32. Pategas, S. G. 1989. Palm markets continue to grow. Fla. Grower and Rancher 82 (5):10-11 + front cover.
33. Perez-Arbelaez, E. 1956. Plantas útiles de Colombia. Libreria Colombiana-Camacho Roldan (Cia. Ltda.), Bogotá, Colombia.
34. Read, R. W. 1961. The native palms. Pp. 27-33 *in* Ledin, R. B. (ed.). Cultivated palms. Amer. Hort. Mag. 40 (1):i-189.
35. Saunders, C. F. 1934. Useful wild plants of the U. S. and Canada. Robert McBride and Co., NY.
36. Smiley, N. 1960. Tropical planting and gardening for South Florida and the West Indies. Univ. of Miami Press, Coral Gables, FL.
37. Sneed, M. V. 1983. *Hyphaene petersiana* amongst animals in the Heartland of Africa. Principes 27 (4):141-151.
38. Sosa, G. 1961. Hablemos de Arboles. Ediciones Vendimiador, Mendoza, Argentina.
39. Standley, P. C. 1920. Trees and shrubs of Mexico (Gleicheniaceae-Betulaceae). Contrib. U. S. Nat'l Herb., Vol. 23, Pt. 1. Smithsonian Inst., U. S. Nat'l Herb., Washington, D. C.
40. Standley, P. C. and J. N. Steyermark. 1958. Flora of Guatemala. Fieldiana: Botany. Vol. 24, Pt. 1. Chicago Nat. Hist. Mus., Chicago, IL.
41. Stresau, F. B. 1986. Florida, my Eden. Florida Classics Library, Port Salerno, FL.
42. Sturtevant, E. L. (Edited by U. P. Hedrick). 1919. Notes on edible plants. New York Agr. Exper. Sta., Geneva, NY,
43. Sweet, M. 1962. Common edible and useful plants of the West. Naturegraph Co., Healdsburg, CA.
44. Watkins, J. V. 1969. Florida landscape plants. Univ. Fla. Press, Gainesville, FL.
45. Yanovsky, E. 1936. Food plants of the North American Indians. Misc. Pub. 237. U. S. Dept. Agr., Washington, D. C.

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POTASSIUM DEFICIENCY IN SOUTH FLORIDA ORNAMENTALS[1]

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Abstract. **Potassium deficiency has been identified as a widespread and often serious disorder of palms, *Pandanus utilis* Bory, cycads, plants in the Zingiberales, and at least four species of dicotyledonous trees (*Eucalyptus torelliana* F. Muell., *Bauhinia* L. spp., *Bucida buceras* L. and *Dalbergia sissoo* Roxb. ex DC). Symptoms in palms and *Pandanus* include translucent yellowish flecking, necrotic spotting, marginal necrosis, and withering of older leaves. On dicot trees and plants in the Zingiberales, symptoms include discoloration, necrotic spotting, and marginal necrosis of the oldest leaves. Potassium deficiency is prevented and treated by applying controlled release K fertilizers to the soil.**

Although K is known to be deficient in soils throughout the state of Florida, K deficiency on ornamental plants was not considered to be a significant problem (5, 7, 8). Dickey (5) identified K deficiency on *Ligustrum japonicum* Thunb., *Cornus florida* L., and *Acer rubrum* L. growing in northern peninsular Florida, but did not indicate that the problem existed in southern Florida. It is now known to be one of the most widespread of all deficiencies in southern Florida. Potassium deficiency symptoms have been described for several species of palms grown in sand culture (1, 2, 4, 6), but since K deficiency was not reported to occur in southern Florida, this work was largely ignored.

Palm growers have for years wondered about the cause of the translucent yellow to orange flecks or spots found on the oldest leaves of many palm species. Since plant pathologists have never been able to isolate pathogens from these spots and because these spots appeared to be nearly ubiquitous among palms, they were generally thought to be a symptom of natural leaf senescence. Similarly, the marginal necrosis found on old leaves of some palms such as *Roystonea* O. F. Cook spp. was generally thought to be caused by high soil soluble salts. The bronzing of old leaf tips of *Phoenix* L. spp. was attributed to Mg deficiency and the "pencil-point" decline and frizzling of the entire canopy of *Cocos nucifera* L. and *Roystonea* spp. were assumed to be caused by Mn deficiency. The discoloration of *Chrysalidocarpus lutescens* H. Wendl. foliage in the landscape was thought to be caused by N deficiency. All of these symptoms have recently been shown to be caused by K deficiency (3).

Symptoms and Susceptible Species

Potassium deficiency symptoms are quite variable on palms (3). In general, the first symptoms expressed in many species are small (1-2 mm) translucent yellow or orange flecks or spots on the oldest leaves. There may or may not be small necrotic spots associated with the yellowish flecks. On older, more severely affected leaves, or on more distal portions of less affected leaves, marginal necrosis will often be present. Entire leaflets of oldest leaves, or most distal parts of less affected leaves, will be necrotic and frizzled in appearance. In severely deficient palms, few leaves remain and these will be light yellowish-green, reduced in size, and partially frizzled. The trunk will taper to a point and death of the palm can follow if the deficiency is not treated. This progression of symptoms is typical for most species of palms, including *Chrysalidocarpus*, *Hyophorbe* Gaertn., *Cocos*, *Roystonea*, *Acoelorrhaphe* H. Wendl., and others (3).

Spotting of the foliage is not usually present on K deficient *Phoenix* spp. In these palms, oldest leaves will have orange leaf tips with the tips of affected leaflets often necrotic (3). Magnesium deficiency symptoms on these palms are similar, except that the oldest leaves will have broad light yellow bands on the leaf edges, the leaflet bases and the rachis remaining green. On some fan palms such as *Livistona chinensis* (Jacq.) R. Br. ex Mart. and *Bismarckia nobilis* Hildebrandt and H. Wendl., spotting is rare and only discolored older leaves with necrotic leaflet tips will be evident (3).

Most palms are susceptible to K deficiency. Of 53 species of palms growing in the landscape at the Fort

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Lauderdale Research and Education Center, 52 were observed with K deficiency symptoms. Specific symptomology, as well as relative susceptibilities to K deficiency are presented elsewhere (3). Native palms in general do not appear to be any more resistant to K deficiency than exotic palms.

Symptoms of K deficiency on *Pandanus utilis* are similar to those of most palms and include translucent yellow flecking, followed by tip necrosis, reduced leaf size and number, and finally pencil-pointing and death of the shoot. *Pandanus* is quite susceptible to K deficiency.

On self-heading *Philodendron* Schott. spp., oldest leaves of K deficient plants have extensive interveinal chlorosis and interveinal and marginal necrosis. Most plants in the order Zingiberales are highly susceptible to K deficiency. Symptoms have been observed by the author on *Canna* L. spp., *Heliconia* L. spp., *Calathea* G. F. Mey. spp., *Musa* L. spp., and *Nicolaia elatior* Horan. On these plants, symptoms include yellowish foliage with scattered necrotic streaking and extensive marginal necrosis on the oldest leaves. Affected plants are severely stunted and are often killed by the deficiency in southern Florida landscapes. Most of the tipburn of *Calathea* spp. and *Heliconia* spp. previously attributed to "leafspot" diseases is actually K deficiency. Symptoms in *Aspidistra elatior* Ker-Gawl. are similar.

Many species of cycads are also susceptible to K deficiency. Most, if not all of the frizzling of newly expanding leaves of *Cycas revoluta* Thunb. in southern Florida landscapes is caused by K deficiency. Manganese deficiency symptoms on these plants may be similar since in this case, symptoms occur primarily on newer leaves. Older leaves of affected *C. revoluta* often have small to medium-sized chlorotic and necrotic spots scattered thoughout the foliage. On *C. circinalis* L., older leaves of affected plants have chlorotic and necrotic areas near the middle of the leaves on either side of the rachis. These symptoms resemble sunburn in appearance. On one unidentified *Dioon* Lindl. spp., newly expanding leaflets drop their necrotic tips, leaving only truncated leaflets. On *C. revoluta*, leaflet tips of newly expanding leaves also become necrotic, but remain on the plant shrivelled and frizzled in appearance, rather than dropping off.

Although monocots appear to be much more susceptible to K deficiency than dicots, some dicot trees do routinely show symptoms. The most susceptible species include *Eucalyptus torelliana*, *Bauhinia* spp., *Bucida buceras*, and *Dalbergia sissoo*. On *Eucalyptus* and *Bauhinia*, oldest leaves are discolored and show interveinal chlorosis and necrosis. Oldest leaves of *Bucida* and *Dalbergia* show a diffuse interveinal chlorosis with extensive necrotic spotting, especially near the leaf margins.

Potassium deficiency has been confirmed by leaf analysis and/or response to potassium sulfate fertilization for all of the plants listed above. Potassium deficiency is suspected, although not yet confirmed, as being the cause of leaf marginal necrosis on older leaves of numerous species of ferns growing in southern Florida, as well as *Agathis robusta* (F. J. Muell.) F. M. Bailey, a gymnosperm.

Causes, Prevention, and Treatment

Southern Florida soils are generally very low in K due to their low nutrient holding capacity and high rainfalls that readily leach K though the soil (5). Potassium deficiency problems have been observed on all types of soils in southern Florida, but appear to be less severe on marl than on white sand, limestone, or muck soils. Potassium deficiency can be induced, or made worse by *continued use of* fertilizers that contain inadequate K relative to N. Many landscape fertilizers have slow release forms of N that provide N over a 1 to 3 month period, but soluble forms of K that can be completely leached from the soil after several rains or irrigations. The resulting imbalance between N and K in the soil can exacerbate K deficiency problems.

Potassium, being mobile within a plant, is readily retranslocated from old leaves to new leaves when necessary. For this reason, deficiency symptoms usually occur first on the oldest leaves. As the plant becomes more and more deficient, it withdraws K from progressively newer leaves in order to supply the growing shoot. Potassium-deficient palms usually hold fewer than the normal number of leaves in the canopy since deficient, frizzled leaves are either dropped prematurely or are cut off by maintenance people. This reduces even further the number of leaves from which the palm can obtain K. Once all leaves in the canopy are drained of their K, the palm goes into a rapid decline and may die if not treated. Therefore, premature removal of symptomatic leaves on palms may acccelerate the rate of decline from K deficiency.

Potassium deficiency is easily prevented, but once present, it is corrected only with considerable time, effort, and fertilizer. Regular applications of fertilizers containing roughly equal amounts of N and K and about half to one-third as much Mg should prevent the problem from ever occurring. However, it is important to use a fertilizer containing slow release forms of all three elements in order to prevent a nutrient imbalance from occurring over time. Since Mg has characteristics similar to K in southern Florida soils and in plants, it should be treated the same way. Fertilizing with K, but not Mg (or vice versa) will usually result in a deficiency of the omitted element. Similarly, the use of a fertilizer containing a slow release form of one element, but a soluble form of the other, will have the same effect.

Treatment of K-deficient trees can be accomplished by applying slow release potassium sulfate to the soil three or four times per year at rates of 1 to 5 kg per tree (depending on tree size) per application in addition to a good complete maintenance fertilizer. Both sulfur-coated and resin-coated potassium sulfate fertilizers are commercially available in southern Florida and are effective in treating and preventing K deficiency.

Most K deficient plants respond readily to soil applications of K fertilizers, yet complete correction of the problem can take years and many applications of K fertilizers. Since K deficient leaves will never recover, they must be replaced by new healthy leaves. In severely deficient plants, this means the entire canopy must be replaced and in palms, that can take 1.5 to 3 years or longer to accomplish.

Foliar sprays with five different K salts on K-deficient *Chrysalidocarpus lutescens* showed no improvement in symptoms nor increase in foliar K levels. Although micronutrient deficiencies can usually be treated with foliar applications of the deficient element, K is a macronutrient and is required by plants in such large quantities (usually 1 to 2% of plant dry weight) that foliar absorption is insignificant. Calculations suggest that correction of severely deficient *Roystonea* spp. or *Cocos* palms would require the uptake of 6.5 kg of actual K by the plant. If a 0-0-38 formulation is used, but only 20% of the applied fertilizer is taken up by the palm, 87 kg of this fertilizer would have to be applied over a several year period to completely correct the deficiency.

One year after treatment with Osmocote 0-0-37 (Sierra Chemical Co.) began, K-deficient *Chrysalidocarpus lutescens* had replaced about two-thirds of their foliage with deep green leaves, while control plants remained orange to yellowish-green with extensive spotting and marginal necrosis. Based on the current growth rate, it is predicted that the treated K-deficient areca palms will be completely green and free from symptoms after about 1.5 years of treatment. One year after treatment began on severely deficient *Hyophorbe verschafeltii* H. Wendl. palms, the greatest difference between treated and control palms was in the vigor and in the number of leaves held by the palms. Treated palms appeared very vigorous and held an average of 6-7 leaves, although deficiency symptoms remained on the oldest leaves. Control palms retained only about an average of 1.5 leaves and all leaves showed severe symptoms. Since the deficient palms originally had greatly reduced canopies, a whole new canopy must be grown before complete recovery from the symptoms can be effected. This is predicted to require about 2 years for this species.

Literature Cited

1. Broeshart, H., J. D. Ferwerda, and W. G. Kovachich. 1957. Mineral deficiency symptoms of the oil palm. Plant Soil 8:289-300.
2. Broschat, T. K. 1984. Nutrient deficiency symptoms in five species of palms grown as foliage plants. Principes 28:6-14.
3. Broschat, T. K. 1990. Potassium deficiency of palms in south Florida. Principes 34:(in press).
4. Bull, R. A. 1961. Studies on the deficiency diseases of the oil palm. 2. Macronutrient deficiency symptoms in oil palm seedlings grown in sand culture. J. West African Inst. Oil Palm Res. 3:254-264.
5. Dickey, R. D. 1977. Nutritional deficiencies of woody ornamental plants used in Florida landscapes. Univ. Fla. Agr. Exp. Sta. Bull. 791.
6. Manciot, E., M. Ollagnier, and R. Ochs. 1979. Mineral nutrition and fertilization of the coconut around the world. Oleagineaux 34:576-580.
7. Marlatt, R. B. 1980. Noncontagious diseases of tropical foliage plants. Univ. Fla. Agr. Exp. Sta. Bull. 812.
8. Street, J. J. and N. Gamon. 1983. Plant nutrient deficiency symptoms. Univ. Fla. Coop. Ext. Serv. Circ. 435.

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MUSHROOM COMPOST AS A SOIL AMENDMENT FOR VEGETABLE GARDENS

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Abstract. **The relatively small industry in Florida that grows mushrooms [*Agaricus bisporus* (Lange) Sing.] produces tons of a by-product called spent mushroom compost. Quincy Farms, Inc., located in Gadsden County, discards around 14 tractor-trailer loads of the compost every 3 days. A study was conducted in 1989 at 3 locations—Crawfordville, Quincy, and Tallahassee, to evaluate the compost as a soil amendment and organic fertilizer for use in vegetable gardens. Effects were observed and evaluated on bush beans (*Phaseolus vulgaris* L.), collards (*Brassica oleracea* L. Acephala group), squash (*Cucurbita pepo* L.), and tomato (*Lycopersicon esculentum* Mill.). At Crawfordville, compost at 20 T/acre combined with 160-69.8-132.8 (N-P-K) fertilizer gave the highest yields. The trial at Quincy showed that a garden could be grown on compost alone, at the rate of 50 T/acre. Collard plants averaged 3 inches taller, squash yields 1 lb. more, and tomato yields about 1 lb. more than when fertilizer (108-62.8-119.5) was applied alone. The compost was evaluated both in 1988 and in 1989 at Tallahassee. In 1988, best plant response was observed in the all-fertilizer plot. However, in 1989 on plots which had received additional compost due to the residual from the previous year and the doubling of the rate from 20 to 40 T/acre, plant response was only slightly less than for plots receiving fertilizer only (224-97.7-185.9). Results of this trial indicated that the spent mushroom compost produced at Quincy Farms, Inc. is an effective organic fertilizer and soil amendment for growing vegetables in north Florida gardens.**

The production and preparation for market of most vegetable crops results in the accumulation of various kinds of by-products that must be discarded in some proper, non-polluting manner. In most instances the disposal problem involves an accumulation of plant trimmings and cull produce. In other cases the waste is composed of such residue as plastic mulch, pesticide-contaminated wash water, and used containers. But with mushrooms, the waste material of concern is the left-over production medium called spent mushroom compost.

The Florida mushroom industry is relatively small compared with that of such states as Pennsylvania, which is ranked No. 1 in the country (2, 3, 5). Sixty percent of the