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and Dawn Berkelaar

ECHO is a Christian non-profit organization whose vision is to bring glory to God and a blessing to mankind by using science and technology to help the poor.

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Extending the Life of your Seeds

By Edward Berkelaar, PhD

Farmers everywhere plant seeds with the expectation that they will germinate, grow and produce a crop that can be harvested. In some cases, the seeds that are planted germinate as hoped. In other cases, seed germination percentage is quite poor. This article will address some aspects about seeds and how to store them so that they remain alive as long as possible.

First of all, what is a seed? A seed is the result of sexual reproduction of a plant; it is the offspring of the previous generation of plants. Seeds are made up of three parts: a tiny little plant called an embryo; stored food and nutrients; and a protective shell called a seed coat. The embryo within the seed may be alive, or it may be dead. If it is alive, the seed is considered viable, and may germinate and grow when planted. Once the embryo dies, the seed is no longer viable and will never germinate. The largest part of the seed is made up of stored food and nutrients. These are the raw materials the young plant depends on from the time when it germinates and begins to grow until the time when its roots are large enough to accumulate nutrients from the soil and its leaves can supply energy from the sun. The embryo, food and nutrients are neatly packaged in a protective seed coat. A healthy mature seed contains a small living plant that will begin to grow once conditions are right for it to do so. To grow, the seed needs sufficient water, a suitable temperature (not too high or too low), and oxygen.

Sometimes seeds will not germinate even though conditions are favorable for them to do so. This can be explained by one or both of two possibilities.

One possibility is that the seed is alive but dormant. Seeds are dormant if they will not germinate even though they are alive and the external conditions are favorable for germination (e.g. seeds have oxygen and water and are neither too cold nor too hot). Something about the seed prevents germination from occurring; perhaps the seed coat is not permitting air or water to pass through, or perhaps the embryo itself is inhibiting germination. Dormant seeds require a pretreatment before planting. Several examples of pretreatments include soaking in water (sometimes hot water), scarification (scratching a hard seed coat with a knife or sand paper), or stratification (prolonged storage under cool conditions). Seeds of many tree species require treatments like these. If seeds require one of these pretreatments before they will germinate, the information is typically included on the seed package or on a paper accompanying the seeds. Seeds of most vegetables and field crops do not require any pretreatment.

The second reason why seeds may not germinate and grow once they are planted is that they may be dead. Like any other living thing, seeds will die after a time; especially if storage conditions are not good. Some seeds will not live long no matter what you do. For example, many tropical tree seeds will only remain alive for up to a few months or a year. These types of seeds are called recalcitrant. Recalcitrant seeds should typically be planted very soon after harvest; they will most likely fail to germinate if dried much or if stored from one growing season to another. Examples include seeds of mango, jackfruit and avocado. Seeds of most common field and vegetable crops are called orthodox seeds. Orthodox seeds can be dried and can typically be stored for several years

under the right conditions. For example, onion and sweet corn may last one to two years, while beans can last for three years and eggplant and squash can last for five years. Some orthodox seeds can remain alive for a very long time. There is a report of *Mimosa glomerata* seeds germinating after being stored for over 200 years. Indian lotus (*Nelumbo nucifera*) seeds that were estimated to be over 1000 years old germinated after being removed from a peat bog. Eventually, though, any type of seed will die if it is not planted; the length of time a seed will live in storage depends on species storage conditions.

A few years ago, we obtained a copy of a booklet published by the seed company Asgrow, titled “*The Preservation of Viability and Vigor in Vegetable Seed*” (Asgrow Monograph No. 2, Associated Seed Growers, Inc., New Haven Conn., 1954). This publication summarizes the results of research that was done to determine which factors affect the quality of orthodox seeds in storage. Seed quality was assessed by looking at both the viability (whether seeds were alive or dead) and vigor (the health of living seeds). Viability of seeds was determined by calculating the percentage of seeds that germinated on wet paper. Vigor was described with a qualitative rating (excellent, good, fair, poor or dead) of how quickly the seeds grew after germinating. Seed vigor typically declines before viability is lost.

The data collected during the study showed that three environmental factors played an important role in determining the quality of stored seeds. These factors were the length of time seeds were stored, the temperature at which the seeds

were stored, and the moisture content of the seeds when they were placed in storage.

Length of Time in Storage: Simply put, the longer the seeds were stored, the greater the decline in seed quality. Some seeds in storage will decline in quality faster than others, but the quality of all seeds will eventually decline. It is best to store seeds only as long as necessary and, if possible, to avoid using seeds collected before the previous year’s growing season.

Storage Temperature: Seed quality remained higher for a longer period of time when seeds were stored at lower temperatures (16 or 21°C; 60 or 70°F) than at a higher temperature (32°C; 90°F). A rough rule of thumb is that the lifespan of stored seeds doubles for every ~5.5°C (10°F) drop in storage temperature.

Moisture Content of Seeds: The quality of stored seeds remained higher for a longer period of time if their moisture content was low at the time they went into storage (6.5%) than if their moisture content was high (9.3%). As seeds mature on the plant, their moisture content declines. After harvest, seeds are typically dried some more, reducing the moisture content of seeds even further. Another rough rule of thumb is that, for every 1% drop in seed moisture, the lifespan of stored seeds will double. Seeds will begin to germinate when their moisture content is above 30%. A seed moisture content of 10-15% will suppress seed activity and the activity of fungi that may spoil seeds. If the moisture content of seeds is below 10%, few insects will survive. Ideal seed moisture content is probably

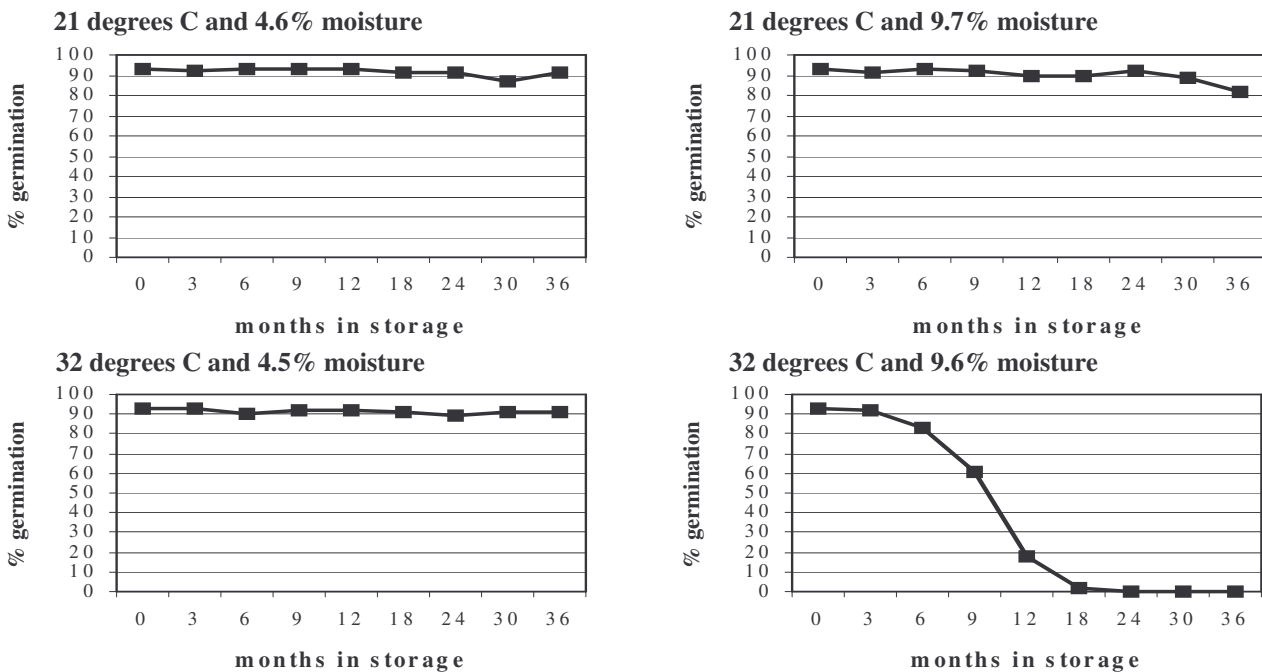


Figure 1: Effects of storage temperature and seed moisture content on percentage germination of tomato seeds stored for up to three years. (Data taken from page 32 of “*The Preservation of Viability and Vigor in Vegetable Seed*,” Asgrow Monograph No. 2, Associated Seed Growers, Inc., New Haven Conn., 1954).

between 5-7%, but if you want to store seeds from one growing season to the next, a moisture content of 8-10% is probably sufficient. As shown in Figure 1, the effects of storage temperature and seed moisture content on viability interact over time; higher seed moisture content is more detrimental when storage temperatures are high.

What determines the moisture content of seeds? Moisture within seeds is in equilibrium with water in the air, so seed moisture content depends on the relative humidity of the air that seeds are in. If the relative humidity of the air decreases, then seed moisture will also decrease. There are two ways to reduce the moisture content of seeds. One way is to keep them, for a time, in air with a low relative humidity. This could be low-humidity air in the dry season, or air sealed in a container with a desiccant. Desiccants (any substance used to absorb moisture from the air) cause seeds in the same space to become drier. Appropriate desiccants include silica gel, powdered milk, rice or grain seed. Desiccants can be dried in an oven or over a fire and then wrapped in paper or cloth and sealed in a container with the seeds. A second way to reduce moisture content of seeds is to expose them to warm air (but not greater than 45°C (110°F)). Seeds will be damaged if the temperature is too high for too long, so hot-air drying must be done with care.

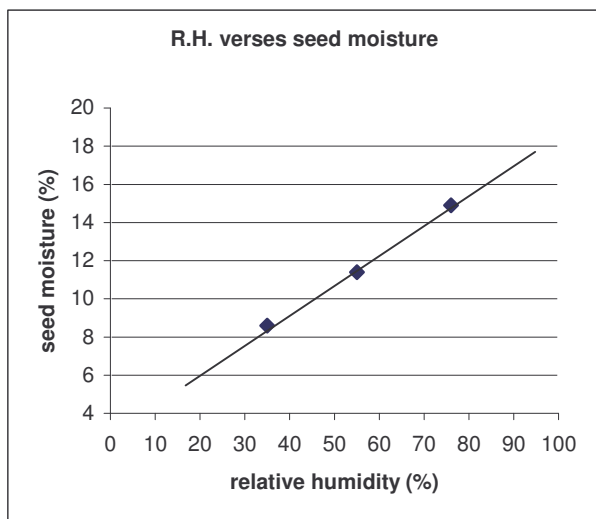


Figure 2: % seed moisture for varying % relative humidities. These data are for onion seed at 68°F. The relationship probably differs for different seed types, but this may be a helpful guide.

Summer temperatures in Florida average in the high 20s°C (low 80s°F) but typically reach 33-34°C (91-92°F) during the day. Average relative humidity ranges from 70 to 90%. Seeds stored in such conditions would be subject to high relative humidity (and would therefore have a high moisture content) and would be subject to high temperatures that fluctuate daily. In such an environment, how can seeds be stored to maintain quality with minimal resources? In the summer of 2002, Krista Pendergrass, a research intern at ECHO, did a simple trial to see how to easily reduce temperature and relative humidity in a container that could be used to store seeds. A PVC pipe six

inches in diameter and about 70 cm (2'4") long was sealed on one end and buried vertically in the ground (in the shade) so that the top was even with the soil surface. Rice was dried in an oven, and then placed in a plastic jar with a remote temperature and relative humidity (RH) sensor. The jar was then closed and dropped in the tube and the top of the tube was sealed. The oven-dried rice seeds in the jar absorbed moisture, reducing the relative humidity to 30-40%. [Tim Motis, ECHO staff member in Haiti, likewise obtained 30% relative humidity with rice in 2004 by oven-drying the rice for one hour at about 300 °F to remove nearly 10% of the initial rice grain moisture content.] Because the tube was buried in the soil, the temperature remained stable at ~27°C (80°F), approximately 6-7°C (11-12°F) cooler than daytime highs (Figure 3).

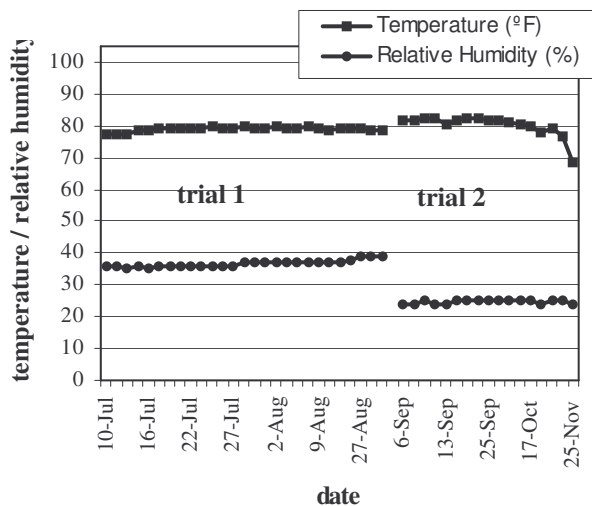


Figure 3: Temperature (in °F) and relative humidity (%) over time in a sealed jar containing dried rice and buried in soil. The relative humidity was much lower than that of outside air. The temperature remained stable throughout the day and was considerably lower than the daytime high temperature. A rule of thumb is that if the temperature in °F and the relative humidity in % add up to 100, conditions are good for the storage of seeds. Using this rule of thumb, imagine a scenario where seeds were stored at 90°F and at 80% RH. Storing seeds at 80°F instead (but still at 80%RH) would double their shelf life. Storing seeds at 90°F and 72%RH would also double their shelf life. Storing seeds at 80°F and 72%RH would quadruple their shelf life compared to the original scenario.

In conclusion, seeds are living, but they have a limited lifespan. The quality of stored seeds will be best if they are stored for as brief a time as possible in an environment that is dry and cool.

***Tithonia diversifolia* as a termite repellent for protecting fruit trees in Central African Republic**

By Timothy Watkins

[Eds: A few years ago, Tim Watkins spent time in the Central African Republic working with a tropical fruit tree project.

While there, he sent ECHO the following information about using *Tithonia diversifolia* as a termite repellent. *T. diversifolia* (also mentioned in the next article) is a fast-growing shrub with dark green leaves and bright yellow sunflower-like blossoms (Figure 4). It is commonly seen along roadsides in Africa.]



Figure 4: *Tithonia diversifolia*.

We read a recipe reported in an *ILEIA* Magazine by a Kenyan farmer. The *ILEIA* article read, "I had eight ant hills on my farm and the underground termites destroyed my crops and trees. I pounded together 4 kilograms of fresh *Tithonia diversifolia* leaves and 4 kilograms of fresh *Melia azedarach* leaves. I immersed this mixture in 20 litres of water and left it to ferment for four days. I then poured the fermented mixture into the opening of each of the eight termite nests. The solution was very effective and controlled most types of underground termites. The good thing is that this mixture is cheap. I do not have to repeat the treatment until new termites move onto my farm. When they do they'll get the same treatment. However, this method only works on underground termites."

We began with this recipe, but we had difficulty obtaining the *Melia azedarach* leaves. So we tried the treatment using only *Tithonia* and it seemed to be effective on its own. We began by harvesting a few small cartloads of fresh leaves, then chopped and pounded the leaves. (The workers preferred to pound them on the cistern, but I thought it was a waste of time and not good for the cistern, so eventually we just chopped the leaves briefly). The rest of the steps went as follows. First, we filled half a barrel with chopped/pounded leaves and soft stems (avoid hard/woody stems). Then we filled the barrel with water and used a board with a rock on it to hold all the plant material down in the water. We allowed that to sit for about 4 days in the shade (we never did it in the sun—I am not sure if it matters or not). After four days the *Tithonia* began to smell very strong and very bad. It also looked very black and mucky. We then poured the black liquid and muck around the bases of trees that had termites or that were known to be susceptible to termites. We had constant problems with termites attacking Inga, Terminalia, Macadamia, *Dacryodes edulis*, and guavas. We regularly treated our problem-prone trees and then any others that showed signs of termites.

Although we were not careful to record how long the treatment was effective, I and the other staff all felt that it was quite effective. Trees that were damaged by termites were free of them for several weeks, perhaps depending on the rains. We began doing this during the rainy season, which probably reduced the duration of the effect considerably. We felt that we had repelled termites from most of our problem-prone trees. We used *Tithonia* as a spot-treatment whenever we saw termites affecting a tree.

We did observe some adverse effects of *Tithonia*. When the blackened leaves and muck were mulched around the base of a tree, touching the tree, it seemed to rot the bark (probably no differently than with most any mulch). So, we began to be careful about not letting the muck touch the bark of the tree. We still poured the black liquid around the base of the tree but were more careful about the muck.

Our recipe in summary:

1. Fill to half a 50-gallon drum with fresh, chopped *Tithonia* leaves and stems (soft, new growth)
2. Fill to level with water
3. Cover, place weight to hold material in the water
4. Allow to ferment 4 days or until vile smelling
5. Pour liquid and black muck around bases of trees, or into termite mounds
6. For trees, take care to keep muck from touching tree, as it may cause the bark to rot (as will any thick mulch or compost touching the bark for many tree species)

Depending on the rains, the treatment may be effective for about 1 month. With heavy rains it is best to treat trees more frequently.

***Tithonia* and *Lantana*—An update**

By Darrell Cox

In issue 57 of *EDN*, we described the merits of *Tithonia diversifolia* and *Lantana camara*, common weedy species in some parts of the world. These non-leguminous species were used as mulches by ICRAF researchers to increase maize yields. Leaves of both species contain up to 3 percent nitrogen. Surprisingly phosphorus also is found in high quantities in the leaves of these hedgerow weeds. *Tithonia* and *Lantana* contain up to three times the quantity of phosphorus found in many plant species. This may in part explain the significant yield response that was obtained with the mulch treatment of 5 t/ha of *Tithonia*.

A field of maize that produces 4 tonnes of grain per hectare accumulates 18 kg of phosphorus in the grain and stover (dried leaves and stalks). To maintain the fertility of the soil over years, phosphorus must be added to the soil as an amendment or through nutrient recycling. [It is not uncommon that soils contain phosphorous but that roots of most plants cannot extract it from the soil.] As plants like *Tithonia* and *Lantana* decompose, some of the phosphorus they contain becomes available to succeeding crops. The yield response the

ICRAF scientists obtained using these mulches surpassed that obtained with the highest phosphorus-only treatment of 50 kg/ha. *Uganda Environews* (June 1997) reported that it is thought that the roots of *Tithonia* and *Lantana* may be associated with mycorrhizal fungi, which form a special relationship with the plants, in a similar way to the root nodules in leguminous plants. Mycorrhizal fungi are known to penetrate the feeder roots of plants and provide the plants with a supply of nutrients and trace elements that they have extracted from the soil.

Tithonia and *Lantana* also are considered valuable dietary supplements by farmers in Africa. Researchers documenting the use of indigenous trees and shrubs for fodder production by Kenyan farmers found that *Tithonia diversifolia* was one of the five most popular species on farms on the slopes of Mt. Kenya (a subhumid climate with 1300 mm mean annual rainfall). *Lantana camara* also was listed as one of the five most popular fodder species for areas characterized as warmer and drier with mean annual rainfall of 950 mm. Both of these species are used by Kenyan farmers for fodder and not only as supplements during the dry seasons. In the higher rainfall areas, *Tithonia* is grown as a hedge and is cut frequently to maintain a height of approximately 1 to 1.5 m, whereas *Lantana* is generally browsed in the drier zones throughout the year. However, caution should be taken with *Lantana camara*. Scientists in South Africa have determined *L. camara* can be toxic to sheep and cattle. It is also known as an aggressive invasive weed and can be difficult to eradicate once it is established. (*Agroforestry Today*, July-Sept. 1997)

[Ed (DRB): I heard Pedro Sanchez speak in June of 2004 about "Hunger and Soil Fertility in Africa." Sanchez is co-chair of the Hunger Task Force of the United Nations' Millennium Project; the goal of the Hunger Task Force is to halve the number of hungry people in the world by 2015. During his talk he discussed the need of farmers to access plant nutrients at the lowest possible cost. *Tithonia diversifolia* (Mexican sunflower) was one of the crops he talked about, because it is such a good nutrient accumulator. Farmers cut it from hedges and use it as a green manure. However, he warned against planting it near other crops, precisely because it is so good at accumulating nutrients!]

Moringa Named Tree of the Year

Lowell Fuglie with Church World Service in Senegal wrote, "The Moringa tree was declared "The Tree of the Year" by the Forestry Ministry here in Senegal."

The work of Lowell and his team has made moringa leaves (fresh or powdered) an important tool in the fight against severe malnutrition. Moringa is now being used by dozens of other organizations and individual farmers.

This is an outstanding example of how a resource with great potential sometimes needs someone or a group to recognize its potential and then dedicate itself to making that potential a reality.

ECHOES FROM OUR NETWORK

Traditional Plant Varieties and Low Fertility Soil

Joel Matthews
SIM International
Niger, West Africa

One of the most common agricultural improvements is the introduction of an "improved seed" for the particular species of plant that is traditionally grown in an underdeveloped area. A second is to increase both fertility and organic content of soils. These two approaches are seldom questioned, and scientists and development workers seem eager to replace all traditional farming methods with improved seed and high fertility soils with high organic content.

While the benefits of traditional varieties are being re-assessed in agricultural research, there has not been a similar reassessment of the possible benefits of what I term "traditional soils" (low fertility and low organic matter). My work in Niger with Maradi Integrated Development Project has forced me to question the wisdom of assuming that increases of organic content and fertility are always best.

Millet is the staple crop of much of West Africa, and several improved varieties have been introduced. One particular variety "HKP" is multiplied at the national agricultural research center and made available for sale to farmers. Most

often, the benefits of improved seed include early maturity, higher yield, and superior response to fertilizer. This millet matures in 70 days, as compared to 90, 100, or even 120 days for traditional varieties. Although early maturity may be a desirable quality in many situations, it may actually be a liability in a traditional farming system.

If higher or earlier yields are the only criteria, then these varieties make a lot of sense. However, early maturing cereals normally require higher levels of fertility than longer season varieties, and achieving these higher levels of fertility is very difficult for traditional farmers. Those who plant HKP and other improved varieties in low fertility areas are invariably disappointed with meager yields. In fact, where fertility is low, traditional varieties will often perform *better* than improved varieties. This is a fact that is often overlooked by development workers and researchers.

Now one could argue that farmers need to increase soil fertility on their farms—there is certainly nothing wrong with higher fertility in certain situations, but it is not a panacea.

In fact, there are situations where lower fertility is preferred to higher!

But how can this be? My experience with farmers in West Africa had forced me to challenge the assumption that higher fertility is always better.

Experienced farmers in the Sahel argue that in years of low rainfall, high fertility soils will not support plants as well as sandy non-fertile soils. Scientists and development facilitators would say that high fertility encourages root growth, plant vigor, disease resistance, and consequently, drought resistance. But if we were to follow these farmers to their fields during a drought, we would see an amazing thing—traditional varieties of millet seemingly unaffected by drought, on fields of very low fertility.

It seems that two “wrongs” can make a right in certain situations, in fact they can be doubly right! The claims of West African farmers are consistent with my observations. In very light rainfall conditions (2-5mm), plants definitely cope better on light sandy soils with low organic content and low fertility. The addition of either chemical fertilizer or manure reduces the ability of plants to cope with these conditions. To make matters much worse, it seems that even the addition of organic mulch increases drought stress.

There are several things working simultaneously here. First, observations of lower drought tolerance in higher fertility sandy soil is probably explained by some sort of reverse osmotic condition which occurs with high levels of dissolved salts—moisture is pulled from the plant tissue into the soil [Ed: or osmotic conditions make it more difficult for water to be pulled from the soil into the roots]. This does not seem to occur in very sandy soil with very low levels of dissolved nutrient salts. Thus, Hausa farmers categorize high nutrient soils as *zafi* (hot/dry), and sandy nutrient poor soils as *sanyi* (cool, moist). Secondly, the explanation for organic mulches increasing drought stress is that in very low rainfall situations (2-5mm) organic mulch absorbs moisture rather than allowing it to penetrate the soil. This limitation does not seem to apply where soils have had a good soak, and are then subjected to droughty conditions, but specifically to conditions of very light rainfall on dry soil, which is a common condition in the early months of the Sahelian wet season. Thirdly, very sandy soils absorb small amounts of moisture very quickly to a deep level where moisture is protected from evaporation. Finally, traditional cereal varieties are better able to take advantage of lower fertility sites, providing high yields where improved varieties do poorly.

Therefore, contrary to conventional agricultural thinking, it is *not* desirable to convert all farms to mulched, high fertility, high organic soils, as this would make them more susceptible to drought *in conditions of very light rainfall on dry soils*. Risk management will be improved if farmers utilize both improved cereals in smaller fertile farms, and traditional varieties in low fertility, low organic sandy soils.

[Ed (MLP): Another factor might be that plants grow larger and more quickly in fertile soils. If there is a subsequent drought, there is greater leaf area and hence more water is pulled from the soil through evapotranspiration. ECHO staff member Tim Motis wrote, “These observations underscore the value of doing variety trials under conditions similar to those under which farmers are growing their crops. If a trial in a

drought situation had been done using irrigation with fertilizer and/or organic matter, one would not pick up on the fact that local varieties might perform better than new varieties under conditions of drought with poor soil fertility.”]

More about Traditional Varieties and Low Fertility Soil

Stan Doerr, an ECHO staff member who worked for several years in Mauritania, had several comments after reading Joel’s article. Below we share Stan’s comments and Joel’s responses.

Stan: I have seen how sand can hold the moisture in the desert. Several months after the last rains I have dug into the sand and found the sand wet only a foot or so below the surface. I suspect this is due to the lattice nature of the pure clean sand in the Sahara. Organic material could possibly increase the evaporation of the soil moisture if it is in fact the lattice nature of the sand that holds the moisture.

Joel: I cannot confirm that organic material may increase evaporation. But Stan’s observation that several months after a rain, moisture can be found only a foot below the surface in pure sands confirms my observations concerning soil moisture retention and sand.

The issue here is organic material shedding moisture. You can conduct a simple experiment by filling two glass jars with dry soil, one with high organic content, the other pure sand. You will see that the pure sand immediately absorbs water as the spaces between particles are filled to saturation. The soil with dry organic content must absorb the moisture more slowly and may puddle on the surface initially. This is because some materials, when dry, will repel moisture initially.

Another experiment that can be conducted is to spread out dry manure and dry organic material on a plot of land while leaving an adjacent plot of untreated sandy soil. Sprinkle both areas with the same quantity of water then dig a hole in each area and measure the penetration of water. Normally, the sands with low organic content will have the greatest depth of moisture.

This same phenomenon can also be observed with zai holes [a technique in which holes are dug and filled with mulch to encourage termite activity and increase the rate of water infiltration when rains come. Seeds are planted in the holes. See *Amaranth to Zai Holes* page 133, or search our web site for more information.] In our experience in Niger, zai holes often have less moisture after a light rain than surrounding untreated sandy soil. This too is due to organic material repelling initial moisture.

Stan: Using chemical fertilizers in low rainfall situations would most likely just burn the plants instead of dissolving the fertilizers. I suspect most farmers cannot afford commercial fertilizers anyway.

Joel: [Stan’s] comment that chemical fertilizer will burn in dry soil is correct. One of the innovations we promote is to powder NPK for application where rainfall may be low or

erratic. Powdered fertilizer dissolves much more quickly in low moisture soil [Ed: which could also cause burning]. However small amounts of chemical fertilizer added to poor soil probably contributed to soil nutrient mining and is not generally encouraged.

Stan: Drought is drought and I have seen too many farmers lose everything due to lack of rainfall and they would never have been able to add chemical fertilizers nor did they have enough organic material to add (all was eaten by the animals) so I have trouble buying into the cause for bad yields being due to organic materials or fertilizers although I do think that locally adapted varieties are often better than "improved" varieties. That is why variety trials by development agencies and then by local farmers are an essential first step before introducing a "new and improved variety" to the communities that we work in.

Joel: [The] comment that "drought is drought" is an over generalization. Drought for farmers is normally defined by the effect on plants rather than actual rainfall. Drought comes by degrees. During droughty periods it is very common to see some crops doing fine, while others are wilting and drying. Sometimes the difference can be chalked up to soil differences. Heavy clays on the surface will repel moisture leading to run off rather than infiltration. Likewise, hardpans either on or below the surface limit infiltration (this is why the best time to buy a field in drought prone regions is during a drought—choose a field where plants show less drought stress than adjacent plots.)

Differing cultivation treatments also make a difference. Frequent cultivation will reduce drought stress because of the dirt mulch that is created when tilling after a rain.

Other times it can be determined that areas experiencing wilting have a much higher fertilizer content (all other factors being the same), leading to the burning mentioned above. This

discovery can only be made by observing different fields during droughty conditions.

Stan: Have you tested soil fertility or are you just assuming the Sahel soils are depleted? We found in Mauritania that often the soil fertility was good because nothing had been growing and thus the soils were not depleted.

Joel: Sahel soils are notoriously low in phosphorus; and nitrogen and potassium are also low where continuous cropping is practiced. This can be demonstrated by the high response to small applications of fertilizer, either organic or chemical. Higher fertility areas do not show nearly as much response to fertilizer application.

Stan: As has been well documented, we have also found that farmers like to grow sorghum in millet areas ("millet is for the poor") and maize in sorghum areas ("sorghum is for the poor"). Isn't this what Tony Rinaudo calls the green drought? [See EDN 77]

Joel: As to choice of crops, our observations are for the same crop planted the same date, mostly millet, but also sorghum. Corn is very risky in low rainfall areas since it requires higher fertility, which causes burning in drought. It will not perform well in low fertility soils, as will millet and sorghum.

Finally, one of the best ways to learn about farming is to interview traditional farmers in the region. Many will confirm that traditional varieties are grown on low fertility soils because longer season varieties (100-200 days) can take advantage of the low fertility levels while short season (60 - 80 days) need higher fertility to do well. This is one reason why "improved varieties" (early maturing) have not done well in this region.

I still maintain that in droughty conditions, especially where scant rainfall occurs, and where the soil is already dry, that high fertility plots will suffer moisture stress much earlier than low fertility high sand plots.

FROM ECHO'S SEEDBANK

Loquat: A Fruit Tree Adaptable to Many Locations

*By Carolyn Langley
Assistant Seed Bank Manager*

A relative of pear, apple, and peach, the loquat (*Eriobotrya japonica*) tree is a lesser-known fruit. The loquat originated in southeast China where it has been cultivated for over 2000 years. The tree is now distributed far and wide. It is cultivated in India, Southeast Asia, the medium altitudes of the East Indies, Australia, New Zealand, South and Central America, and Mexico. It can grow in very tropical regions such as the

Congo, as observed by ECHO's farm manager Danny Blank during a past visit. In the U.S. it is grown in California, Hawaii, and even in areas as temperate as the Carolinas. However, in the Carolinas, loquats don't produce fruit and are grown purely as an ornamental. The loquat tree is the only evergreen among its relatives; its evergreen leaves, moderate size (20 to 30 feet or 7 to 10 meters) and attractive canopy make it an ideal plant for landscaping.

If one word were used to describe loquat, it would have to be 'adaptable.' Loquat can tolerate cooler weather like its relatives, but also thrives in tropical

conditions. According to several sources, it can survive temperatures as cold as 12°F (-11° C) for a brief period of time. There is a lack of information on maximum temperatures tolerated by loquat; however, loquat fruits poorly (if at all) in a climate that is "too" tropical. As far as elevation, it grows naturally at an altitude of 3,000 to 7,000 feet (914 to 2,100 meters) in China. Loquat fruit production at any given elevation depends on the latitude. A loquat growing at an altitude of 3,000-7,000 feet near the equator may not produce fruit, while the same tree at the same elevation in China will. Of course there

are exceptions to all of these climactic ranges depending on the microclimate. For example, Bob Hargrave at ECHO says that loquat trees produced well at 5,000 to 7,000 feet in Kenya, very close to the equator.

Many varieties of loquats have been selected. There are over 800 varieties according to one report from the Orient. Here at ECHO we have 'Oliver', 'Wolfe', 'Christmas', and 'Bradenton' planted on the farm. These varieties are well adapted to southern Florida's subtropical climate. Wherever loquats can be found, a selection of improved seedling varieties is usually present, perfectly fit for that location and climate.



Figure 5: Loquat fruits on the tree.

Trees grown from seeds are not identical to the parent, so desirable varieties are maintained through grafting. However, unlike many fruit species, fruit from loquat grown from seed is usually very acceptable. For most species of fruit, grafting is done to maintain a desirable varietal characteristic (e.g. short and compact tree canopy) or to promote early fruit production. It should be noted, though, that grafted loquat trees do not necessarily produce fruit any earlier than non-grafted loquat seedlings. The time to fruiting is 4 to 6 years with a non-grafted

seedling, compared to 3 to 5 years with a grafted plant. Of course, these times are dependent on the care and climate under which the tree is grown.

Loquat trees are pollinated by bees and are usually self-fertile. In some cultivars they are self-incompatible and need cross pollination to set fruit. It is recommended to have several different varieties or seedlings for optimal fruit set. The season of fruit production varies from country to country. Loquat trees at ECHO fruit from February to March, the cool time of year here. Interestingly, the tree blooms most of the year at ECHO. This is a reminder that where the year-round climate is hot and humid, people planting loquats will probably only see leaves and blossoms but never fruit.

The fruit is borne on the terminal ends in clusters of 3 to 5. The time from flower to fruit is 90 days. Many people I know have tasted loquat and found they liked it right away. The fruit is sub acid and juicy with a texture similar to peach or apricot. Fruits are ready when they are totally orange or yellow.

Loquat trees are subject to few diseases and pests, though fruit fly damage to the fruits is severe at ECHO. The female Caribbean fruit fly (*Anastrepha suspense*) lays her eggs in the fruit. Larvae that emerge from the egg then eat their way out of the fruit. Caribbean fruit fly quickly ruins the quality of fruit. The best control is to either bag the immature fruit on the tree or pick the fruit before the flies damage it. Avoid planting loquats in an area where there is a serious infestation of fruit flies.

The drought tolerance of the loquat is impressive. Many of the loquat trees planted here at ECHO are not irrigated. However, during the peak of the dry season in May, the trees do show signs of water stress. Irrigation is recommended during fruiting to increase the quality of fruit.

Despite all of the loquat's great characteristics, there are a few drawbacks. This tree has little tolerance to flooding. The best location to plant a loquat is on higher ground where there will be no standing water. The loquat is also intolerant of saline soil, although it tolerates a wide range of soil types.

All in all, the loquat is a fruit tree that is easy to grow in many locations and is a beautiful ornamental even when grown where the tree may not bear fruit. The ECHO seed bank can provide loquat seeds to our network. However, because the seeds do not keep well in storage, they are only available seasonally from February through June. Even though the seedlings may vary from the parent plant, they will produce tasty fruit. You may even enjoy selecting for yourself a superior seedling that is best suited to your taste and location.

If you are a member of our network, you may request a free sample seed packet. E-mail echo@echonet.org with your request, and include a mailing address. Order in January. If you are not a member of our network, the seed is available at \$3 per packet while supplies last.

UPCOMING EVENTS

Ninth North American Agroforestry Conference

June 12-15, 2005
Rochester, Minnesota

The theme of this conference of the Association for Temperate Agroforestry

(AFTA) is "Moving Agroforestry into the Mainstream." It is intended to attract people interested in the production and environmental benefits of agroforestry. It will provide a forum for practitioners, scientists, NGOs, and agency representatives to share their experiences

and discuss production and environmental attributes of different agroforestry systems. There will be concurrent sessions on various themes, poster sessions, field trips and panel discussions. For more information, visit www.cinram.umn.edu/afta2005.

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