Nutrient Management Guidelines for Pacific Island Crops

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What is Nutrient Management?

Nutrient management in crop production is a process designed to optimize the utilization of resources while protecting the island's natural resources and the environment as a whole. It is a system that incorporates the grower's yield goal, or expectations, with the crop's nutrient requirement and nutrients from the soil.

The key principle underlying an effective nutrient management plan is balancing the nutrient requirements for a specific crop with the nutrients available in the soil and additional nutrient inputs, such as commercial fertilizers and livestock waste. Soils vary in their ability to store and release nutrients. The nutrient source and the chemical and physical properties of the soil influence nutrient availability.

These guidelines focus on managing the three primary nutrients — Nitrogen (N), Phosphorus (P), and Potassium (K) — since these nutrients represent the largest costs to producers and present the greatest risk to the environment when not managed properly.

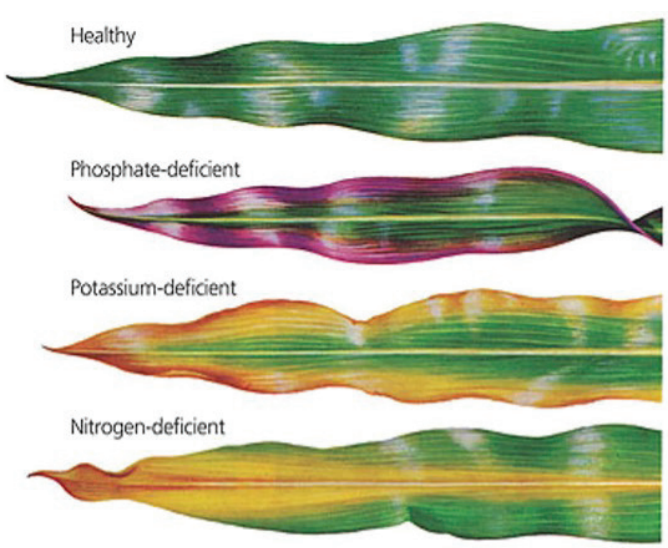

Figure 1
Difference between a healthy leaf and leaves with phosphate, potassium, and nitrogen deficiencies.
Source: www.bio.miami.edu/dana/pix/deficiency.jpg

Benefits of Nutrient Management Planning

Nutrient management planning can be beneficial for all crop producers, from the home gardener to the large-scale commercial farmer. The benefits of a well-planned nutrient management program include:

- maintenance of optimum conditions for crop development
- a corresponding increase in farm profits
- maintenance or improvement of soil quality
- decreasing potential negative impacts to natural resources from agricultural practices.

Grower's Goal

People grow plants for different reasons. Their expectations on the return from their investments can vary from having an attractive foliage plant in the kitchen to producing 65,000 pounds of papaya from one acre. The yield and quality of the crops produced is directly related to the amount of effort and resources invested in producing the crop. To a limited degree, higher yields and better quality can be achieved by increasing the quantity and quality of inputs.

When inputs are increased beyond the optimum levels for each crop, yields, quality, and profits are sacrificed. Proper nutrient management is designed to balance crop nutrient requirements and yield expectations with soil nutrient availability and nutrient inputs.

Recommended plant spacing and expected yields for selected crops grown commercially in the Pacific Islands can be found in the Guam Crop Charts fact sheet (url.uog.edu/guam-crop-charts). Recommended crop density per acre is achieved under good management practices using the recommended spacing in Table 1 (see next page).

Crop Nutrient Requirements

Numerous references list the amount of nutrients required to produce vegetables under a wide range of conditions. The Nutrient Requirements of Crops chart in the Guam Crop Charts fact sheet (url.uog.edu/guam-crop-charts) lists the recommended rates of plant nutrients for the production of selected crops grown on soils in the Pacific

Recommended Crop Density Per Acre

Common Name	CHamoru Name	Recommended Distance (in.) Between Hills	Recommended No. of Plants Per Hill/ Bed Hill	Recommended Distance (in.) Between Rows	No. of Plants Per Acre
Cucumber	Kåmba	10-18	1	36-72	5,032-17,666
Eggplant, long	Biringhenas	36-48	1	48-72	1,924-3,740
Okra	Okra	36-48	1	72-120	1,924-3,740
Pepper, chili/hot	Donne' pika	18-36	1	48-72	2,516-7,480
Tomato	Tumåtes	18-48	1	48-60	2,288-7,480

Table 1
Example of common crops on Guam and their recommended plant spacing. For a complete list of Guam crops with recommended spacing and estimated yields, visit url.uog.edu/guam-crop-charts.

Recommended Nutrient Requirements Per Acre

Pounds Per Acre Recommendation										
Common Name	CHamoru Name	Nitrogen (Ammonium, Nitrate)			Phosphorus (Phosphate)			Potassium (Potash)		
		Low	Average	High	Low	Average	High	Low	Average	High
Cucumber	Kåmba	180	215	250	150	200	250	200	225	250
Eggplant, long	Biringhenas	150	200	250	150	225	300	150	200	250
Okra	Okra	100	125	150	150	200	250	120	160	200
Pepper, chili/hot	Donne' pika	150	175	200	150	200	250	150	200	250
Tomato, cherry	Tumåtes	150	175	200	200	250	300	150	200	250

Table 2
Example of common crops on Guam and their recommended nutrient requirements for pounds per acre. For a complete list of Guam crop nutrient requirements, visit url.uog.edu/guam-crop-charts.

region. Recommended nutrient requirements for pounds per acre is achieved under nutrient management practices using Table 2.

Soil Analysis

Soils contain nutrients that are essential for plant growth and development. Some of the nutrients held in soils may be unavailable to plants. Soil testing determines the amount of plant-available nutrients from a properly sampled field.

The Soil & Plant Testing Laboratory of the UOG College of Natural & Applied Sciences (located in Room 216 of the in the Agriculture & Life Sciences building, or visit url.uog.edu/soil-analysis for more information) routinely tests soil for farmers and other clientele. The tests determine the organic matter (% OM), which is used to account for available N (lbs/acre), available P (ppm P), exchangeable K (ppm K), calcium (ppm Ca), magnesium (ppm Mg), and pH. Special tests on trace elements and soil physical properties are available upon request.

University of Guam Cooperative Extension & Outreach produced the Guam Crop Charts as a basic guide for the proper production of fruits and vegetables grown in the Pacific region. The extension office also provides technical assistance and advice to the general public regarding crop production issues. Extension personnel can help develop nutrient management plans for desired plants. It is advisable to have your soils tested prior to planting in order for extension personnel to provide the most efficient and effective plant nutrient recommendations.

The Cooperative Extension office can be contacted at (671) 735-2080 or you can visit www.uog.edu/extension for additional information.

The Importance of NPK to Plants and the Environment

Nitrogen

Nitrogen is found in soils in the form of organic matter (OM) and minerals. Organic matter is found in various stages of decomposition of plant and animal residues. As OM decomposes, nitrogen is mineralized forming ammonium and nitrate plus humus. Ammonium and nitrate are readily available to plants. Ammonium ions adhere to soil clay particles temporarily and, therefore, are not subject to leaching or runoff. Nitrate is highly soluble and moves freely with the soil water and, thus, is highly susceptible to runoff and leaching. Runoff and leaching should be avoided since both move nutrients out of plant root zones, wasting nutrients and possibly contaminating surface and groundwater sources. The maximum level of nitrates allowed in drinking water is 10 parts per million. High nitrates in drinking water can cause health problems, especially for infants.

The most common test for nitrogen in soils is the determination of organic matter levels. Compared to other forms of nitrogen, organic matter is relatively stable and is indicative of the amount of nitrogen the soil can supply. In the mineral soils of Guam, every unit of 4 percent OM is credited with providing 30 pounds N per acre. Organic and some chemical forms of nitrogen fertilizers are eventually converted to ammonium or nitrate ions before absorption by plants. Since nitrates are highly subject to movement out of plant root zones, soluble N fertilizers should be applied in small doses whenever possible. The most efficient method of applying soluble N fertilizers is by injecting the soluble N fertilizers into the irrigation water (fertigation) and applying it directly to the plant root zone by drip irrigation.

Phosphorus

Phosphorus (P) is taken up by plants in smaller quantities than either nitrogen or potassium. In most soils a large portion of the phosphorus is tied up chemically and thus is not available to plants. Since P is bound by soil particles, it is not subject to leaching or runoff. Phosphorus does, however, move along with soil particles when soils erode. Elevated levels of P in surface waters encourage the undesired growth of algae.

Figure 2
Yellow discoloration in leaves from nitrogen deficiency.
Source: National Parks Board of Singapore (www.nparks.gov.sg)

If the soil test shows that phosphorus needs to be applied, an amount must be applied that exceeds the difference between the available P in the soil and the desired level. All the phosphorus required to produce a vegetable crop is applied prior to planting. In soils that fix large amounts of phosphorus, the P fertilizer should be applied in a band and covered with soil before planting.

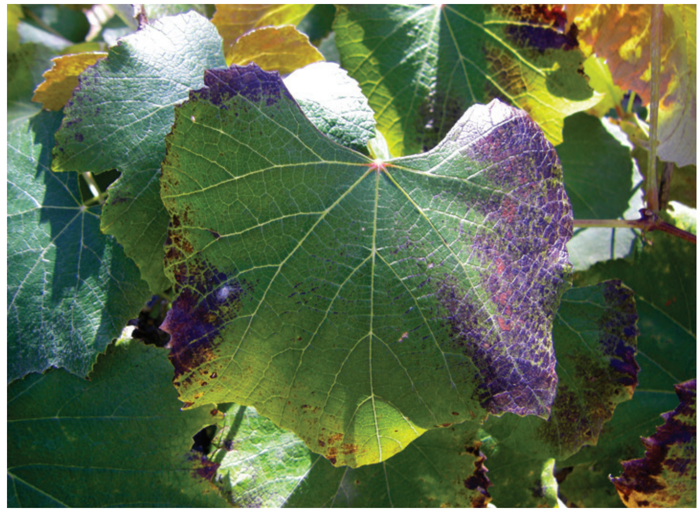

Figure 3
Purpling of the outer part of the leaf indicates phosphorus deficiency.
Source: ePlants.com.au

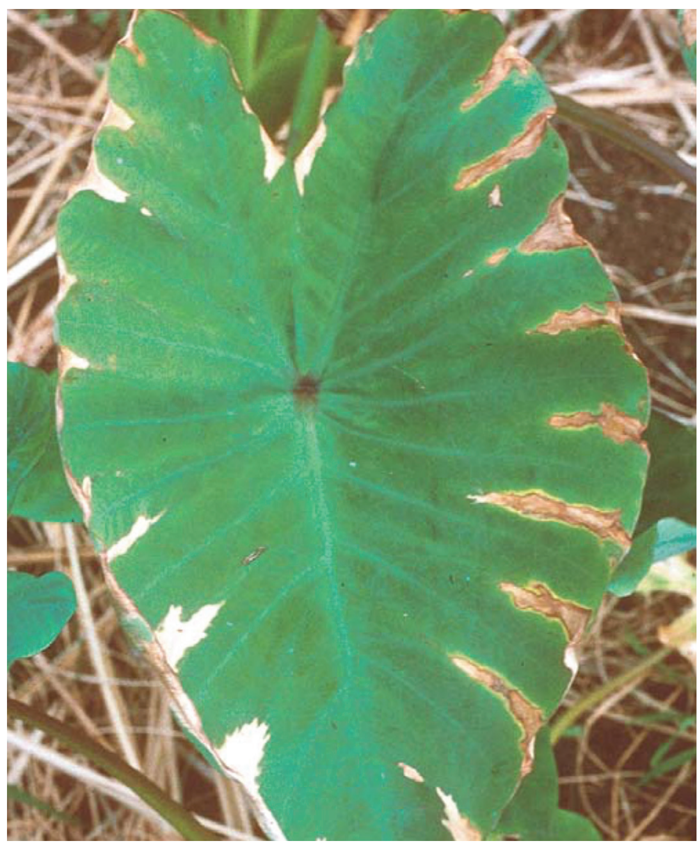

Figure 4
Potassium deficiency in 'Bun Long' taro leaf.
Source: Cooperative Extension Service, University of Hawai'i at Manoa (https://cms.ctahr.hawaii.edu/ce)

Potassium

When compared to nitrogen and phosphorus, potassium presents very few problems for growers and the environment. It does not leach as quickly through soils as nitrogen does. Unlike P, elevated levels of K in surface waters do not promote the growth of algae. The two primary potassium fertilizers are potassium chloride and potassium sulfate. Because these are both salts, if they are applied too close to plant roots or seeds, the high osmotic pressure is likely to draw water from the plant and thus cause serious injury. Plant injury can be avoided by applying the fertilizer several days prior to planting or by applying smaller doses over an extended period.

Environmental Issues

Possible side effects of fertilizers on the environment are a concern shared by most. The concern is related to both mineral fertilizers and organic sources of plant nutrients. Environmental problems associated with the use of plant nutrients are less dependent on the nature of the nutrients than on the amounts and on the way they are applied. Detrimental effects are primarily due to over-application or to improper or unbalanced use.

Not all nutrients applied to the soil are taken up by crops, and the unused portion may become an environmental problem. The remaining nutrients may stay in the soil building up soil reserves and later become available, or they may leach through the soil or run off or volatilize into the atmosphere. Excessively high soil levels of one nutrient can affect the availability of other nutrients. In tropical conditions, all soluble nitrogen compounds are fairly quickly converted to nitrates, which move freely with soil water. Nitrogen is the most likely nutrient to become an environmental problem. Phosphorus applied to soils that is not used by plants is tied up by clay particles in the soil. The unused phosphorus remains in the soil unless it is washed off the land or carried off by soil erosion. In surface waters high phosphorus levels result in algal blooms.

Figure 5
Runoff along the coastline of Merizo, Guam, after Tropical Storm Maria in July 2018.
Source: Dontana Keraskes, Guam Daily Post

Guam soils carry an excess of nitrogen and phosphorus. Heavy rains and typhoons contribute to the occurrence of runoff, which eventually leads to the excretion of this runoff into bays. Extensive sediment runoff can cause detrimental environmental damage by smothering corals or blocking the gills of fish and marine life (Golabi, Guam Daily Post Communication, 2018).

Proper management of plant nutrients is the key to the prevention of environmental problems associated with fertilizer use. Balanced fertilization should prevent the problem of nutrient depletion or excessive nutrient accumulation. Pollution from nutrients can be avoided by applying just the right amounts of nutrients to meet the crop requirement. Good soil and water management, plus soil conservation practices and the use of improved varieties, can further minimize the risk of environmental damage from plant nutrients.

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