GUAM ENABLED GARDENING: ADAPTIVE GARDENING SERIES
Plant Fertilizers

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In the U.S. today, gardening is considered a favorite outdoor activity, right alongside golfing and jogging. Approximately 75% of U.S. households, whether novice or experienced, participate in some type of gardening activity.

However, gardening is not only a recreational hobby. It can also help one's physical and mental well-being, regardless of age. For instance, people affected by health conditions that limit mobility can benefit from increased physical activity. Furthermore, through the activity of nurturing plants to bear vegetables, fruits or flowers, one can experience the product of the effort. Also, decreased stress and an increased sense of well-being are reported as other benefits of gardening activities.

*Nevertheless, there are barriers for those who experience physical and mental limitations. For example, people who experience arthritis may be challenged due to joint pain from bending or stooping to tend to the garden. An enabled garden allows an individual with specific challenges to participate. This series of fact sheets explain gardening methods, technique adaptations, and how to create enabled gardens specific to Guam.**

Fertilizers are used to provide nutrients that may be lacking in the soil. There are different types of fertilizer used for containers and raised bed gardens. Always remember: "MORE" is not always good.

There are 17 essential nutrients plants need to grow (**Tables 1-3**). Based on Liebig's "law of minimum," if any one of the essential plant nutrients is deficient, plant growth will be compromised even if the other nutrients are abundant.

* The references used for the Introduction of each fact sheet in the Guam Enabled Gardening: Adaptive Gardening Series is listed in the Bibliography of *Site Selection*.

Table 1: Macronutrients *(needed in the largest amount)*
*** = Supplied by the air and water**

Carbon (C)*	**Hydrogen (H)***	**Oxygen (O)***
Nitrogen (N)	**Phosphorus (P)**	**Potassium (K)**

Table 2: Secondary nutrients

Sulfur (S)	**Calcium (Ca)**	**Magnesium (Mg)**

Table 3: Micronutrients *(needed in minute amounts)*

Iron (Fe)	**Chlorine (Cl)**	**Boron (B)**	**Copper (Cu)**
Zinc (Zn)	**Manganese (Mn)**	**Molybdenum (Mo)**	**Nickel (Ni)**

- **Functions of Macronutrients**
  - ***Nitrogen (N)***
    - Responsible for green color and growth of leaves.
    - Promotes rapid plant growth.
  - ***Phosphorus (P)***
    - Stimulates root formation and growth.
    - Encourages early growth and root formation.
    - Promotes flowering, fruiting, and seed production.
    - Increases disease resistance.
  - ***Potassium (K)***
    - Encourages root growth.
    - Increases disease resistance of plants.
    - Increases size and quality of fruits and vegetables.
    - Helps plants overcome drought stress.

- Read fertilizer label before purchasing fertilizers.
  - All fertilizers have three numbers on container.
    - These numbers indicate the percentage of nitrogen (N), phosphorus, and potassium.

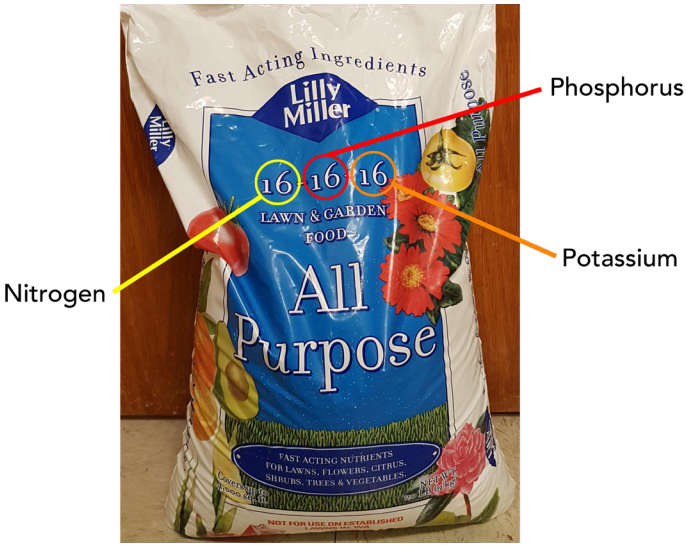

Fig. 1 - Complete Fertilizer

- Secondary nutrients and micronutrients are listed on label if they are present.
- Label may also suggest how the fertilizer is used.

- Fertilizers and pH
  - pH affects availability of plant nutrients to plants.

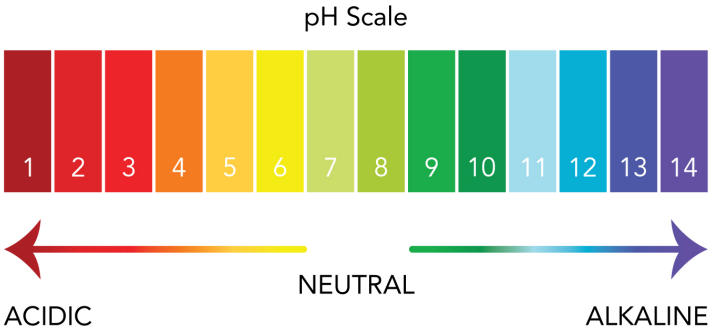

Fig. 2 - pH scale

- Most vegetable plants do best in soils with a pH value between 6.0 and 7.0.
- pH > 7: phosphorus, boron, copper, iron, manganese, and zinc are less available to plants.
- pH < 5: calcium, magnesium, and molybdenum are less available to plants.

- Types of fertilizers
  - Synthetic (processed) fertilizers
    - Usually less expensive (per pound of nutrient) than other formulations.
    - Readily available for plant growth.
    - Has higher concentration of nutrients than natural fertilizers.
    - Examples of fertilizers used for fruits and vegetables include 16-6-16 and 10-20-20.
  - Organic (natural) fertilizers
    - Good source of organic matter.
    - Nutrients slowly released into soil.
    - Lower concentration of nutrients.
    - More expensive than synthetic fertilizers.
    - Improves soil quality.
    - Examples include manure **(Figure 3)** and natural fertilizers, such as bone meal **(Figure 4)**.

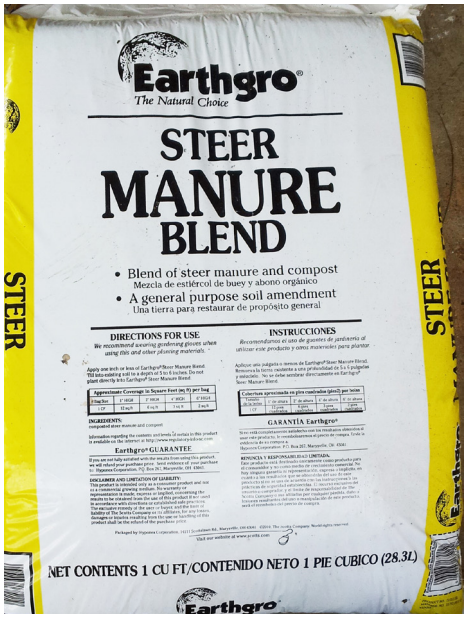

Fig. 3 - Steer Manure

Fig. 4 - Bone Meal (6-9-0)

- Formulations
  - Water soluble fertilizers (**Figure 5**)

Fig. 5-7 - Water soluble fertilizer, powder fertilizer, and fertilizer solution.

- Commonly used as a starter fertilizer for vegetable seedlings to be transplanted.
- Concentrated liquid or powder (**Figure 6**) is mixed with water to make a solution (**Figure 7**).
- Generally, contains micronutrients (**Figure 8**).

Total Nitrogen (N+)	15%
8.0% Ammoniacal Nitrogen	
7.0% Nitrate Nitrogen	
Available Phosphate (P_2O_5)	9%
Soluble Potash (K2O)	12%
Calcium (Ca)	1.9%
Magnesium (Mg) (Total)	1.4%
0.7% Water Soluble Magnesium (Mg)	
Sulfur (S) (Total)	4.0%
4.0% Combined Sulfur (S)	
Boron (B)	0.02%
Copper (Cu) (Total)	0.05%
0.05% Water Soluble Copper (Cu)	
Iron (Fe) (Total)	0.45%
0.42% Water Soluble Iron (Fe)	
0.03% Chelated Iron (Fe)	
Manganese (Mn) (Total)	0.06%
0.06% Water Soluble Manganese (Mn)	
Molybdenum (Mo)	0.02%
Zinc (Zn) (Total)	0.05%
0.019% Water Soluble Zinc (Zn)	

Fig. 8 - Macronutrients

- Granular/Dry fertilizer
  - Generally, not recommended for container gardens.
  - Can burn plant roots if fertilizer comes in contact with roots.
- Slow-release fertilizer (**Figure 9**)

Fig. 9 - Slow-release fertilizer

- Fertilizer is usually encased in small, round, bead-like capsule (**Figure 10**).

Fig. 10 - Slow-release fertilizer

- Release rate may be too slow for fast-growing crops.
- Lasts for 3-4 months, but nutrients are released faster in warm and moist conditions.

- Fertilizer recommendations for container garden and elevated raised garden.
  - Slow release fertilizer
    - Apply to top of potting mix.
    - Maintain water application because water releases nutrients gradually when potting mix is irrigated.
    - Contains micronutrients.
- Fertilizer recommendations for raised bed garden
  - Granular fertilizer can be used for plants in raised bed garden.

- Add fertilizer before planting to improve growth of plants.
- Fertilizers need to be applied periodically to encourage healthy, vigorous growth of fruits and vegetables.

- **Some tips to consider:**
  - Do not use too much nitrogen for flowering and fruiting plants, because fertilizer will cause plants to have less fruit and more leaves.
  - Always follow recommendations on fertilizer labels.

Glossary:

Fertilizer burn - a result of excessive fertilizing, which can cause damage to plants that appear as browning of leaf edges or leaf scorch, and the soluble salts from fertilizers can remove moisture from root tissues and lead to marginal yellowing, wilting, and stunting. This is especially damaging in hot, dry weather.

pH - measure of acidity and alkalinity of a soil that ranges from 0 to 14 with 7 being neutral. A pH value lower than 7 it is said to be acidic and one greater than 7 is basic (alkaline). Examples of common household items that are acidic are vinegar and lemon juice. Bleach and baking soda are examples of alkaline solutions.

Table 4: Summarized symptoms of deficiency and excess of some essential nutrients

Nutrient	Deficiency	Excess
Nitrogen	✦ Yellowing of lower leaves ✦ Reduced growth	✦ Dark green, brittle appearance of leaves ✦ Fruit and seed may fail to produce ✦ Plants may be prone to damage as a result of diseases, insects, and drought
Phosphorus	✦ Purple coloration of leaves may develop ✦ May have distorted shape of leaves ✦ Thin stems	✦ May cause nutrient deficiency of iron or zinc
Potassium	✦ Older leaves appear yellow on margins ✦ Poor development of root system ✦ Fruit development is irregular	✦ May cause nutrient deficiency of magnesium or calcium
Sulfur	✦ Yellowing of young leaves, then the entire plant ✦ Has similarities with nitrogen deficiency but occurs on new growth ✦ Veins appear lighter in color than the interveinal area	✦ May cause leaves to drop prematurely
Calcium	✦ Death of growing tips ✦ Reduced growth ✦ Blossomed rot at end of fruit (e.g., tomato)	✦ May cause nutrient deficiency of magnesium or potassium
Iron	✦ Starts with yellow or white areas between veins of young leaves that leads to spots of dead leaf tissue	✦ Tiny brown spots may appear on leaves

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