

CYCAD AULACASPIS SCALE (CAS) AULACASPIS YASUMATSUI TAKAGI AS A MAJOR PEST OF SAGO PALM CYCAS SPP. IN NIGERIA

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ABSTRACT: *Cycad aulacaspis scale (Aulacaspis yasumatsui Takagi) is native to the Southeast Asia specifically Thailand. Due to the trade in cycad plants for ornamental use in the world, it has been introduced widely in Asia, North America, the Caribbean, Europe, Pacific Islands, Ivory Coast and South Africa. Infestation by this scale can kill cycads in only a few months. Its introduction to these countries endangered the ornamental cycad-growing industry. In 2014, an introduced scale insect (Cycad aulacaspis scale) was discovered damaging cycads in a Bank premise, Port Harcourt. Survey was conducted on eight states (Cross River State, Rivers State, Abuja, Edo state, Akwa-Ibom state, Bayelsa state, Delta state and Lagos state) in Nigeria and report of severe damage was recorded. Management methods (cultural, chemical and biological) employed to manage the infestation proves ineffective as the scale insect was significantly seen three weeks after. The scale insect outnumbered their natural enemy tiny black lady beetle (*Rhyzobius lophanthae*) in these sampled locations and totally covers the entire plant within two months in a whitewashed scale-like appearance leading to chlorotic-yellow-brown leaves and eventual death of the plant. Therefore, this paper is aimed at reporting and creating awareness of the presence and outbreak of this insect pest (Aulacaspis yasumatsui Takagi) in Nigeria. Also, instant remedial measures should be taken to reduce the spread of this scale insect (Cycad aulacaspis scale) to other parts of Africa as to reduce the distribution of the scale insect on cycad species in this region.*

KEYWORDS: Cycad Aulacaspis scale, Sago palm, damage, infestation, Nigeria.

INTRODUCTION

Sago palm (*Cycas spp.*) is a species of gymnosperm native to the tropical islands of southern Japan, but it grows well in the subtropics of the United States, particularly in Florida, California, Georgia, and Puerto Rico (Schneider *et al.*, 2002). It is a member of the family Cycadaceae, division Cycadophyta, class Cycadopsida, order Cycadales, genus *Cycas*. Sago plant has a king plant (*Cycas revoluta*) and a queen plant (*Cycas rumphii*, *Cycas circinalis*) (Schneider *et al.*, 2002).

Cycads were officially introduced into Nigeria as an ornamental palm by the Nigerian Institute for Oil Palm Research (NIFOR), Benin City in 1975, and the two species officially introduced were *Cycas revoluta* and *Cycas circinalis*. Both species have feather like leaves arranged in a rosette that crown the single trunk, but the *circinalis* is larger and more graceful than *Cycas revoluta* (Chamberlain, 1990). Both of them have become very important in the horticultural landscape of Nigeria, especially around homes and institutions, horticultural gardens and offices (Nwaobasi, 2008). *Cycas spp.* grows well in full sun or partial shade but exhibits larger leaves in more shaded situations. Slow growing, the sago palm can reach heights of up to 15 feet in 50 years. Leaves are pinnately compound, 4 to 5 feet long, and up to 9 inches wide. The dark-green, stiff leaflets have a linear shape with a shiny upper surface. They are approximately 4 inches long, have revolute or curled under margins, and an acuminate or pointed tip. The trunk of the sago palm is dark brown and thick, and appears shaggy. Plants are either male or female and the reproductive structures are found in the center of the plant. The male organ resembles a large yellow cone that reaches lengths of up to 2 feet. The female organ resembles a yellow furry globe, and it houses many bright orange seeds that are 2 inches in diameter (Northrop *et al.*, 2010).

Mourya *et al.* (2011) and Rao *et al.*, (2007), reported that sago palm has potent antimicrobial, antiviral and antioxidant properties. The dried leaves of this plant are commonly used as accents in floral arrangements. Also, the inner bark of the sago palm can be used as a food source but if not properly prepared, it can cause paralysis or even death due to the powerful neurotoxin it contains. The seeds can also be poisonous to humans and animals if ingested (Northrop *et al.*, 2010).

Horticulturally, sago palm is an ornamental plant grown in most homes, corporate offices and institutions for landscaping and decoration. It is among the highest rated ornamental plant in floriculture business in Nigeria (Sani *et al.*, 2016) and sold from ₦10,000-~~₦~~45,000 per pot depending on the quality of the pot and the plant age (Personal discussion with Floriculturist). Unlike some other African countries like Kenya whose floriculture business has developed to export level, Floricultural business in Nigeria is still at a juvenile state with several challenges which include low awareness of the importance of flowers (aesthetic, social-economic and medicinal uses); lack of coordinated scientific research programme focusing on floriculture growth, poor level of investment both by public and private sectors (Aker and Healy, 1988).

Presently, this cycad plant production and commercialization is faced with a major constraint which is infestation of the plant by a scale insect known as Cycad Aulacaspis Scale (CAS). Cycad Aulacaspis scale (*Aulacaspis yasumatsui* Takagi) is a pest of the family Diaspididae and Kingdom Metazoa, originated from South East Asia (Heu and Chun, 2000). It was first observed and collected in Heu Bangkok, Thailand by K. Yasumatsu in 1972 and was described in 1977 by Takagi (1977). The outbreak of CAS had been reported in several continents/countries like Asia

(China, Hong Kong, Indonesia, Singapore, Taiwan, Thailand and Vietnam) (Chao, 2005; Bailey 2005), North America (Mexico, USA, Alabama, California, Florida, Georgia, Hawaii, Louisiana, South Carolina and Texas) (González-Gómez *et al.*, 2016; Cave and Duetting, 2004), Central America and Caribbean (Barbados, Cayman Island, Guadelope, Costa Rica and Puerto Rica) (Segarra-Carmona and Pérez-Padilla, 2008), Oceania (Guam, Palau, New Zealand and Northern Mariana Island) (Marler, 2008, 2009 and 2010; Moore, 2005a & 2005b and 2009), Europe (Croatia, Bulgaria, UK, France) (Trencheva *et al.*, 2010), Africa (South Africa and Ivory Coast) (Nesamari *et al.*, 2015; Germain and Hodges, 2007). Haynes (2005) reported that CAS was introduced in the early 1990s in South Miami Florida either through the transportation of cycad plants to botanical gardens or by people smuggling cycad plants from Southeast Asia.

This pest, CAS or Asian cycad scales have been recorded to affect plants of the genera: Cycads, *Dioon*, *Stangeria*, *Encephalartos*, *Ceratozamia*, *Macrozamia*, *Microcycas* (Howard *et al.*, 1999). The female cycad scales has a waxy covering, white or orange in color and tend to have pyriform shape (Weissling *et al.*, 1999) while the male cycad scale are orange-brown in color and are similar in appearance to tiny flying midges (Heu *et al.*, 2003). An Asian cycad scale lays egg within 21-35 days of hatching in warmer weather condition, hatching occurs within 8-12 days (CABI, 2018); the life cycle of cycad scale is approximately 35 days from egg to adult and average longevity is 75 days (Howard *et al.*, 1999). Infestation of CAS on cycad begins on the undersides of leaflets or at the base of the petiole, as the infestation progresses the scale insect infest the upper surface of the leaflets, pinnae, rachides, strobili, the trunk, seed/cones and the roots of various cycad species (Heu *et al.*, 2003; Howard *et al.*, 1999; Weissling *et al.*, 1999) making its management difficult. The leaves of infested cycads are snow-covered or whitewashed appearance due to the numerous white scales (Heu *et al.*, 2003). Heu *et al.* (2003) further explained that the effect of CAS on cycad plants ranges from chlorotic, yellow-brown leaves, continuous plant sap removal and finally death of the plant. The insect pest totally covers the plant within a couple of months (Broome, 2004) leading to death of the plant.

This notorious scale insect pest which was first observed in a bank premises at Port Harcourt, Nigeria in 2014 by our research team has speedily caused reduction in the population of this ornamental cycad plant in Nigeria. Therefore, this paper is aimed at reporting and creating awareness of the presence and outbreak of this insect pest (*Aulacaspis yasumatsui* Takagi) in Nigeria.

MATERIALS AND METHODS

Study Area

Seven major cities in Nigeria were selected for this study based on convenience and available resources. These cities are located in eight different states which include Cross River, Lagos, Abuja, Rivers, Bayelsa, Delta, Akwa-ibom and Edo.

Survey

As upon observation of CAS, we surveyed the infestation on Sago palms in four banks/institutions in Rivers State, Lagos State, Cross River State, Abuja, Bayelsa State, Delta State, Edo State and Akwa-Ibom State where they were used as ornamental plant to beautify the environment.

The infestations of CAS on the leaves of sago palm were assessed using a modified 5-grade scale of Compton (1991) below:

0 wilted – No damage

1-2 wilted leaves – Slightly damage

3-4 wilted leaves – Average damage

5 wilted leaves – Severe damage

6 wilted leaves or above – Very severe damage

Management

Pruning (cultural method) was done to remove the severe/infested leaves, investigation for the presence of natural enemies that coexist with the scale insect and use of some insecticides (Cypermethrin, dimethoate, Lambda-cyhalothrin) were all employed in the management of the notorious scale insect on Sago palms including the combination of the various pest management methods in an integrated approach.

RESULTS

The result observed in Plate 1a &b from the various locations indicated that the CAS infested both the underside of the leaf and petiole close to the crown of the plant. Snow covering of the petiole was also noted (Plate 1b), this whitish or snow covering on the petiole caused by the CAS gradually proceeded to the upper part of the leaves (Plate 1c), this heavy infestation resulted to the coloration of the leaves to yellowish brown (Plate 1d). After the chlorotic coloration of the plant, the sago palm dies off (Plate 1e).

Pruning was used as a cultural method for reducing the spread of the CAS insect (Plate 1f) though was not effective as the scale insect resurfaced on arrival of new leaves. Similarly, the scale insect

also reappeared after 3 weeks of insecticides applications. Observation before control measures reported very severe damage in the sampled cycad plants, while averagely to severe damage was recorded in the sampled plants in all the cities after three weeks of combined management measures Table 1. Some few numbers of the CAS natural enemy tiny black lady beetle (*Rhyzobius lophanthae*) was observed Plat 1a.

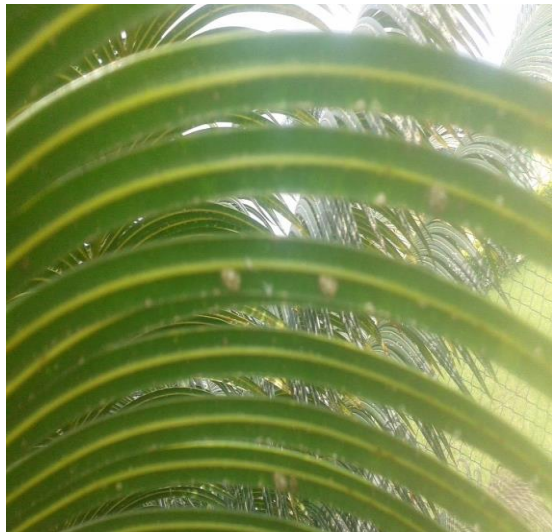


Plate 1a: Early Infestation of the leaflet by CAS the infested petiole



Plate 1b: Snow-covered appearance of



Plate 1c: Movement of the CAS to the upper part of the leaves



Plate 1d: Chlorotic yellow-brown leaves



Plate 1e: Eventual death of the Sago Palm



Plate 1f: Pruned Sago Palm Plant

Table 1: Damage of *Aulacaspis yasumatsui* Takagi on Sago Palm on the Studied Locations in Nigeria before and after Management Practices

LOCATIONS	DAMAGE	RATING	DAMAGE	RATING AT 3 RD
	BEFORE MEASURES	CONTROL	WEEK AFTER MEASURES	CONTROL
Lagos State	Very severe damage		Averagely damage	
Rivers State	Very severe damage		Severe damage	
Cross River State	Very severe damage		Averagely damage	
Akwa-Ibom State	Very severe damage		Severe damage	
Delta State	Very severe damage		Severe damage	
Bayelsa State	Very severe damage		Averagely damage	
Edo State	Very severe damage		Averagely damage	
Abuja	Very severe damage		Severe damage	

DISCUSSION

The infestation started from base of the petiole near the crown of some sago palm while some infestation started from the undersides of the leaflet (Plate 1a & e), this infestation progresses to

the upper part of the leaves after which yellow-brownish coloration of the leaves was noticed and eventually death of the plant. This finding was in conformity with Heu *et al.* (2003) and Weissling *et al.* (1999) who explained the pattern of infestation of CAS (Cycad Aulacaspis Scale) on *Cycad spp.* and that the chlorotic yellow-brownish coloration of the leaves is due to removal of plant sap by the scale which will lead to death of the leaves. When the color of the leaves changes, the photosynthetic process of the plant stops and this retards their growth/development and destroys the entire plant. Weissling (1999) further described that heavy infestation of a plant can consist of 3,000 scale per square inch in several layers, this layers formed comprises of high proportion of dead insect as well as live insects. The color of the highly infested petiole and underside leaflet shows snow covered or white-washed covering (Plate 1b and c), the chlorotic coloration of the leaves after infestation is as a result toxicity in the saliva secreted by the scale insect (Muniappan *et al.*, 2012).

The introduction of the different Cycad species to Nigeria is due to its beautification to the environment as it is been imported into the country as ornamental/horticultural plant (Nwaobasi, 2008; Chamberlain, 1990). This cycad species are been transported from Asia and CAS are introduced as well as they are able to hide in the crevices and roots thereby not detected in plant quarantine inspection due to their small size (Marler and Moore, 2010). This Cycad Aulacaspis Scale (CAS) was similarly introduced to Southern China in the 1990s through the importation of infested *Cycas inermis* Lour from Vietnam. It later spread from China to Hong Kong, Taiwan and Malaysia where it caused significant damage to cycads in 1992 (Haynes, 2005; Hodgson & Martin 2001). This invasion of CAS to cycad plants in Nigeria will endanger the available species and will cause the extinction of this ornamental/aesthetic plant and negatively affect cycad-growing industry in the country.

The management techniques used in the study was ineffective due to the fact that the scale insect has the ability to hide deep in the crevices and roots of the plant, this findings is in agreement with the research work of Marler & Moore (2010). This rapid growth and infestation of scale insect after three weeks of control measures may be due to their high fecundity and egg production rate as mature female lays over 1000 eggs (CABI, 2018; Howard *et al.* 1999). They further reported that this Asian cycad scale lays egg within 21-35 days of hatching in warmer weather condition, their hatching occurs within 8-12 days and their life cycle is approximately 35 days from egg to adult.

Pruning was done to minimize the spread of the scale insect in the sampled banks and institutes after which chemicals (Permethrin, dermatol, Lambda-cyhalothrin) were applied using knapsack sprayer and mist blower. There was low population of tiny black lady beetle (*Rhyzobius lophanthae*) in these sampled locations and this caused ineffectiveness of the biological method as the scale insect outnumbered the tiny black lady beetle. Re-infestation of the scale insect was later

observed after the three weeks of control measures and these findings was in line with the statement of Howard *et al.* (1999) and Heu *et al.* (2003) who said these infested Sago plant parts (trunk, leaf petioles and roots) are difficult to reach with pesticides and this can be a source of scale re-infestation after infested leaves are pruned.

CONCLUSION

This survey studied the outbreak of a notorious scale insect pest Cycad *Aulacaspis yasmatsui* (CAS) in Nigeria. Several banks and institution were sampled in seven states (Cross River, Lagos, Bayelsa, Abuja, Rivers, Delta, Akwa-ibom and Edo) in which CAS caused colossal loss and severe damage to Sago Palms. Different management methods (cultural, chemical and biological) were adopted to manage the loss caused by cycad aulacaspis scale but they proved ineffective. Instant remedial measures should be taken to reduce the spread of this scale insect (Cycad aulacaspis scale) to other parts of Africa as to reduce the distribution of the scale insect on cycad species in this region.

REFERENCES

- Aker, S. M. & Healy, W. E. (1988). Factors limiting floriculture growth in Nigeria. Proceedings of stakeholders retreat organized by the National Horticultural Research Institute. 114-126.
- Bailey, R. (2005). Update on CAS Research in Taiwan. Unpublished
- Broome, T. (2004). Horticulture: the Asian cycad scale. <http://www.plantapalm.com/vce/horticulture/asiancycad>.
- CABI (2018). *Aulacaspis yasmatsui* (Cycad Aulacaspis Scale). Invasive Species Compendium. Wallingford, UK: CAB International.
- Cave, R. D. & Duetting, P. S. (2004). Predatory Coleoptera on King Sago (Cycadaceae) in South Florida. Poster presented at the Entomological Society of America meetings, 7-11 November 2014, Salt Lake City, UT.
- Chao, Jung-Tai (2005). CAS status update in Taiwan. Personal communication Jody Haynes Cycad Biologist, Montgomery Botanical Center.
- Chamberlain, C. J. (1990). The Living Cycas. University of Chicago Press. Chicago. 40p
- Compton, J. A. F. (1991). Survey of Farm Storage Maize and Dried Cassava Chips in Togo. Feb-March 1991 NRI Report R. 1773, 90pp.
- Germain, J. F. & Hodges, G. S. (2007). First report of *Aulacaspis yasumatsui* (Hemiptera: Diaspididae) in Africa (Ivory Coast) and update on distribution. *Florida Entomologist*, 90(4): 755-756.
- González-Gómez, R., Riverón-Giró, F. B., Garcia- González, A. Martínez-Rosas, R. & Solis-Montero, L. (2016). First report of *Aulacaspis yasumatsui* (Hemiptera: Diaspididae) in Mexico. *Florida Entomologist*, 99(3): 583-584.
- Haynes, J. (2005). Cycad aulacaspis scale: A global perspective. *Cycad Newsl*, 28:3-6.
- Heu, R. A., Chun, M. & Nagamine, W. T. (2003). Sago palm scale, *Aulacaspis yasumatsui* Takagi (Homoptera: Diaspididae). State of Hawaii Department of Agriculture New Pest Advisory No. 99-01.

- Heu, R. A. & Chun, M. E. (2000). Sago palm scale. New Pest Advisory no. 99-01. Honolulu: State of Hawaii Department of Agriculture.
- Hodgson, C. J. & Martin, J. H. (2001). Three noteworthy scale insects (Hemiptera: Coccoidea) from Hong Kong and Singapore, including *Cribropulvinaria tailungensis*, new genus and species (Coccidae), and the status of the cycad-feeding *Aulacaspis yasumatsui* (Diaspididae). *Raffles Bull Zool*, 49:227-250.
- Howard, F. W., Hamon, A., Mclaughlin, M., Weissling, T. & Yang, S. L. (1999). *Aulacaspis yasumatsui* (Hemiptera: Sternorrhyncha: Diaspididae), a scale insect pest of cycads recently introduced into Florida. *Florida Entomol.*, 82:14-27. <http://dx.doi.org/10.2307/3495833>
- Marler, T. (2008). CAS confirmed on Palau. December 2008. <http://www.cycadsg.org/publications/CAS-confirmed-on-Palau.pdf>.
- Marler, T. (2009). Rota Update. 28 April 2009. <http://www.cycadsg.org/publications/CAS-Rota-update.pdf>
- Marler, T. (2010). Guam Update. 19 January 2010. <http://www.cycadsg.org/publications/CAS-Guam-update.pdf>
- Marler, T. E. & Moore, A. (2010). Cryptic scale infestations on *Cycas revoluta* facilitate scale invasions. *Hort. Science*, 45:837-839.
- Moore, A. (2005a). Evaluation of emergency insecticide treatments for conservation of Guam's endemic cycad, *Cycas micronesica* during invasion by the Asian cycad scale, *Aulacaspis yasumatsui*, Draft proposal.
- Moore, A. (2005b). Cycad Scale, *Aulacaspis yasumatsui* (Homoptera: Diaspididae). Micronesian invasive insect survey website.
- Moore, A. (2009). UOG Entomologist Helps Palau with their cycad scale infestation. Western Pacific Tropical Research Center.
- Mourya, M. K., Prakash, A., Swami, A., Singh, G. K. & Mathur, A. (2011). Leaves of *Cycas revoluta*: Potent antimicrobial and antioxidant agent. *World Journal of Science and Technology*, 1(10): 11-20.
- Muniappan, R., Watson, G. W., Evans, G. A., Rauf, A. & Von-Ellenrieder, N. (2012). Cycad *Aulacaspis* Scale, a Newly Introduced Insect Pest in Indonesia. *HAYATI Journal of Biosciences*, 19(3): 110-114.
- Nesamari, R., Millar, I. M., Coutinho, T. A. & Roux, J. (2015). South African cycads at risk: *Aulacaspis yasumatsui* (Hemiptera: Coccoidea: Diaspididae) in South Africa. *African Entomology*, 23(1): 196-206.
- Northrop, R. J., Andreu, M. G., Friedman, M. H., McKenzie, M. & Quintana, H. V. (2010). *Cycas revoluta*, Sago Palm. UF/IFAS Extension Service, University of Florida.
- Nwaobasi, L. N. (2008). *Cycas circinalis* and its Horticultural Potential. Department of Plant Biology and Biotechnology, Undergraduate Seminar Series. University of Benin, Nigeria. 17p.
- Rao, G. P., Baghel, A. K. S., Singh, R. K. & Chatterji, K. S., (2007). Antiviral activity of coralloid root of *Cycas revoluta* extract against some viruses of tomato plant. *Cellular and Molecular Life Sciences*, 40(11), 1257-1258.
- Sani, Y. A, Isah, A. S., Babaji, B. A., Barnabas, S., Yahaya, R. A. & Hassan, M. B. (2016). Identification and Description of Some Common Ornamental Plant Species at Ahmadu Bello University Zaria, Nigeria. *Advances in Nutrition and Food Science*, 1(1): 1-5.

- Schneider, D. Wink, M. Sporer, F. & Lounibos, P. (2002). Cycads: their evolution, toxins, herbivores and insect pollinators. *Naturwissenschaften*, 89(7):281-294.
- Segarra-Carmona, A. E. & Pérez-Padilla, W. (2008). The cycad scale, *Aulacaspis yasumatsui* Takagi (Homoptera: Diaspididae): a new invasive pest of Puerto Rico. *Journal of Agriculture of the University of Puerto Rico*, 92: 123-129.
- Takagi, S. (1977). A new species of *Aulacaspis* associated with a cycad in Thailand (Homoptera: Coccoidea). *Insecta Matsumurana*, 11:63-72.
- Trencheva, K. Trenchev, G., Tomov, R. & Wu SanAn (2010). First report of *Aulacaspis yasumatsui* Takagi 1977 (Homoptera: Diaspididae) in Bulgaria. *Rasteniev'dni Nauki*, 47(3): 206-209.
- Weissling, T. J., Howard, F. W. & Hamon, A. (1999). Featured creatures: Cycad aulacaspis scale, *Aulacaspis yasumatsui* Takagi.