

Growing Lettuce (*Lactuca sativa*) on Guam

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Introduction

Lettuce (*Lactuca sativa*) is a member of the sunflower family Asteraceae. Lettuce was originally cultivated thousands of years ago in ancient Egypt (Parkell *et al*, 2015), likely domesticated from the weed *Lactuca serriola* (University of California, Davis, 2017). Lettuce is now cultivated in many countries around the world.



Source: <http://www.cooksinfo.com/lettuce>

The United States is one of the largest lettuce-producing countries in the world, where it is a valuable and important crop (University of California, Davis, 2017). On Guam, lettuce (leaf type) has been produced occasionally on small-scale farms. Today, there are only two known commercial farms on Guam that produce lettuce year-round in hydroponic systems. Hydroponics is defined as cultivating plants by placing it in liquid nutrient solutions rather than soil (Dictionary.com, 2017).

In this fact sheet, information is provided on lettuce basics, types, nutrition, and results on recent lettuce variety trials conducted on Guam.

About Lettuce

Lettuce is most widely consumed as a fresh leafy vegetable in dishes like salads, tacos, sandwiches, and much more. It is also used as a cooked vegetable in many dishes as well.

The most common lettuce types grown include:

1. Crisphead or Iceberg—Large firm and round heads are surrounded by broad green overlapping wrapper leaves attached at the bottom (Institute of Food and Agricultural Sciences Extension, 2009).



Source: http://gardeningsolutions.ifas.ufl.edu/mastergardener/outreach/plant_id/vegetables/lettuce.shtml

2. Leaf—Heads are loosely formed with leaves varying greatly in color (red, bronze, yellow, green), size and shape (wavy, notched or frilled) (Institute of Food and Agricultural Sciences Extension, 2009).



Source: http://gardeningsolutions.ifas.ufl.edu/mastergardener/outreach/plant_id/vegetables/lettuce.shtml

- 3. Butterhead—Heads are soft, velvety smooth, surrounded by green wrapper leaves (Institute of Food and Agricultural Sciences Extension, 2009).



Source: http://gardeningsolutions.ifas.ufl.edu/mastergardener/outreach/plant_id/vegetables/lettuce.shtml

- 4. Romaine or Cos—Leaves with prominent central ribs are gathered in a loose fashion to form an upright head similar to Chinese cabbage (Institute of Food and Agricultural Sciences Extension, 2009).



Source: http://gardeningsolutions.ifas.ufl.edu/mastergardener/outreach/plant_id/vegetables/lettuce.shtml

There is an abundance of varieties that fall under these lettuce types that are cultivated throughout the world.

Leaf-type lettuce is low in saturated fat and cholesterol. It is also a good source of protein, calcium, magnesium and phosphorus, and a very good source of dietary fiber, vitamin A, vitamin C, vitamin K, thiamin, riboflavin, vitamin B6, folate, iron, potassium and manganese (Self Nutrition Data, 2014).

Nutrition Facts	
Serving Size 360 g	
Amount Per Serving	
Calories 54	Calories from Fat 5
% Daily Value*	
Total Fat 1g	1%
Saturated Fat 0g	0%
Trans Fat	
Cholesterol 0mg	0%
Sodium 101mg	4%
Total Carbohydrate 10g	3%
Dietary Fiber 5g	19%
Sugars 3g	
Protein 5g	
Vitamin A 533%	Vitamin C 108%
Calcium 13%	Iron 17%

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

NutritionData.com

Fig. 1. Nutrition facts of 1 head of raw, green leaf lettuce as provided by the United States Department of Agriculture (USDA). Source: USDA

Growing Lettuce

Lettuce can be transplanted as seedlings or direct-seeded into the ground. Seeds usually germinate within a week. Lettuce is generally harvested between 30-60 days after germination. In open fields plants are commonly spaced from 4-18 inches apart depending on variety. In hydroponic systems, lettuce is recommended to be spaced at 12 inches apart in hydroponic trays. (Ako and Baker, 2009). Lettuce can also be grown individually in pots. Common one-gallon flower pots are suffice.

Lettuce is generally a cool-season crop that can withstand light frost. For optimum growth, lettuce grows best in temperatures of 55-65°F (13-18°C) (Clemson Cooperative Extension, 2015). Increased day-lengths

and high temperatures usually results in early flowering (bolting) and bitter flavor. There are available varieties that are heat resistant and can be grown successfully in the tropics including Tropicana, Cherokee (Red), StarFighter, and more (Marutani and Barber, personal communication).

A general fertilizer recommendation for one growing season for lettuce is 1300-1700 lbs of 5:10:10 (N-P2O5-K2O) per acre, or approximately 3-4 lbs. of the same nutrient ratio for every 100 square feet. (PennState Extension, 2012).

Lettuce grows best in fertile, well-draining soils with high organic matter such as Guam-Yigo complex, Pulantat clay, and Togcha-Akina silty clay soils, and prefers a media/soil pH of 5.8 to 6.5 (Clemson Cooperative Extension, 2015).

Irrigation of lettuce should consist of frequent watering. During dry periods, ensure soils are kept moist, but not saturated. During extended rainfall events, watering may not be necessary until soils are nearly dried up. Mulching around lettuce conserves moisture.

Common Pests and Diseases

Lettuce is a host for a wide range of pests and diseases. There is very little documentation on pests and diseases of lettuce on Guam, which is likely due to lettuce not being commonly cultivated on the island. Bacterial spot (*Pseudomonas spp.*) (bacterium) has been reported as a disease found on lettuce in Guam (Wall, 1989). Some fungal diseases that affect a wide range of crops, including lettuce, that are known to exist on Guam include Southern Blight (*Sclerotium rolfsii*) and two species, both named Powdery Mildew (*Sphaerotheca fuliginea* and *Erysiphe cichoracearum*) (Guam Cooperative Extension, 2014). Unidentified disease-like symptoms observed on lettuce on Guam include a leaf spot and root rot (Perez, personal communication).

Some common insects that infest lettuce that may be found on Guam include aphids (Family: Aphididae), cabbage looper (*Trichoplusia ni*), and the cluster caterpillar (*Spodoptera litura*). Unidentified insect pests of lettuce observed on Guam include a semi-

looper caterpillar (Family: Noctuidae), a cutworm (Family: Noctuidae), whitefly (Family: Aleyrodoidea), and New Red Fire ants (Family: Formicidae) (Perez and Nangauta, personal communication). Registered insecticides, used at labeled rates, can help control insect infestations. Insect pests can also be controlled by cultural practices such as monitoring, crop rotation, weeding, and general field sanitation.

Plant Care

It is always good practice to consistently monitor plants for pests and diseases. If a pest or disease is unknown, collect samples and submit to CNAS Extension & Outreach program at the University of Guam for correct identification and treatment recommendations.

Weeding and mulching around plants will reduce weed competition and conserve soil moisture.

It is also advisable to keep good records of all field activities. Good record-keeping will identify good practices and mistakes, along with identifying desired varieties of plants. This will improve decision-making for future crops.

Harvest

Depending on lettuce type and variety, most lettuces are generally harvested within 30-60 days from germination. Although there are different methods of harvesting lettuce, harvesting whole lettuce heads is the most common method. Lettuce heads are usually harvested by cutting one (1) inch above the soil line.

Post-Harvest Handling

Lettuce is best stored at 32°F (0°C) at 95 percent relative humidity for up to two (2) weeks (University of Maryland, 2017).

2016 and 2017 Lettuce Trial on Guam

In 2016 and 2017, variety trials of lettuce and compost treatments were conducted in individual pots in a plant nursery at Dean's Circle House 1, Western Pacific Tropical Research Center (WPTRC), College of Natural & Applied Sciences (CNAS), University of Guam (UOG). The objectives of the variety trials were to observe growth response of two lettuce varieties to

different compost mixes comprised of store-bought potting mix and renewable waste material including food waste, woodchips, and chicken manure. Table 1 depicts the composition of 13 compost treatments that lettuce varieties were treated with.

Table 1. *Lactuca sativa*: varieties StarFighter and New Red Fire grown in 13 compost treatments. PM = Potting Mix (Sunshine Mix # 4) W = Woodchips, F = Food Waste, and C = Chicken Manure

Treatment Name	Compost Mix	Percent of Compost Material per Treatment
WFC25	PM + W + F + C	PM = 75 W = 18 F = 6 C = 1
WFC50	PM + W + F + C	PM = 50 W = 35.5 F = 12 C = 2.5
WFC100	W + F + C	PM = 0 W = 74 F = 24 C = 5
WF25	PM + W + F	PM = 75 W = 18 F = 7 C = 0
WF50	PM + W + F	PM = 50 W = 36 F = 14 C = 0
WF100	W + F	PM = 0 W = 72 F = 28 C = 0
WC25	PM + W + C	PM = 75 W = 22.5 F = 0 C = 2.5
WC50	PM + W + C	PM = 50 W = 45 F = 0 C = 5
WC100	W + C	PM = 0 W = 90 F = 0 C = 10

Treatment Name	Compost Mix	Percent of Compost Material per Treatment
W25	PM + W	PM = 75 W = 25 F = 0 C = 0
W50	PM + W	PM = 50 W = 50 F = 0 C = 0
W100	W	PM = 0 W = 100 F = 0 C = 0
PM100	PM	PM = 100 W = 0 F = 0 C = 0

From November to December, 2016 and from January to February 2017 StarFighter, a leaf type, heat tolerant lettuce variety (Johnny’s Selected Seeds, 2017), was grown in individual pots consisting of various types of compost mixes containing woodchips, food waste, chicken manure, and potting mix. From January 2017 to February 2017, the experiment was repeated with StarFighter and an additional leaf type, heat tolerant lettuce variety, New Red Fire (Johnny’s Selected Seeds, 2017). For both trials, lettuce seedlings were nursed in planting trays for two (2) weeks before being transplanted individually into pots as shown in Fig. 2.



Fig 2. StarFighter and New Red Fire lettuce seedlings growing in pots filled a variety of compost mixes (treatments).

For the November-December 2016 and January-February 2017 trials, StarFighter seedlings grew in pots for 26 days and 30 days, respectively. Entire lettuce heads were harvested and measured for fresh weights of shoots. Average fresh shoot weights of StarFighter lettuce were clearly superior when grown in compost treatment WFC100, which consisted of woodchips, food waste, and chicken manure. Compost treatments WFC50 (woodchips, food waste, chicken manure, and potting mix), WF100 (woodchips and food waste), and WC100 (woodchips and chicken manure) also resulted in good growth development of StarFighter. StarFighter grew poorly in all other compost treatments, particularly in treatment PM100 (potting mix only) (Fig. 3 and Fig. 4).

In the January-February 2017 trial, New Red Fire was also evaluated for fresh shoot weight. Similar to StarFighter, New Red Fire had superior average fresh shoot weight when grown in compost treatment WFC100. New Red Fire also displayed vigorous growth when grown in compost treatments WFC25, WFC50, and WC100 (Fig. 5).

The results shown in Fig. 3 and Fig. 4 for compost treatments consisting of 25% of different combinations of woodchips, food waste, and chicken manure (Treatments WFC25, WF25, WC25, and W25) resulted in poor growth of StarFighter, similar to the treatment with potting mix alone (Treatment PM100). However, growth of New Red Fire in a 25% mix of woodchips-food waste-chicken manure added to 75% potting mix (Treatment WFC25) displayed vigorous growth as shown in Fig. 5. This was likely due to the presence of chicken manure. New Red Fire is also known to perform well under poorer growing conditions (Marutani, personal communication).

Specific varieties of crops may respond differently to an assortment of compost mixes. In these trials, it was clear that the compost mix consisting of renewable resources such as woodchips, food waste, and chicken manure (no potting mix added) resulted in the most vigorous growth of both lettuce varieties.

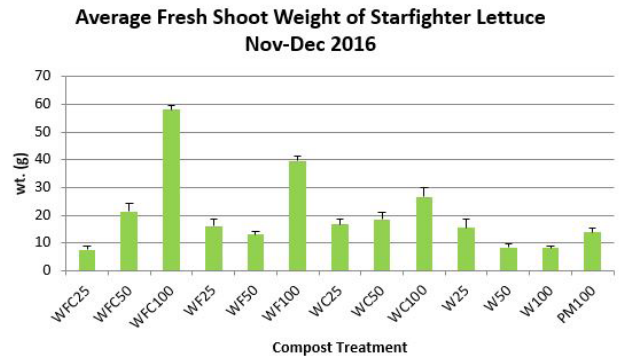


Fig 3. StarFighter leaf lettuce grown in 13 compost treatments (Nov. 7-Dec 3, 2016).

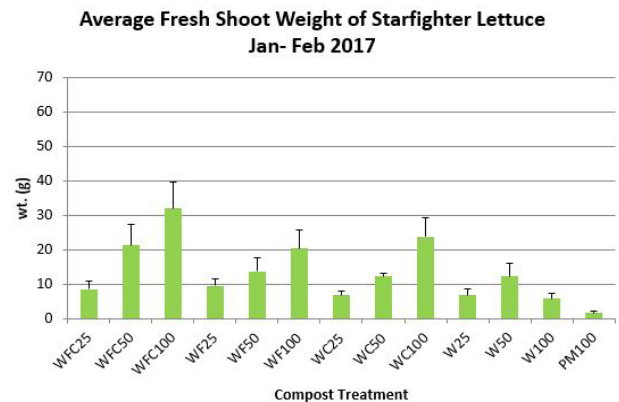


Fig 4. StarFighter leaf lettuce grown in 13 compost treatments (Jan. 16-Feb 17, 2017).

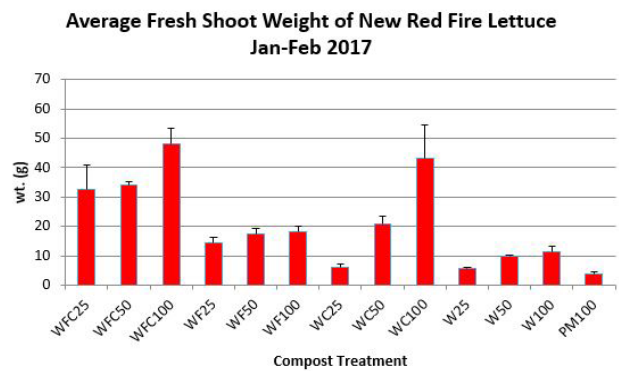


Fig 5. New Red Fire leaf lettuce grown in 13 compost treatments (Jan. 16-Feb 17, 2017).

Discussion

Knowing that lettuce is a valuable commodity on Guam, and that it can be grown in open fields, hydroponic systems, and confined spaces (garden beds, pots), there is a potential market for commercial and subsistence growers to engage in lettuce cultivation. Increasing the local variety of crops will enhance the agriculture industry and food security on Guam.

This preliminary research on growth response of lettuce on compost shows potential of renewable resources such as chicken manure, woodchips, and food discards, in certain combinations, being used as compost media for growing crops.

Compost treatments used in these experiments have proven to be adequate media for growing crops and is recommended to be tried as amendments in open fields where common soils are cultivated for future experiments, which may lead to healthier soils and a reduction of inorganic fertilizer inputs.

When using compost, ensure the material has undergone a thorough composting process, and is fully cured. Composting material that has not been fully cured will not be stable, and have the potential to contain plant pathogens and other organisms that will compete with plants for nutrients. Fully cured compost will result in a stable and disease-free media that will provide as a good growing media for plants. It is advisable to have compost analyzed for its nutrient content. This will enable growers to make better decisions on plant nutrition.

Summary

Like many crops, growing lettuce successfully in respective localities highly depends on varieties. Understanding that lettuce is generally a cool-season crop, choose varieties that are adequate for Guam's tropical climate. Seek characteristics from seed sources that include terms like 'heat-tolerant' and 'slow-bolting.' Several varieties that have proven successful on Guam include Tropicana, Cherokee, New Red Fire, Muir, Tango, and StarFighter (Nangauta, personal communication).

References

Ako, H. and Baker, A. 2009. Small-Scale Lettuce Production with Hydroponics or Aquaponics. Sustainable Agriculture, SA-2. Department of Molecular Biosciences and Bioengineering, College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa. 7p.

Barber, R., Extension Specialist, Agricultural Economics, Cooperative Extension & Outreach Service, Agriculture and Life Sciences Division, College of Natural and Applied Sciences, University of Guam.

Clemson Cooperative Extension. 2015. Home & Garden Information Center: Lettuce. HGIC 1312. Clemson University, Clemson, SC. <http://www.clemson.edu/extension/hgic/plants/vegetables/crops/hgic1312.html>. (Accessed March 27, 2017).

Dictionary.com. 2017 "hydroponics," in *Dictionary.com Unabridged*. Source location: Random House, Inc. <http://www.dictionary.com/browse/hydroponics>. Available: <http://www.dictionary.com/>. (Accessed: March 16, 2017).

Guam Cooperative Extension. 2014. Guam Cucurbit Guide. 2nd Edition. College of Natural & Applied Sciences, University of Guam. 80p.

Institute of Food and Agricultural Sciences Extension. 2009 (Last updated). Plant Identification Learning Module: Vegetables, Lettuce (*Lactuca sativa*). University of Florida. http://gardeningsolutions.ifas.ufl.edu/mastergardener/outreach/plant_id/vegetables/lettuce.shtml. (Accessed March 20, 2017).

Johnny's Selected Seeds. 2017. http://www.johnnyseeds.com/search/?q=starfighter&lang=en_US. (Accessed April 10, 2017).

Johnny's Selected Seeds. 2017. http://www.johnnyseeds.com/vegetables/lettuce/new-red-fire-organic-pelleted-lettuce-seed-430GP.html#q=red%2Bfire&lang=en_US&start=1. (Accessed April 10, 2017).

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Nangauta, J. 2017. Research Associate, Triton Farm, Western Pacific Tropical Research Center, Agriculture and Life Sciences Division, College of Natural & Applied Sciences, University of Guam.

Parkell, N.B., Hochmuth, R.C., and Laughlin, W.L.. 2015. An Overview of Lettuce Production Systems and Cultivars Used in Hydroponics and Protected Culture in Florida. Horticultural Science Department HS1258, University of Florida Extension. 6p.

Perez, J. 2017. Local Guam Farmer.

PennState Extension. 2012. Growing Lettuce & Spinach. Penn State College of Agricultural Sciences. <http://extension.psu.edu/cumberland/news/2012/growing-lettuce-spinach>. (Accessed March 27, 2017)

Self Nutrition Data. 2014. Lettuce, Green Leaf, Raw Nutrition Facts & Calories. <http://nutrition-data.self.com/facts/vegetables-and-vegetable-products/2477/2#ixzz4clvMbud5>. (Accessed March 30, 2017)

University of California, Davis. 2017 (Last updated). The Compositae Genome Project: Lettuce (*Lactuca sativa* L.). The Michelmore Lab of UC Davis Genome Center. http://compgenomics.ucdavis.edu/compositae_data.php?name=Lactuca+sativa. (Accessed March 16, 2017)

University of Maryland Extension. 2017. Vegetable Profiles: Lettuce. College of Agriculture and Life Sciences, University of Maryland. <http://extension.umd.edu/growit/vegetable-profiles-lettuce>. (Accessed March 27, 2017)

Wall, G.C. 1989. Plant Diseases Reported on Guam. AES, Plant Pathology Laboratory, college of Agriculture & Life Sciences, University of Guam. 20p.

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