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A Review on *Mononychellus tanajoa* (Bondar, 1938) Pest of Cassava in Brazil

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ABSTRACT

Cassava is a subsistence food to 200 million people in the African continent and in the Brazil serves as food for millions of poor people and plays an important role in the generation of employment and income, especially for small and medium producers. But damage caused for pests in the cassava difficult the increased of production, Nigeria is the major producer world followed of the Brazil, both the countries have serious losses economic due to the *Mononychellus tanajoa* mite, in the Africa the losses are of 80% and Brazil 51%. Diverse methods biological are being used as alternative to the chemicals method that are in viable due the long cycle of the crop and environmental problems. In the Brazil the biological control, the crop improvement and natural extracts are alternative used to control of *M. tanajoa* in the country. The objective of the work was show the different techniques that are being used to control of *M. tanajoa* in the cassava. The methods presented showed that exist difficulties practical to substitute completely the chemicals method however the integration of methods biological can be the way better of the Brazil increased the production of cassava eliminated pests without the use of pesticides and with the use of Integrated pest management-IPM effective.

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INTRODUCTION

Origin, Dissemination and Economic Importance of Cassava:

Cassava it is a shrub that would have had its most remote origins in the western Brazil (southwestern Amazon) and that, before the arrival of Europeans in America, was already widespread as a food crop, to Mesoamerica (Guatemala, Mexico), and then dispersed onto to various parts of the world by the Portuguese. The variety of cassava was domesticated from wild species of *Manihot esculenta Crantz* suggesting that *Manihot esculenta* Crantz, *Manihot esculenta* Crantz *flabellifolia* and *Manihot esculenta* Crantz *peruviana* were possible ancestors of cassava.

Manihot esculenta Crantz is the only commercial cassava and had its origins in the cultivation of several indigenous nations of Latin America who consumed their roots. The name Manihot was given due to the stem of the foot of cassava, which is called maniva, this is cut in pieces and used in the planting and then exported to other parts of the world.

The genotype *M.*Crantz, has an important social role as a source of carbohydrates for humans. Its main product consists of the roots that are excellent sources of energy. As byproducts can cite bran shave; cassava flour, byproduct of industrialization, aerial parts, and the hay of the aerial part, this rich in protein, and what can be used for animal feed (Almeida, 2004).

For the African continent, *M.*Crantz is an important subsistence crop for over 200 million people in the tropical and subtropical Africa where, in many cases, is the basis of the diet having the Nigeria as one of their major producers.

The derivatives of cassava consumed in the Africa normally pass by a fermentation process. The main derivative is gari, similar to flour produced in Brazil, but pre-fermented. Another expressive use is derived from

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fufu prepared with pulp only of the roots, that after anaerobic fermentation for about 3 days. Although there are some differences, this derivative has great similarity in the manufacturing process, with the flour of water and puba Amazon. Fresh roots and leaves, preferably cooked, are also of common use in African cuisine. The portion of the roots used for the production of starch or flour shaved represents a very part small in relation to the total production (Herren and Bennett, 1984; Otsubo and Lorenzi, 2004).

Cultivated in all regions of the Brazil, cassava plays an important role in the generation of employment and income, especially for small and medium producers. Lorenzi and Dias (1993) estimated that 50% of the production intended for human consumption and the remaining to animal. The Brazil has in the flour of table its main derivative, it is estimated that in the phase of primary production and processing flour and starch about one million direct jobs were created, providing an equivalent annual gross revenue to $ 2.5 billion and a tax contribution of $ 150 million. The production transformed in flour and starch generates, respectively, revenues equivalent of 150 million to 600 million dollars. The objective of the work was show the different techniques that are being used to control of *M. tanajoa* in the cassava.

Green mite: Origin, dissemination and taxonomy:

In the early 1970s, a species of mite was found attacking cassava in Africa and was identified as the green mite, *Mononychellus tanajoa* (Bondar, 1938) (Acari: Tetranychidae), this specie was eventually accidentally introduced in cassavas in the Africa. The farmers of this country suspect that the pest could to have come from imports from Colombia, South America (Lyon, 1974; Yaninek *et al.,* 1989).

M. tanajoa was discovered near Kampala, Uganda, in 1971 (Lyon, 1973). Since then the pest has spread to at least twenty-seven countries in Africa causing damage (Gutierrez *et al.,* 1988; Yaninek, 1985; Yaninek *et al.,* 1989).

In Nigeria, one of the main producers of cassava in Africa, its focus was first noticed around Ikeja, near Lagos, in 1979, severely damaging the country's production, causing damage estimated at 80% in cassava production in throughout the continent (Akinlosotu and Leuschner 1981; Yaninek *et al.,* 1989).

A year later Muaka-Toko and Leuschner (1980), made the first studies in the African continent on the development of different stages of the life cycle of the mite in temperatures of 22, 28 and 35 ° C, found that oviposition of *M.tanajoa* increased in temperatures of 28 ° C and greater hatching at temperature of 22° C, while the period of development (eggs / adult) was faster when temperature increased from 22 to 35 ° C.

Yaninek *et al.,* (1989) studied in different months of the year the occurrence of *M.tanajoa* in different seasons, and found that in the driest period the mite infestation was greater than in periods of high humidity in relation to other species infested cassava, demonstrating that in periods of dry seasons occur the most damage of the pest.

Other researchers also studied *M. Tanajoa* and affirmed that this is biologically similar to other agronomically important tetranychidae. The adult female lays fertilized eggs females and unfertilized male eggs. There are four active stages: A six-legged larva, two nymphal stages (protonymph and deutonymph) and the adult stage (Figure 1). The active phases prefer to feed in the terminal parts of the plant, killing the cells of the sheet and reducing photosynthesis (Yaninek, 1985; Van de vrie McMurtry, 1970; McMurtry and Van de vrie Huffaker, 1970).

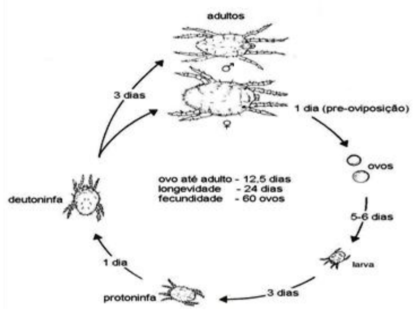

Fig. 1: Egg to adult cycle *Mononychellus tanajoa*. Adapted from Yaninek *et al.,* (1989).

Noronha (2001); Flechtmann and Moraes , (2008) add that the incidence of the mite is evident mainly in the growing points of the plants and buds, affect the formation of leaves that become reduced in plants that severely attacked presenting deformed such as reduction of internodes and reduced crop productivity and affect the quantity and quality of planting material .

M.tanajoa was originally discovered in 1938 in cassava variety of *Manihot esculenta* Crantz variety (Bondar 1938). But in the Brazil only began to be studied 33 years later when he was found in Uganda, Africa, despite the continent has a greater knowledge of the species, the country still needs further technological development (Nyiira, 1972; Noronha, 2001).

The state of Bahia was the first place of occurrence of this mite; *M.tanajoa* is also a serious problem in Brazil, as well as in the African continent where it causes losses of 51% in the cassava production. In the State of Pernambuco, this mite has been considered one of the main pest that affect cultivation in semi-arid conditions, with the attack starting at the end of the rainy season, extending until the end of the first cycle of the plant, the biggest problems in country are in the Northeast region (Fukuda *et al.*, 1996).

There are also reports of *M.tanajoa* attacks in the Asian continent, specifically in China, but the damage to production still are not well known (Chen, *et al.*, 2010). According Lu *et al.*, (2012);. Yaninek, (1989) *M. tanajoa* has a rapid dispersal ability, both between countries of the same continent and outside, quickly infesting and colonizing its host, which makes it the pest present in many places in the world such as Africa, South America, Central America and Asia where is considered a quarantine pest (Figure 2).

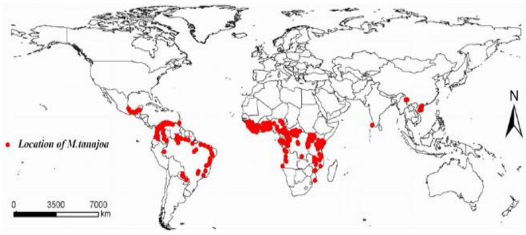

Fig. 2: Global distribution of *Mononychellus tanajoa* (Bondar 1938) in cultures of cassava, adapted from Lu *et al.*, (2012).

In the Asian continent there was already suspected introduction mite since 2008 when in Thailand there was the first occurrence, was observed through monitoring its presence on the continent in cassavas (Bellotti *et al.*, 2008).

Were related occurrence of the mite also in Vietnam, Cambodia, Thailand, Laos, Malaysia, Indonesia, Myanmar and New Guinea. Although it is possible that the distribution of green mites in these zones is limited by high precipitation, these regions also have dry periods that are favorable to the development of the species. Several regions in Asia appear to be highly suitable for the establishment of the pest because potential distribution estimates are similar to values in Africa, where substantial economic damage from green mite invasions has already occurred (Campos *et al.*, 2011).

Green mite control potential in Brazil:

The increased crop in the world has provided a higher incidence of agricultural pests that cause damage. The control *M.tanajoa*, is being done basically with the use of pesticides, but the problems of their use are mainly related to pest resistance. Furthermore, there is a pressure these days for the use of less control techniques that damage the environment (Silva *et al.*, 2007; Bellotti *et al.*, 1999).

Furthermore Brazilian producers reported some difficulties that prevent the use of chemicals to control mite as long crop cycle, as this has a low economic return, and the limited resource of the producers are determinant factors for use.

In order to get an idea of the national cassava production for the year 2011 is estimated at 27.1 million tons, increase of 9.1% compared to the 2010 crop (Figure 3), the production is one of the largest in the world losing only to the African continent (IBGE, 2011).

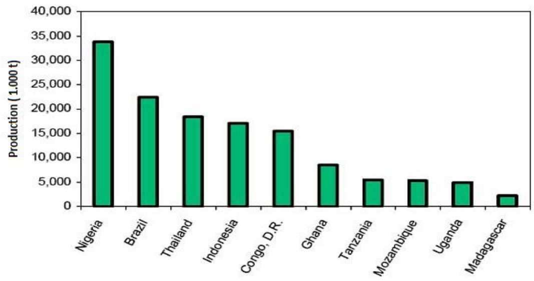

Fig. 3: World production of cassava. Adapted of FAO, (2004) and IBGE, (2011).

For the country continue to raise its agricultural production is necessary to invest in new control tactics such as improvement of vegetables genetic improvement to acquire resistant cultivars, natural extracts and biological control with fungi and releases of predatory mites have been used in the reduction of the green mite infestations in different producing regions.

Technologies such as the use of genetically improved varieties are being studied. Observations have shown that cassava has wide genetic diversity, concentrated mainly in Latin America and the Caribbean. The first major collection of cassava was established in Latin America, the International Center for Tropical Agriculture (CIAT) in Cali, Colombia, in the early 70s, and national Embrapa Cassava and Tropical Fruits, Cruz das Almas, Bahia, Brazil, at the same time. This genetic patrimony has been preserved and expanded to serve as a basis for genetic improvement programs with culture around the world (Fukuda and Iglesias, 2006).

Today more than 8.500 accesses have been cataloged worldwide, including 7.500 in the South America. In Brazil considered as a possible center of origin and diversification of the species were cataloged over 3.000 accesses, which are kept in collections and / or germplasm banks around the country (Lorenzi *et al.*, 2002).

According to Hershey, (1985) what exist collected and available in the collections and germplasm banks in the world, presents sufficient variability to provide to the researchers most of the characters of economic interest.

Manihot esculenta species possesses genetic diversity for almost all the characteristics, including those of morphological, agronomic and resistance to major pests and diseases that affect the culture in the country have been identified. (Fukuda *et al.,*1996). They also have great reservoirs of genes to be transferred to commercial species (CIAT, 2003).

However, these species have not been used in breeding programs due to high heterozygosity on gender, which takes production of hybrid populations that segregate for different characteristics.

The irradiation is a useful tool in plant breeding, because artificially induced mutations, rather than waiting that occur randomly in nature. Since the initial studies by Johnson, (1933) and Smith, (1942), it is observed that varieties, lineages, hybrids, varietal groups, and plant tissues and developmental stage of the plant organs may exhibit differences in the sensitivity to gamma radiation (radiossensitivity). In maize, it was observed that the lineages are more radiosensitive than hybrids simple (Saric, 1961).

The method of genetic vegetable improved by irradiation is promising due to high rates of occurrence of mutations that are rare in nature, and thus can be used for an increased number of not deleterious mutations for plant breeding, some studies using this technique have show good results, as experiments of Kikuchi *et al.*, (2009), which evaluated the effect of different irradiation sources in wheat, has been observed that these do generate not deleterious recombination, thus artificially increasing the rate of recombination in this culture. In banana, some studies have been conducted in order to generate genetic variability for vegetables by irradiation (Ho *et al.*, 2001; Pestana *et al.*, 2010).

In State of Rio Grande do Sul - RS, Brazil are being made studied the improvement genetic of rice across of artificial mutations by irradiation in the control of some pests as *Oryzophagus oryzae*, *Nymphula indomitalis* and bedbugs as *Oebalus poecilus* and *Tibraca limbativentris* (SOSBAI, 2010).

As a lower cost option, vegetable extracts, are currently the target of research as an alternative method to control phytophagous mites. Extracts of nim *Azadirachta indica* A. Juss. and the azadirachtin formulations possess tetranortriterpenoid that have a action insecticide and acaricide, this substance is present in nim seeds (Schmutterer, 1990), the results of some studies show a decreased of the survival on red mite *Tetranychus cinnabarinus* Boisduval and also of two spotted mite *Tetranychus urticae* Koch, causing inhibition of oviposition , reduced egg viability and mortality of immature and adult (Mansour *et al.*, 1997; Miller and Uetz, 1998).

In *M. tanajoa* there only one work on the use of plant extracts in the control of the green mite, in which activity of nim and carnation of India *Syzigium aromaticum* L. at concentrations 5 to 10% caused the mortality of females between 85 and 100% of the adults mites (Gonçalves *et al.*, 1999).

Vegetable extracts have an action in more of 400 species and causing effects such as: repellency reduced feeding, repellency posture, interruption of the development and ecdysis, reduced fertility and fecundity and several behavioral alterations and physiology of insects which can lead to death (Martinez, 2002).

Although there information in the literature on the effect of extracts of some plant species on mites, these are still not enough to cause significant changes in pest control options. There are still many unknown vegetables species with acaricides functions and moreover there is the difficulty of the mass production of these natural extracts due volatility of natural extracts.

Others techniques, as biological control have need of a low cost technology, the use of entomopathogens as fungus in the control of insects and mites are potential methods that have with the objective reduce the populations of economically important crops, in Brazil the mite-pathogenic fungus *Neozygites floridana* Fisher, *Beauveria bassiana* (Balsamo) Vuillemin, and *Metarhizium anisopliae* (Metsch) Sorokin has been considered for introduction (Yaninek *et al.*, 1996, Odindo, 1992).

Studies potentials with this fungus on *M.tanajoa* mites show that Conidia viability for *M. anisopliae* and *B. bassiana* isolates was superior at 95% for these organisms (Barreto *et al.*, 2004). For *N.floridana* its efficiency is dependent on the environmental conditions as temperature and relative humidity (Elliot *et al.*, 2000).

Others authors obtained successful in its works as mite *Brevipalpus* spp. in Mexico, Acevedo & Rosas (2000) concluded that the control with fungus *Hirsutella thompsonii* Fischer was superior to organophosphate chemical products.

For one of cases of major susscessful the *Entomophaga maimaiga* Humber, Shimazu & Soper (Entomophthoraceae), a Japanese fungus which has shown striking success in managing Gypsy Moth *Ymantria dispar* L. (Linnaeus) (Lepidoptera: ymantriidae L.) in populations of the North America, across forests in north-eastern North America (Hajek, *et al.*,1996).

Tamai, (1997) for *Tetranychus urticae* Koch using other kind of fungus with *Beauveria* spp. observed levels of 73% mortality on the mite. Oliveira *et al.*, (2002), working with *B. bassiana* for the red mite *Oligonychus yothersi* McGregor, verified mortalitys of until 98%.

Studies with the fungus presented in the review produced good results, however the production on artificial medium makes it difficult to use it in green mite biological control programs principally due to practical difficulties in working with this group (e.g. culturing in vitro, resting spore germination), it is still a challenge (Leite *et al.*, 2000).

The biological controls with mite predators are used also as attempts to control *M.tanajoa*, the implanted biological control in Africa to *M. tanajoa* is one of the successful programs in the control of pest mites. Predatory mites were imported from Brazil for effective control of *M.tanajoa* in Africa, which was causing considerable losses in cassava crops. The species *Neoseiulus idaeus*, *Amblydromalus manihoti* (Moraes) and *Thylodromalus aripo* De Leon are considered as efficient predators (Moraes, Flechtmann, 2008).

Typhlodromalus aripo De Leon (Acari: Phytoseiidae) is so far the most successful predatory mite spread across 20 African countries causing a significant reduction in *M. tanajoa* populations (Hanna and Toko, 2001).

According to Moraes *et al.*,(1990) the predators associated the cassava in the Brazil are phytoseiid mites *Amblyseius idaeus* Denmark and Muma, *Amblyseius limonicus* Garman and McGregor s.l. and *Amblyseius aripo* DeLeon.

Most recently studies with *Euseius citrifolius* Denmark and Muma and *Euseius concordis* Chant that are predatory mites of the family Phytoseiidae, commonly found in agroecosystems of cassava in South, Southeast and Center-West regions of Brazil. The results show the viability of the use these organisms as biological control agents in cassava to control green mite (*Mononychellus tanajoa* Bondar), (Furtado, 1997).

However mite predators needs of a basic certification study of species, biology and understanding of their relations with the pest mite as also the hosts that are necessary for successful this control.

The different forms of mite control *M.tanajoa* presented in this work should be encouraged, since the chemical method is practically inviable to this culture of long cycle. But the use of these techniques are still not perfectly feasible to completely replace the chemical method because they still have some flaws and can be used only in appropriate situations such as temperature and humidity and specific locations. The difficulty of these methods most often were related to methods of mass rearing of organisms and gradually in relation to existing pest of cassava studies. And although the methods are effective in the laboratory, further studies need to be developed to achieve the greatest possible number of biological agents in the case for predators and fungi and the discovery of new varieties for breeding and new substances to natural extracts.

Therefore the choice of method should be made for each region by studying its climate and its local fauna. The difficulties of establishing control methods for agriculture, can be resolved if there is an integration of the methods. Thus, studies on the integration of biological methods should be encouraged, so all methods of pest control presented in this review can be used individually or associated within the integrated pest management (IPM) as potential control *M. tanajoa* in cassava in the Brazil.

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REFERENCES

Acevedo, J.L.R., L.S. Rosas, 2000. Controle biológico de *Brevipalpus* spp. em *Citrus aurantifolia* en Guerrero, México. Manejo Integrado de Plagas, 55: 56-59.

Akinlosotu, T.A. and K. Leuschner, 1981. Outbreaks of two new pests *(Mononychellus tanajoa* and *Phenacoccus manihoti)* in southern Nigeria. Tropical Pest Management, 27: 247-250.

Almeida, J. Mandioca na alimentação animal, 2004. http://www.agronline.com.br/artigos/artigo.php?id=189&pg=5&n=5. Accessed on May 15, 2012.

Barreto, R.S., E.J. Marques, M.G.C. Jr. Gondim and J.V. de Oliveira, 2004. Selection of Beauveria bassiana (Bals.) Vuill. and Metarhizium anisopliae (Metsch.) Sorok. for the control of the mite *Mononychellus tanajoa* (Bondar). Scientia agrícola, 61(6): 659-664.

Bellotti, A.C., J.C. Herrera, M. Del P. Hernández, B. Arias, J.M. Guerrero and E.L. Melo, 2010. Three major cassava pests in Latin America, Africa and Asia. In the Proceedings of the Eighth Regional Workshop held in Vientiane.

Bellotti, A.C., L. Smith and L.S. Lapointe, 1999. Recent advances in cassava pest management. Annual Reviews Entomology, 44: 343-370.

Bondar, G., 1938. Notas entomológicas da Bahia. III. – Revista Entomologia, Rio de Janeiro, 9: 441-445.

Campo, B.V.H., G. Hyman, A. Bellotti, 2011. Threats to cassava production: known and potential geographic distribution of four key biotic constraints. Food Security, 3(3): 329-345.

Chen, Q., F.P. LU, G.X. Huang, K.M. LI, J.Q. YE and Z.W. Zhang, 2010. General survey and safety assessment of cassava pests. Chinese Journal Tropical Crops, 31: 819-827.

Ciat, 2003. Annual Report Project IP3, Improved Cassava for the Developing World. Cali, Colombia:CIAT, pp: 8-68.

Elliot, S.L., G.J. de Moraes, I. Jr Delalibera, C.A.D. da Silva, M.A. Tamai and J.D. Mumford, 2000. Potential of the mite-pathogenic fungus *Neozygites floridana* (Entomophthorales: Neozygitaceae) for control of the cassava green mite *Mononychellus tanajoa* (Acari: Tetranychidae). Bulletin of Entomological Research, 90:191-200.

FAO, 2014. A cassava industrial revolution in Nigeria. Rome, Italy: Food and Agriculture Organization of the United Nations, Web Site http://www.fao.org/docrep/007/y5548e/y5548e00.htm#Contents, 2004. Accessed on Jan 12.

Fukuda, W.M.G.J., Cavalcanti, S.L. de. Oliveira, I. Delalíbera Júnio, C. and Iglesias, R. Caldas, 1996. Avaliação de germoplasma de mandioca para resistência ao ácaro verde (*Mononychellus tanajoa* Bondar) em quatro ecossistemas do Nordeste semi-árido do Brasil. Revista Brasileira de Mandioca, Cruz das Almas, 15(1/2): 67-78.

Fukuda, W.M.G.; S. de O. Silva, R. A. Mendes, 1996. Caracterização morfológica e agronômica do banco ativo de germoplasma de mandioca do Centro Nacional de Pesquisa de Mandioca e Fruticultura Tropical. In Congresso Latino Americano de Raízes Tropicais, I; Congresso Brasileiro de Mandioca IX.

Fukuda, W.M.G., C. Iglesias, 2006. Recursos genéticos. In Souza, L. da S., A. R. N. Farias, P.L.P de Mattos, W.M.G. Fukuda, Eds., Aspectos socioeconômicos e agronômicos da mandioca. Cruz das Almas, Embrapa Mandioca e Fruticultura Tropical, pp: 301-323.

Gonçalves, M.E., de C., F.F. Pereira, M.V. Magno, A.C.S. Costa and J.V. Oliveira, 1999. Efeito de extratos aquosos de plantas sobre o ácaro verde da mandioca *Mononychellus tanajoa* (Bondar) (Acari: Tetranychidae). In Simpósio de pesquisa e pós-graduação da universidade federal rural de Pernambuco.

Gutierrez, A.P., B. Wermelinger, F. Schulthess, H.R. Herren, J.U. Baumgaertner, C.K. Ellis and J.S. Yaninek, 1988. Analysis of biological control of cassava pests in West Africa. I. Simulation of carbon, nitrogen and water dynamics in cassava. Journal of Applied Ecology, 25: 901-920.

Hajek, A.E., J.S. Elkinton, J.J. Witcosky, 1996. Introduction and spread of the fungal pathogen *Entomophaga maimaiga* (Zygomycetes: Entomophthorales) along the leading edge of gypsy moth (Lepidoptera: Lymantriidae) spread. Environmental Entomology, 25: 1235-1247.

Hanna, R. and M. Toko, 2001. Cassava green mite biological control in Africa: project overview and summary of progress. In Hanna R and M. Toko, Eds., Proceedings of the Regional Meeting of the Cassava Green Mite Biocontrol Project, Dar e Salaam, Tanzania, pp: 4-22.

Herren, H.R. and F.D. Bennett, 1984. Cassava pests, their spread and control. In Proceedings of CAB's First Scientific Conference on Advancing Agricultural Production in Africa, D.L. Hawksworth Eds., Commonwealth Agricultural Bureau, pp: 110-114.

Hershey, C.H., 1985. Cassava germoplasm resources. In: Hershey, C.H. Cassava breeding: a multi-disciplinary review. Proceedings of a workshop, held the Philipines. Cali, Colombia: CIAT., pp: 1-24.

Ho, Y.M., C. Mak, K.W. Liew, 2001. Selection of banana cultivars for tolerance to fusarium wilt race 4 in Malaysia. In Eds., Molina, A. B., N. H. Nik Masdek, K. W. LIEW**.** Banana Fusarium wilt management: towards sustainable cultivation. Los Baños, Laguna: International Network for the Improvement of Bananas and Plantains - Asia and Pacific Network, pp: 234-238.

Huffaker, C.B., M. Van de Vrie, J.A. Mcmurtry, 1970. Ecology of tetranychidae mites and their natural enemies: a review. II. Tetranychid populations and their possible control by predators: an evaluation. Hilgardia, 40: 391-458.

Iita, 1990. Mandioca de África Tropical. Um Manual de Referência, Ibadan, Nigéria, pp. 2-10 and 83-85.

Instituto Brasileiro Geografia e Estatística, 2011. http://www.ibge.gov.br/home/presidencia/noticias/noticia_visualiza.php?id_noticia=1798&id_pagina=1. Accessed on May 01, 2012.

Johnson, E.L., 1933. The influence of X-radiation in Atriplex hortensis L. New Phytologist, London, 32: 297-307.

Kikuchi, S., Y. Saito, H. Ryto, N. Fukunishi, T. Abe, H. Tanaka, and H.T. sujimoto, 2009. Effects of heavy-ion beams on chromosomes of common wheat, *Triticum aestivum*. Mutation Research, 669: 63-66.

Leite, L.G., L. Smith, G.J. de. Moraes and D.W. Roberts, 2000. In vitro production of hyphal bodies of the mite pathogenic fungus *Neozygites floridana*. Mycologia, 92: 201-207.

Lorenzi, J.O., C.A. Dias, 1993. Cultura da mandioca. Campinas: Cati, 41. (CATI. Boletím técnico, 211).

Lorenzi, J.O., A.A. Otsubo, D.A. Monteiro and T.L. Valle, 2002. Aspectos fitotécnicos da mandioca em Mato Grosso do Sul. In: Otsubo, A.A., F.M. Mercante, C. de S. Martins (Coord.). Aspectos do Cultivo da Mandioca em Mato Grosso do Sul. Dourados/Campo Grande: Embrapa Agropecuária Oeste/UNIDERP, pp: 77-108.

Lu, H., N.M. Qingfe, Q. Chen, F. Lu and X. Xu, 2012. Potential geographic distribution of the cassava green mite *Mononychellus tanajoa* in Hainan, China. African Journal of Agricultural Research, 7: 1206-1213.

Lyon, W.F., 1973. A plant feeding mite *Mononychellus tanajoa* (Bondar) (Acarina: *Tetranychidae*) new to the African continent threatens cassava (*Manihot esculenta Crantz*) in Uganda East Africa. Pans, 19: 36-37.

Lyon, W.F., 1974. A green cassava mite recently found in Africa. FAO Plant Protect. Bull., 22: 11-13.

Mansour, F.A., K.R.S. Ascher, F. Abo-moch, 1997. Effects of Neemgard on phytophagous and predacious mites and on spiders. Phytoparasitica, 25: 333-336.

Martinez, S.S., O. Nim, 2002. *Azadirachta indica*: natureza, usos múltiplos, produção, Londrina. IAPAR. 142 p.

Miller, F., S. Uetz, 1998. Evaluating biorational pesticides for controlling arthropod pests and their phytotoxic effects on greenhouse crops. HortTecnology, 8:185-192.

Moraes, G.J., de; A.R. Braun, J.S. Yaninek and J.A.de. Alencar, 1990. Preliminary selection of predators of the cassava green mite (Acari: Tetranychidae) in Brazil for introduction into Africa. In Abstracts VIIi International Congress of Acarology.

Moraes, G.J. and C.H.W. Flechtmann, 2008. Manual de Acarologia: Acarologia básica e ácaros de plantas cultivadas no Brasil. Ribeirão Preto: Holos, pp: 308.

Muaka-Toko and K. Leuschner, 1980. Aspects of the biology and control of *Mononychellus tanajoa* (Bondar) infesting *Manihot esculenta* (Crantz) in Southern Nigeria. Proceedings of Workshop on Cassava Outreach in Zaire. Mbanza-Ngungu, Bas Zaire, Zaire (*In Press*).

Mcmurtry, J.A., C.B. Huffaker, M. Van de Vrie, 1970. Ecology of tetranychid mites and their natural enemies: a review. I. Tetranychid enemies: their biological characters and the impact of spray practices. Hilgardia, 40: 331-390.

Noronha, A.C.S., 2001. O ácaro verde da mandioca. In Sa, L.A.N. and G.J. de Moraes. Ácaros de importância quarentenária. Jaguariúna: Embrapa Meio Ambiente, pp. 21-29. (Embrapa Meio Ambiente. Documentos, 25).

Nyira, Z.M., 1972. Report of investigation of cassava mite *Mononychellus tanajoa* Bondar. Unpublished report, Kawanda Research Station, Kampala, Uganda, pp. 14.

Odindo, M.O., 1992. Future prospects for application of insect pathogens as a component of integrated pest management in tropical root drops. Biocontrol Science and Technology, 2: 179-191.

Oliveira, R.C. de, L.F.A. Alves, P.M.O.J. Neves, 2002. Suscetibilidade de *Oligonychus yothersi* (Acari: Tetranychidae) ao fungo *Beauveria bassiana*. Scientia Agricola, 59:187-189.

Otsubo, A.A. and J.O. Lorenzi, 2004 Cultivo da mandioca na região Centro-Sul do Brasil. Dourados: Embrapa Agropecuária Oeste, (Sistemas de produção, 6).

Pestana, R.K.N., E.P. Amorim, S.O. Silva and A. Tulmann Neto, 2010. A. Irradiação gama para mutagênese in vitro em bananeira 'Terra Maranhão'. Pesquisa Agropecuária Brasileira, 45:1328- 1330.

Saric, M., 1961. The effects of irradiation in relation to the biological traits of seed irradiated. In International Atomic Energy Agency. Effects of ionizing radiation on seeds. Vienna, pp: 103-115.

Silva, A.S., E. Sagrilo, E.S. Silva, C.S. Silva, G.A. Morais, 2007. Potencialidade do Extrato Aquoso de Nim e Manipueira no Controle da mosca-branca em mandioca. Raízes e Amidos Tropicais, 3: 4.

Sosbai, 2010. Arroz irrigado: recomendações técnicas da pesquisa para o sul do Brasil. Congresso Brasileiro de Arroz Irrigado. Reunião da Cultura do Arroz Irrigado, 28. Porto Alegre: Sosbai, pp: 188.

Smith, L., 1942. Hereditary susceptibility to X-ray injury in *Triticum Monococcum*. American Journal Botany, London, 24: 189-191.

Tamai, M.A., 1997. Avaliação de fungos entomopatogênicos para o controle de *Tetranychus urticae* Koch. (Dissertação - Mestrado), Escola Superior de Agricultura Luiz de Queiroz, Universidade de São Paulo.

Yaninek, J.S., 1985. An assessment of the phonology, dynamics and impact of cassava green mites on cassava yields in Nigeria, a component of biological control. Ph.D thesis, University of California, Berkeley.

Yaninek, J.S., G.J. Moraes, R.H. Markham, 1989. Handbook on the cassava green mite (*Mononychellus tanajoa*) in África. Ibadan: International Institute of Tropical Agriculture, pp: 140.

Yaninek, J.S., A. Onzo, J.B. Ojo, 1993.Continent-wide release of neotropical phytoseiids against the exotic cassava green mite in Africa. Experimental & Applied Acarology, 17: 145-160.