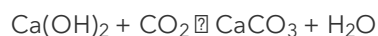
Due to an oversupply of fruit at harvest time in Mozambique, prices received by pineapple farmers drop from US\$0.90/pineapple to US\$0.25/ pineapple for large 2 kg pineapples (smooth cayenne type). Happy are the farmers whose pineapples mature before or after the peak season because they get more than three times the peak price. Production gluts are common during peak season in areas where many farmers are producing and selling the same perishable crops.

The solution to production gluts is to extend the season (i.e. have a harvestable product a bit earlier or later than most farmers) or to grow totally out of the normal season. Most crops are not easy to grow out of season. However, pineapple flowering is easily induced at any time of the year though the application of cheap chemicals. The most common compound used to stimulate flowering for commercial pineapple growers is ethephon, a commercial product that when mixed with water produces ethylene gas, a flower inducing plant hormone. It is somewhat toxic and needs to be applied with protective eyewear. A much older method of inducing flowering uses calcium carbide, which can be safely applied by farmers without any special equipment. We have observed that trying to apply the latest commercial technologies to small farms does not always work, as the varieties, inputs and methods are not all appropriate to the situation of smallholder farmers. The introduction of this older technology fits in well with Mozambican farmers' lack of equipment and resources.

Calcium carbide in contact with water (or humidity) produces acetylene gas, which induces flowering. (The acetylene molecule is the same shape and almost the same size as the ethylene molecule, and so is able to mimic that natural plant hormone.)



The calcium hydroxide formed in the reaction causes minimal leaf burn but no serious harm. It eventually turns into a harmless calcium carbonate precipitate (limestone is primarily made of calcium carbonate) through the following reaction:



Calcium carbide reacts immediately when it comes into contact with water, producing a flammable gas. Before the days of electricity, miners around the world wore lanterns (carbide lights) on their heads. The light came from burning the gas that was produced as water was very slowly dripped onto the calcium carbide. Uncontrolled addition of water to calcium carbide could produce so much acetylene gas that it could be explosive if ignited. Calcium carbide should be kept dry in airtight containers. I handle very small amounts of it without gloves, but it eventually absorbs moisture from my hands, reacts, and burns my flesh. It is probably the alkaline calcium hydroxide that causes the burning.

So calcium carbide should be applied to pineapple either with gloves or a spoon. Most of our farmers use spoons to apply dried granules.



Figure 1: A farmer applies calcium carbide in a pineapple field intercropped with maize. A small amount of water was in the funnel which reacted immediately to produce the “smoke” visible in the photo. Visual confirmation is important for new farmers trying the technology. Photo by Brian Hilton.

Induction of flowering in pineapple can be done any month of the year. We have had good success inducing flowering when the plants were 8-12 months old. It is best to pick large pineapple plants to induce, since small plants will produce smaller pineapples. Farmers can induce flowering up to one month before the normal flowering period to take advantage of high off-season prices. Place 0.8-1.0 gram of calcium carbide in the whorl of the plant (the opening at the very top) at sunrise (Figure 1). On nights with dew, the whorl will contain a little water, which makes the calcium carbide even more effective. Cool cloudy days are the best days for calcium carbide application. The most difficult time to induce flowering is when it is hot and

dry. Calcium carbide burns the leaves slightly and stresses the plant. We have considered putting a little water in the whorl to reduce the stress during hot, dry periods of flower induction. We recommend reapplication if heavy rain occurs within a few hours of the initial application.

A US \$6.00 bottle (500g) of calcium carbide can induce the flowering of 500 pineapples. Pineapples grown out of season sell for at least twice as much as peak season fruits. We calculate that difference at a conservative \$0.30/pineapple. So an investment of just \$0.012 per pineapple returns \$0.30 six months later. There are not many agricultural investments more profitable than stimulating flowering out of season.

Unexpected Problems in Introducing the Technology

Because of the high returns and the simplicity of the technology, we thought its introduction and adoption would be rapid. That assumption was very wrong. Theft of the out-of-season pineapple during the night was a problem in some areas, greatly discouraging farmers. Organized groups of thieves with machetes would come at night and steal as many of the ripe out of season pineapples as they could carry and then sell them in distant markets. Also, farmers making the most profit from calcium carbide would sabotage the field days by vocally complaining in order to discourage others from using the technology. An informed agricultural extension agent explained that farmers using the technology were afraid that the prices would drop if their neighbors began to produce out-of-season pineapple too. To alleviate this concern we tried to convince farmers of the large demand for pineapple (in the fresh market) and to help them sell in innovative ways by advertising and making roadside stands.

Table 1: Percentage of pineapple flowers successfully induced by calcium carbide applied at 3 different times of day to pineapple at different ages. *Sunrise on the date of application was 4:29 am.

	Time of Application								
	5:00 am*			8:00 am			6:00 pm		
Age of pineapple plant (months)	8	10	12	8	10	12	8	10	12
% plants successfully induced	70%	68%	81%	28%	3%	8%	47%	21%	32%

(/resources/dc9cd566-9ee3-416e-934d-34bd15a2a6f8)The most serious problem we encountered was a low percentage of pineapple flowering after calcium carbide application. Since the stomata of pineapple plants are open only at night, we suspected that the poor flowering was due to the fact that farmers were applying the calcium carbide in the mid-morning. We did a number of experiments to determine the best times of application (see Table 1).

Farmers were involved in the experiments, and during the field day, groups went around and counted the percentage of pineapple that had flowered. Once again hands-on experience convinced not only farmers but the extension staff and myself that earlier application times were necessary. The leaves of the smooth cayenne pineapple are spiny at the end so farmers get scratched. We suspect that some of the chemical falls outside of the funnel as farmers are leaning and reaching with a spoon in order to decrease leg scratching. Because of these realities, we consider flower induction greater than 70% to be satisfactory. Plants that do not flower can be induced again or left to flower during the normal period. Most farmers prefer to

stagger production so that weekly sales of fresh pineapple are possible. The closer the pineapple is to normal flowering the easier it is to induce. We have achieved over 90% flowering by applying the calcium carbide to 12-month-old pineapple plants one month before normal flowering.

Seasonal timing of the calcium carbide application is also important. Pineapple develops most of its sugars in the last month of maturation. Hot temperatures in the last month of maturation result in sweet fruit, while cool temperatures result in fruit that is less sweet. Here in central coastal Mozambique, we are at latitude 18°S, the same distance from the equator as Cuba and with a similar climate. However, we are in the southern hemisphere. June and July are our coolest months, so we encourage farmers to stagger their production so that less pineapple is produced during these cooler months.

Calcium carbide is a very useful chemical. A small amount of calcium carbide spray on tomatoes can force uniform ripening. Small amounts of calcium carbide can also be used (placed dry in a paper bag) to ripen fruit such as banana. These interventions produce higher prices for market-oriented farmers. However calcium carbide has been much criticized because it contains trace amounts of arsenic and produces trace amounts of phosphine gas. I suspect the concerns about calcium carbide are overblown but we are experimenting with alternative natural methods of ripening bananas.

Import Issues

Besides demonstrating the calcium carbide to farmers, we had to help the local seed store stock the chemical. We also helped the importer in the capital of Maputo to import calcium carbide from South Africa. Working to ensure the input supply is the kind of thing I never like doing as a missionary. I view it as side-tracking me from working with farmers. However it is necessary to ensure inputs are available in order to move to a more intensive agricultural system. We made numerous telephone calls to the factory in South Africa and arranged the quote for the importer in Mozambique. We made sure that we were paying enough so that the importers and store owners were also making money. Store owners who do not make money selling calcium carbide will not stock it. Calcium carbide was promoted as widely as possible amongst farmers to create a threshold demand that would guarantee the future sustainability of calcium carbide sales.

Conclusion

I wish I could say that this technology is already sustainable. It is not yet. We were too confident that flower induction would work, while having very little experience using calcium carbide. We lost about two years promoting calcium carbide widely without fully appreciating or understanding the problems that were occurring in the field. We were slow in interacting with farmers. But when we finally did begin to interact with farmers, we got much better results. Conducting participatory trials with farmers answered many questions and put us back on the right track. A core group of farmers is now using calcium carbide successfully to induce pineapple flowering.



Figure 2: Pineapple seven weeks after calcium carbide application. Residue appears on the flower and leaves. Slight leaf burning is evident on leaves which seven weeks previously were part of the whorl. Photo by Brian Hilton

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