



## Noni cultivation in Hawaii

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Cultivation of noni has recently undergone a revival in Hawaii as interest in plants with nutraceutical properties has increased. Noni (Indian mulberry, *Morinda citrifolia* L.) is an evergreen shrub or small tree that grows to about 10–20 feet tall. Its angular branches bear short-stemmed, ovate leaves that are thick, shiny, dark green, and deeply veined. Noni flowers are “perfect,” containing both male and female organs. The fruits have an unusual shape, are about 2–4 inches long, ovoid, and yellowish-white, and become quite soft at maturity.

Noni is found in Southeast Asia and Australia, and it has been distributed throughout the Pacific region. It was among the plants that Hawaii’s Polynesian colonizers brought with them in their voyaging canoes, because they valued its use as medicine and a source of dyes. Today, the traditional medicinal uses of the plant persist, and nutraceutical teas, juices, and extracts are marketed in Hawaii and worldwide.

Noni is naturalized on all of the main Hawaiian islands. It grows where it is relatively dry to moderately wet, from sea level to about 1500 feet elevation. It can be found near the coast, in open lowlands and grasslands, in gulches, and in disturbed forests of the dryer areas, such as the areas where *hala* (pandanus) grows. It tolerates soil salinity and brackish irrigation water.

Many of Hawaii’s noni growers shared their knowledge and experience with the author. Statements here about noni cultivation are not intended as explicit recommendations but rather as suggestions based on growers’ experience.

### Propagation

Noni is propagated either from seed or stem cuttings. The primary disadvantage of seed propagation is that without seed treatment and applied heat, uniformity of seed germination may be unreliable and seedling production may take 6–12 months for germination and 9–12 more months before they are ready to transplant, whereas stem cuttings can be rooted in about 2 months and be ready for transplanting in 4–6 months. The disadvantage of producing plants vegetatively from cuttings is that they may not be as strong and disease-resistant as seedlings, and the trunk and branches may split and break during the first years of fruit production.

### Propagation from seed

Noni seeds are reddish-brown, oblong-triangular, and have a conspicuous air chamber. They are buoyant and hydrophobic due to this air chamber and their durable, water-repellant, fibrous seedcoat. The seedcoat is very tough, relatively thick, and covered with cellophane-like parchment layers. A single large noni fruit can contain well over 100 seeds.

Only soft, ripened noni fruits should be chosen for seed collection. The seeds must be separated from the fibrous, clinging fruit flesh. First, split the fruit by hand into smaller pieces. Separate the seeds from the flesh using a strong spray of water and a firm screen or colander, washing the pulp through the screen while retaining the cleaned seeds. Rubbing the fruit fragments on the screen by hand or with a blunt object can help force the fruit flesh through the screen. It may take 15 minutes or more of vigorous washing and rubbing to detach most of the flesh from the seeds.

Scarifying the hard seedcoat by nicking or puncturing it significantly reduces germination time, improves germination percentage, and promotes uniform sprouting. Whereas in nature the seedcoat must gradually decompose before water can enter, scarification overcomes this natural seed dormancy. Using a household blender to separate seeds from the ripened fruit flesh can also result in nicking the seedcoats, or the seeds can be suspended in water and subjected to short pulses of blending.

Noni seeds can be dried and stored, but the length of time they will remain viable is not known. After cleaning, spread the seeds out on newspaper and dry them in the shade or indoors for 2 or 3 days. Store the seeds in an airtight container at room temperature.

Fresh noni seeds can be planted immediately after extraction from the fruit. Some growers soak the seeds until they start to germinate, then plant them in containers, while others plant fresh seeds without presoaking treatment. Some growers just plant fruit fragments containing seeds directly into the field soil.

Noni seeds require hot, wet conditions for optimum germination. Unscarified seeds need several months to a year before natural germination takes place, but this period can be reduced to a month or so using heat. The seeds can

tolerate temperature of 100°F (38°C), perhaps even higher. Select the warmest spot in the nursery or greenhouse to germinate noni seeds. Or, heat can be supplied using nursery heating pads under the seed flats, or by placing the flats or containers in a special “hoop house” covered with clear plastic. If germinated outside, partial sun is preferable to full sun to avoid excessive drying of the medium.

Noni seeds may be germinated in seedling flats or trays or sown directly in containers. A light medium that retains water yet remains aerated is best. Suitable components for a planting medium include vermiculite, perlite, peat moss, commercial potting media, compost, and fine volcanic cinder. For seedling flats, use a light medium, such as one part each of perlite and peat moss, or perlite, vermiculite, and potting soil in a 2:1:1 ratio. For containers, a slightly heavier medium is better, such as one part of perlite or vermiculite and three parts of a potting mix. Fertilizers should not be mixed into the medium, because additional nutrients are not needed until after the plants have their first true leaves.

Artificial growth media are preferred to field soil for germinating and growing out noni seedlings. These relatively sterile media give the plants the cleanest start, whereas soil (particularly agricultural field soil) tends to contain pathogens that cause plant diseases. For example, many agricultural soils are infested with root-knot nematodes, and noni is highly susceptible to the disease (known as noni root-knot disease) caused by these microscopic, parasitic worms.

Deeper seedling flats are preferred to shallow flats, because seedlings with longer tap roots are produced. Seedlings with deep, well established taproots tend to withstand the shock of transplanting better and become established more quickly than seedlings with short, misshapen (“J-rooted”) taproots.

When seeds are germinated in flats, they should be transplanted into growing containers within a few weeks of germinating. The plant size and vigor achieved depend to a large extent on the size of pot used—the larger and deeper the pot, the larger and more vigorous the noni seedling. “Gallon” pots (about 6 inches in diameter at the top) provide sufficient rooting volume to produce large, healthy seedlings for transplanting. Noni plants can become pot-bound and stop growing if the pot is too small or shallow or they are grown for more than 9–12 months. Fortunately, noni is a vigorous plant with a strong root system that can easily recover from being pot-bound once transplanted into suitable field conditions.

Generally, noni seedlings are grown in pots in full sun for a minimum of 9–12 months before they are transplanted to the field. Seedlings up to 3 years old or more may also be planted. If noni plants are transplanted too young, they

are more susceptible to weed competition, mechanical damage, and slug attack.

Seedlings and young plants grown from cuttings can be given liquid fertilizer once a month, or a controlled-release fertilizer less often (depending on the formulation’s release period). Balanced formulations such as 14-14-14 that also contain micronutrients (“minor elements”) are advised. Young plants also respond well to applications of dilute, liquid foliar fertilizers. As plants become established, granular, rapidly soluble formulations can be used. Noni is relatively salt-tolerant, and fertilizer burn is uncommon under normal conditions.

### Vegetative propagation

Cultivation of noni plants from stem cuttings (verticals or laterals) reduces the time required to obtain plants that are ready for transplanting. Cuttings from stems and branches will sprout roots readily under the proper conditions.

Select vigorous plants for propagation. Remove a branch or stem and check for fresh sap flow from the wound. If the sap flows readily, cuttings could be made from these materials. If sap does not ooze from the cut end, discard the material and select another plant, another location, or perhaps wait for a better time of year. Sap flow indicates a vigorous, actively growing plant with relatively high reserves of energy.

Insert the cut end of the freshly cut noni stem into a pot containing a general-purpose growth medium. Rooting hormone should improve or accelerate rooting of vegetative cuttings, but it is not necessary. As with seed germination, bottom heat enhances rooting, and an artificial, pathogen-free medium is preferred to untreated agricultural field soil. Select a location with partial shade and keep the cuttings well watered until rooting occurs. After rooting, move the plants into full sun and begin fertilizer applications.

Noni plants may also be produced by air layering or by digging up plants that have sprouted from the root system of a mature plant.

### Site selection

Avoid locations where other crops have been planted recently, due to the susceptibility of noni to root-knot nematodes. Select a site in full or partial sun with well drained, well aerated soil. Avoid heavy soils, compacted areas, and flood-prone sites. Prepare a hole about the size of the pot and transplant carefully. In rocky locations, “rip” the land (disturb or plow the subsoil) before grading to prepare a flat or gently sloping field.

### Windbreaks

Young noni transplants do not grow well where winds are

strong. Such conditions may exist along windward coasts. On the island of Hawaii, parts of the Hamakua coast and Kau are very windy. If a windy site is selected for noni cultivation, windbreaks should be planted for protection. Trees such as eucalyptus, ironwood, or wili-wili in rows 150 feet apart are excellent windbreaks for noni. Noni is not adversely affected by planting near ironwood.

### Varieties

No cultivated varieties of noni are recognized in Hawaii, and no germplasm collections are known of anywhere. Another species, *Morinda trimera*, resembles *M. citrifolia* but has smaller leaves and fruits. *M. citrifolia* var. *potteri* is a noni with variegated, green-and-white leaves.

Among noni plants grown in Hawaii, there appears to be significant, heritable variability in fruit size, shape, and number of seeds. This suggests that through selection, improvement for desirable noni fruit traits can be achieved.

### Plant spacing

An appropriate interplant spacing for noni is 10–15 feet. At 12-foot spacing there are 290 plants per acre. Closer interplant distances result in plant crowding and may exacerbate certain pest and disease problems.

### Pruning

Young plants less than 3 years old should be pruned back after or during their first production of fruit. In the following years, the pruned plants will become bushy. Because noni trees can reach a height of approximately 20 feet, growers may wish to prune the vertical branches of mature plants to facilitate picking. Pruning is an effective means of disrupting conditions conducive to pest and disease outbreaks.

### Nutrition and fertilizer

The amount of nutrients and frequency of fertilizer applications required by noni depends on the soil and rainfall. Noni trees growing in forests usually appear healthy without benefit of fertilizer. This suggests that noni may require only small amounts of applied fertilizer to grow well. In general, however, if intensive fruit production is desired in an agricultural setting, a fertilizer program is recommended. Research is needed to develop the best fertilizer regimes for noni production in the various regions of Hawaii where noni might be grown. It is suspected that noni will do best with relatively frequent applications of small amounts of fertilizer.

The strategy for providing nutrients to noni is similar to that for other fruit crops such as citrus or coffee. Young, nonfruiting noni plants are encouraged to produce lush vegetative growth with balanced fertilizers (such as 14-14-14 or 16-16-16), whereas more mature or flowering or fruit-

ing plants are encouraged to produce many large fruits by applying high-phosphorous fertilizers such as 10-20-20 or 10-45-10. Young seedlings and transplants are given controlled-release fertilizer formulations, while older, mature plants are given rapidly available granular formulations. Fertilizer should be applied away from the trunk at the “drip line” of the plant, the area where water drips from the edge of the leaf canopy.

Noni plants of all ages respond well to sprays of foliar fertilizer. Noni flower and fruit production is very responsive to sprays of high-phosphorous foliar fertilizers (e.g., 10-45-10) and products (e.g., seaweed emulsions) containing nitrogen and minor elements.

Noni should be fertilized frequently using smaller amounts of fertilizer, rather than infrequently using larger amounts. In high-rainfall areas, young plants up to a year old can be given ½ pound per month of balanced fertilizer (14-14-14), and more mature plants can be given up to 1 pound per month.

Effective organic fertilizers for noni cultivation include crushed coral, dolomite, K-mag, 7-7-7, and composted chicken manure and macadamia nut husks. Some locations will benefit from yearly applications of lime, about 1 pound per plant.

### Irrigation

Noni thrives with moderate irrigation and can survive extended drought once established and mature. When plants are less than 2–3 years old and conditions are dry, irrigate once or more a week, applying up to 10 gallons per plant; for older plants, irrigate less frequently. Overwatering can accelerate damage from root-knot nematodes, cause root rot, and leach fertilizer nutrients beyond the root zone.

### Plant diseases

#### *Black flag of noni*

A severe leaf and fruit blight occurs in the Puna district of the island of Hawaii. The disease is caused by the pathogen *Phytophthora botryosa*. Symptoms include a black leaf and stem blight, stem or branch dieback, and a chocolate-colored or black fruit rot. The disease is favored by prolonged periods of wet weather. Control measures include pruning, weed control, and field sanitation. For more information, see CTAHR publication PD-19.

#### *Sooty mold*

Sooty mold is a black, superficial growth of a nonparasitic fungus that utilizes the sugary exudates produced by soft-bodied insects such as scales and aphids. Sooty mold can easily be wiped off leaves by hand. Heavy infestation of

the fungus can reduce photosynthesis, resulting in poor plant growth and reduced fruit size and quality. A soapy water spray can control sooty mold.

#### **Noni root-knot disease**

Noni root-knot is a disease of the roots caused by root-knot nematodes, *Meloidogyne* species. Above-ground symptoms include reduced vigor, plant stunting, and yellowing. Affected roots can be galled, swollen, cracked, and rotten. This disease can be minimized by using nematode-free transplants and by adding organic soil amendments such as composts containing chicken manure. Moderate irrigation and fertilizer use will also minimize the damage and reduce the magnitude of secondary root rot by saprophytic fungi and bacteria. For a description of this disease on 'awa, see CTAHR publication PD-20.

#### **Stem rot**

In stem rot, tissues at the base of the plant decay, resulting in stunted plants. The initial plant symptom is wilt, including leaf flagging, yellowing, and drop. The disease arises from a complex of multiple causes including predisposing stresses (root-knot nematodes, flooding, stem injury) and stem-girdling decay by a soilborne fungus, *Sclerotium rolfsii*. Planting pathogen-free plants, selecting appropriate sites, and avoiding plant stress can minimize the occurrence and severity of stem rot.

#### **Insect pests**

Pest attacks of cultivated noni can cause significant damage. Pests known to attack noni in Hawaii include aphids (*Aphis gossypii*), ants, scales (the green scale), mites (eriphyid mites), whiteflies (fringe guava whitefly), and slugs. Pest outbreaks are favored by monocultures of noni. Thus, intercropping with other species of nonhost plants can minimize the overall severity and frequency of pest attacks.

Eliminate weeds that are alternate hosts of noni pests to prevent outbreaks. Significant weed hosts of noni pests are identified by periodic inspections of both noni and nearby weeds for the presence of pests such as aphids, scale, and whitefly. These and other soft-bodied insects can be effectively controlled with sprays of insecticidal soaps and oils. Mites can be controlled by pruning affected leaves and by applications of approved pesticides, such as sulfur. For slugs and ants, apply a temporary barrier at the base of the noni plant, such as copper tape (for slugs), or a sticky substance such as pine tar (for ants).

#### **Weeds**

Noni transplants are susceptible to competition from weeds such as Guinea grass and sensitive grass (*Mimosa pudica*). Young noni plants should be weeded by hand until the stem

is sufficiently large to withstand potential mechanical injury from mowers or string trimmers. Although weed mats can suppress weeds, they also inhibit granular fertilizers from penetrating to the root zone, and heat can accumulate under the mat, which may favor nematode reproduction. Once noni plants are well established, competition from weeds is less damaging than when the plants are young. Care should be taken to eradicate weeds that are hosts of root-knot nematodes or of insect pests such as aphids and scales. Weeds hosts of root-knot nematodes may be identified by inspecting their roots for the presence of the characteristic galls and swellings. Noni is susceptible to attack by dodder (*Cuscuta sandwichensis*), a parasitic weed. Dodder should be manually removed from infested noni plants.

#### **Harvesting and yield**

Noni plants can begin to bear fruit about 9 months after planting. Fruits can be harvested at this early stage, although they generally are small and few. Some farmers choose to forgo harvest during the first and second years in favor of pruning back the branches instead. This pruning results in a bushy plant with more vertical and lateral branches and ultimately produces greater fruit yield.

In Hawaii, noni fruits may be harvested year round, although there are seasonal trends in fruit production that may be affected or modified by the weather and fertilizer applications. Fruit production may diminish somewhat during winter months in Hawaii. The expected yield from mature, healthy plants is 250–500 pounds per plant per year, depending on nutrition and plant spacing. However, yields at some locations can exceed 500 pounds per plant per year with good crop management. Fruits may be picked just before they begin to ripen fully and turn completely whitish-yellow on the tree. These fruits are suitable for shipping and will continue to ripen en route unless measures are taken to retard ripening. For processing locally, fresh fruits are picked when ripe, just before they fall naturally from the tree. Juice can be squeezed directly from the ripened fruits or allowed to drip from the fruits and ferment as in the traditional method.

#### **References**

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- Hawaii Plant Conservation Center. 1992. Noni. National Tropical Botanical Garden, Kauai. 2 pp.