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SCIENTIFIC COMMUNICATION

EVALUATION OF LITCHI VARIETIES SEEKING SOURCES RESISTANT TO *Aceria litchi* MITE[1]

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ABSTRACT - Since the first report of *Aceria litchi* in Brazil, litchi productivity is reducing in the main productive regions. The aims of this study were to evaluate litchi varieties in relation to feeding by *A. litchi* mite and to determine the moisture and reducing sugars contents, seeking sources resistant to this mite. The experiment was conducted in the Fruit Growing Active Germoplasm Bank, Laboratory of Acarology and Laboratory of Soil Biochemistry at FCAV/UNESP. The plant varieties evaluated were Americana, Bengal, Groff, Mauritius and Sweet Clift varieties. Descriptions were performed regarding symptoms caused by *A. litchii*, moisture and reducing sugars contents present in the leaves of plant varieties. There were differences among varieties with respect to the symptoms caused by *A. litchi* regarding erinose formation and coloring. The final erinose formed in 'Groff', 'Americana' and 'Bengal' varieties is similar in relation to color and density of erineos. The highest reducing sugars and moisture contents were observed in 'Bengal', while the lowest values were found in 'Mauritius'. Visually in the field, 'Bengal' was highly susceptible to *A. litchii* and 'Mauritius' was the least damaged by erinose. 'Sweet Clift' was as susceptible to *A. litchi* as Bengal variety. The results are pioneer in Brazil and provide subsidies for breeding programs on litchi trees resistant to *A. licthii*.

Index terms: Erinose mite, Eriophyidae, Reducing sugars, Plant breeding.

AVALIAÇÃO DE VARIEDADES DE LICHIA VISANDO A FONTES DE RESISTÊNCIA AO ÁCARO *Aceria litchi*

RESUMO - Desde o aparecimento do ácaro-da-erinose *Aceria litchii* no Brasil, a produtividade das lichieiras (*Litchi chinensis*) vem diminuindo nas principais regiões produtoras. Os objetivos do trabalho foram avaliar variedades de lichieiras quanto às reações de alimentação de *A. litchii*, bem como determinar os teores de umidade e de açúcares redutores, visando a fontes de resistência a este ácaro. O experimento foi realizado no Banco Ativo de Germoplasma de Fruticultura e nos Laboratórios de Acarologia e de Biogeoquímica de Solo da FCAV/UNESP. As variedades estudadas foram: Americana, Bengal, Groff, Mauritius e Sweet Clift. Foram realizadas descrições dos sintomas causados por *A. litchii* e determinaram-se os teores de umidade e de açúcares redutores presentes nas folhas das variedades. Há diferenças entre as variedades com relação à sintomatologia causada por *A. litchii* quanto à formação e à coloração da erinose. A erinose final, formada na 'Groff', 'Americana' e 'Bengal', é semelhante quanto à coloração e a densidade de eríneos. Os maiores teores, de umidade e de açúcares redutores foram verificados na 'Bengal', enquanto os menores teores na 'Mauritius'. Visualmente no campo, 'Bengal', mostrou-se altamente suscetível ao *A. litchii,* e 'Mauritius' foi a que se apresentou menos danificada pela erinose. 'Sweet Clift' apresentou-se suscetível ao *A. lichii* semelhante à variedade Bengal. Os resultados obtidos são pioneiros no Brasil e fornecem subsídios para programas de melhoramento de lichieiras resistentes ao ácaro-da-erinose.

Termos para indexação: Ácaro-da-erinose, Eriophyidae, Açúcares redutores, Melhoramento de plantas.

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Litchi (*Litchi chinensis* Sonn.), belonging to the Sapindaceae family, is native to South China, a region that has the largest crops until today (MENZEL, WAITE, 2005). Brazil produces about 5,000 tons of litchi per year, values that put the country in the ninth place in the world ranking (ABRALI, 2016). The state of São Paulo is the main producer, accounting for more than 90% of national production, followed by Paraná, Bahia and Minas Gerais (MARTINS et al., 2001; YAMANISHI et al., 2001). 'Bengal' is the most cultivated variety in Brazil, followed by Brewster and Americana, which are among the most cultivated (CAVALLARI, 2009).

One of the main factors for the decrease in the world's litchi production volume is the is the litchi erinose mite *Aceria litchii* (Keifer) (Acari: Eriophyidae). In Brazil, litchi erinose mite was reported infesting litchi plants in 2008 in the region of Limeira (SP) (RAGA et al., 2010). This is the main phytosanitary problem of litchi in the major producing countries, such as Australia, China, India, Thailand and Vietnam (HUANG, 2008). In 2012, there was a 30% reduction in the litchi volume produced in the state of São Paulo attributed to the litchi erinose mite (LICHIAS, 2016).

Aceria litchii has high host specificity and is reported to infest litchi and occasionally longan (*Dimocarpus longan* Lour), a plant also belonging to the Sapindaceae family (WAITE; HWANG, 2002). The symptoms caused by this mite are known as erinosis, which are abnormally developed trichomes of singular and variable color according to variety (MANSON; OLDFIELD, 1996). Symptoms appear in leaves, fruits and branches (PICOLI, 2010).

Although it occurs throughout the year, the damage caused by *A. litchii* is more severe and worrying. Litchi erinose mite can be disseminated through the wind, infested seedlings, birds, bees and man (WAITE, 1988, RAGA et al., 2010). The control is performed mainly for the elimination of affected parts with pruning for surveys and with acaricides; however, there are no registered products to control this mite in Brazil (BRAZIL, 2016).

The identification of variables resistant to *A. litchii* can bring a number of benefits, among them reduction of production costs and decreased application of plant protection products, which are responsible for environmental contamination. Some parameters measured in plant tissues such as moisture content, amino acids and reducing sugars may help understand differences in pest sustainability among varieties (AGRIOS, 1997).

Plants with high amounts of amino acids and reducing sugars are more attractive to pests and have increased rates of development of pest populations (WHITE, 1984). Therefore, the aims of this study should be adapted to the needs of *A. litchii* feeding reactions, as well as to determine moisture content and reducing sugars, seeking resistance sources to this mite.

This research was carried out in the Fruit Growing Active Germoplasm Bank, Laboratory of Acarology and Laboratory of Soil Biochemistry at FCAV / UNESP, from September 2013 to April 2014. The geographical coordinates of the Germoplasm Bank are 48º17 '18 '' W and 21º 14 '07' 'S and 615 m asl.

The evaluated litchi varieties were 'Americana', 'Bengal', 'Groff', 'Mauritius' and 'Sweet Clift', all 15 years old and in full production, arranged in lines close to each other. The soil of the experimental area is a Moderate Eutrophic Red-Dark Latosol, with very clayey texture and smooth undulating relief (ANDRIOLI; CENTURION, 1999). The climatic conditions recorded during the survey by the Agroclimatological Station of FCAV / UNESP were average temperature of 24.8 ºC, average relative humidity of 72.3% and total precipitation of 522.3 mm.

For the description of *A. litchii* symptoms in plant varieties, biweekly leaflets were collected between September and January 2014. Four leaves per quadrant were taken from each plant, two young leaves (freshly sprouted) and two developed leaves. In this case, one of the leaves should be healthy and the other with the presence of erinosis (symptomatic), totaling 16 leaves per plant per collection. In the laboratory, after visual separation, 1cm^2 leaf segments were photographed using Olympus SZ61 stereomicroscope coupled to a SC30 camera. Images of healthy and symptomatic leaves were recorded to describe the symptomatology and details of the progression of symptoms. Photomicrographs of plant material previously prepared under JEOL JSM 5410 Scanning Electron Microscope (ANDRADE et al., 2011) were also performed.

The moisture content of leaves of plant varieties was determined in the third and fourth leaves located from the apex of branches, always in the eastern quadrant of plants and at height of approximately 1.75 meters in relation to the soil. Three samples were collected to determine leaf moisture content between December 2013 and February 2014. Leaf samples were placed in Fanem 315 SE drying oven for 72 hours to determine moisture content, which was determined by the difference between the wet mass and the dry mass of samples. Data obtained in water percentage were

submitted to analysis of variance and the means were compared by the Tukey test at 5% probability.

In order to determine the reducing sugars content in leaves of each plant variety, leaves were collected in the same manner as those mentioned for the moisture content, using the anthrone method to obtain the reducing sugars content (GALICIA et al., 2009).

Healthy litchi leaves have few trichomes, are tiny, almost imperceptible, located mainly along veins (Figure 1A). Mite feeding induces the formation of erinosis, which according to Westphal (1977), are trichomes abnormally developed due to the injection of toxic substances by *A. litchii* mite (Figure 1F). Schulte et al. (2007) have reported that *A. litchii* can transmit parasitic algae to *Cephaleuros virescens* Kunze, inducing erinosis. However, this fact has not yet been fully elucidated.

In the Bengal variety, the first symptoms are eryne scattered on the abaxial surface of light brown leaves (Figure 1B). Over time, ermane density increases, in which some acquire brown and other whitish color (Figure 1C and 1D). The fully formed erinosis has reddish color, forming a dense eryne layer (Figure 1E). There is also twisting of leaves and formation of galls.

The first symptoms in 'Americana' are linear spots from beige to light brown. The first erines are light in color and less dense than those observed for the Bengal variety. The erinose formed at was similar to that observed for 'Bengal' in relation to color and general appearance. However, in the field, 'Americana' variety was visually less attacked compared to 'Bengal' under equal conditions.

Groff and Americana initially present linear stains of brown coloring, where erine plants begin their development. The erineums loses the reddish color that evolves to brown with some lighter patches in beige shade. The evolution of the symptoms observed in 'Sweet Clift' variety was similar to 'Bengal'. In the field, 'Sweet Clift' seems to be visually as susceptible to *A. lichii* as Bengal.

During the study, no initial symptoms of mite feeding on 'Mauritius' were found. In the several leaves analyzed, the first symptoms were formation of erineous of varied coloration, occurring in white, beige and brown shades. Among the varieties evaluated, 'Mauritius' was the one that was visually less damaged by field erinosis. In addition, it was verified that the leaves of this variety possibly presented smaller leaf area damaged by erinosis, comparatively. Another interesting feature of 'Mauritius' refers to the size and architecture of plants. Although the five varieties evaluated were of the same age and received the same cultural treatments, 'Mauritius' plants were larger. This variety seems to be more resistant to *A. litchii* mite attack, which characteristic can be exploited in breeding programs for plant resistance to mites.

In the first moisture content evaluation performed in December 2013, 'Bengal' presented the highest levels in leaves, while 'Groff" had the lowest levels (Table 1). In the other evaluations, the highest moisture content levels were verified in 'Bengal', 'Mauritius' and 'Sweet Clift'(Table 1). 'Bengal' also showed the highest amount of reducing sugars in leaves, while 'Mauritius' had the smallest amounts (Figure 2). Plant tissues with higher amount of reducing sugars make them more attractive to phytophagous plants and also favor the development of these organisms (AGRIOS, 1997).

It should be noted that the Bengal variety was the one that presented the highest severity caused by erinosis and also the highest moisture and reducing sugars contents. These results should be better investigated in future work. Thus, the results indicated that the Bengal can be used as a positive pattern of susceptibility to *A. litchii* in breeding programs.

The other varieties evaluated, although susceptible to the mite, clearly showed different responses regarding erinosis formation and severity, with emphasis on 'Mauritius'. In Brazil and in other countries, especially in China, there are several other varieties that can be studied for resistance to *A. litchii* and included in breeding programs. The results obtained in this work, although initial, are pioneer in Brazil, and open positive perspectives for obtaining materials resistant to mites, guaranteeing crop sustainability.

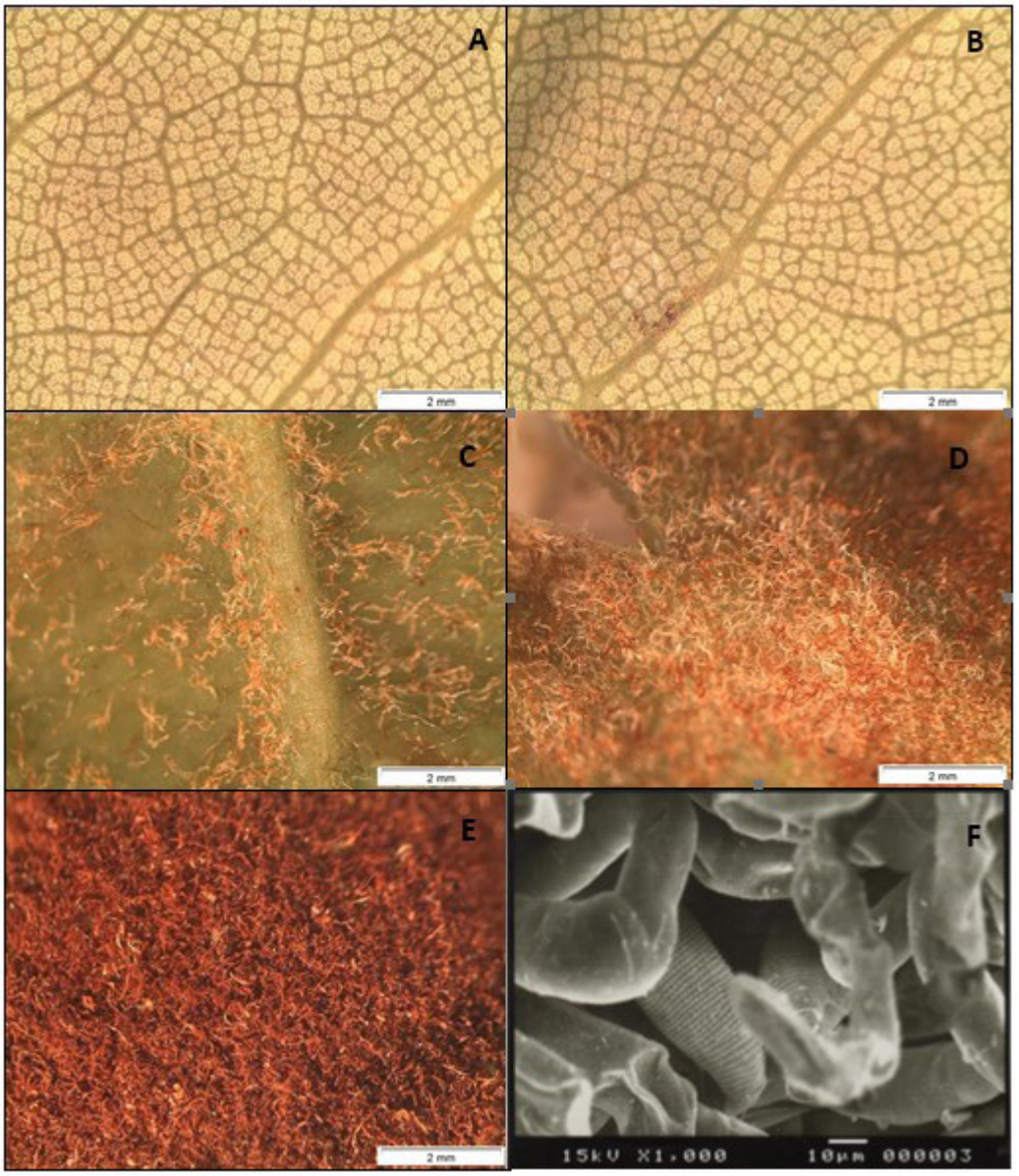

FIGURE 1- Evolution of symptoms (erinosis) caused by *Aceria licthii* on the abaxial surface of litchi leaves of Bengal variety (A-E). *Aceria licthii* (F).

TABLE 1 - Moisture content of litchi varieties in evaluations carried out at the Germplasm Bank of FCAV/ UNESP from December 2013 to February 2014.

Varieties	December (2013)	January (2014)	February (2014)
	Moisture (%)	Moisture (%)	Moisture (%)
Bengal	56.94 a	53.47 a	53.23 a
Americana	53.99 c	49.65 b	50.86 b
Mauritius	54.64 c	52.26 a	52.94 a
Sweet Clift	55.71 b	53.09 a	53.19 a
Groff	52.96 d	49.17 b	49.22 c
Test F	41.02**	34.05**	28.21**
V.C.%	0.98	1.48	1.45
SMD	1.02	1.44	1.42

Means followed by the same letter in the column do not differ significantly by the Tukey test (p=0.05);
** Significant at 1% probability; V.C.: Variation coefficient; SMD - Significant minimum difference.

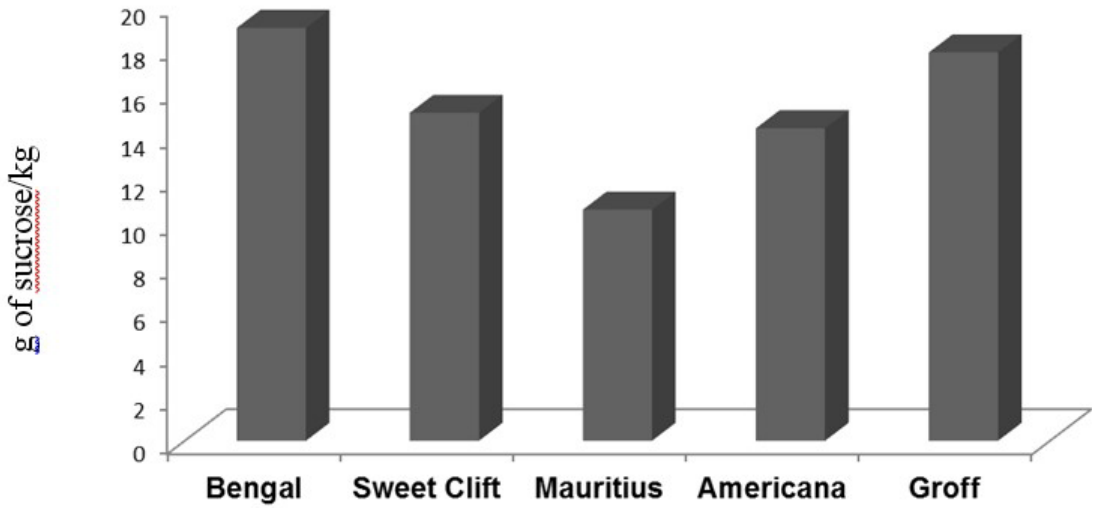

FIGURE 2- Reducing sugars contents in grams of sucrose per kilogram of dry matter in litchi varieties at FCAV / UNESP Germplasm Bank.

REFERENCES

ABRALI - Associação Brasileira de Lichia e Longana. **Principais países produtores de lichia**. Disponível em: <http://www.abrali.org.br/lichiaemnumeros.htm>. Acesso em: 8 fev. 2016.

AGRIOS, G. N. **Plant pathology**. 4th ed. San Diego: Academic Press, 1997. 635p.

ANDRADE, D.J.; COSTA, L.L.; SANTOS, J.M. Ocorrência, características morfológicas e danos causados por *Aceria litchii* (Acari: Eriophyidae) em lichieira no município de Jaboticabal-SP. In: CONGRESSO BRASILEIRO DE FITOSSANIDADE - CONBRAF, 1., 2011, Jaboticabal. **Anais...** Jaboticabal: FUNEP, 2011. CD-ROM.

ANDRIOLI, I.; CENTURION, J.F. Levantamento detalhado dos solos da Faculdade de Ciências Agrárias e Veterinárias de Jaboticabal. In: CONGRESSO BRASILEIRO DE CIÊNCIA DO SOLO, Brasília, 1999. **Anais...** Brasília, DF: Sociedade Brasileira de Ciência do Solo, 1999. CD-ROM

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Sistema de agrotóxicos fitossanitários.** Brasília. Disponível em: <http://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons>. Acesso em: 6 fev. 2016.

CAVALLARI, L.L. **Florescimento e frutificação em lichieiras**. 2009. 42f. Dissertação (Mestrado Agronomia – Produção Vegetal) - Faculdade de Ciências Agrárias e Veterinárias, Universidade Estadual Paulista, Jaboticabal, 2009.

GALICIA, L.; NURIT, E.; ROSALES, A.; PALACIOS-ROJAS, N. **Laboratory protocols: maize nutrition quality and plant tissue analysis laboratory**. Mexico: Cimmyt, 2009. 42p.

HUANG, K. *Aceria* (Acarina: Eriophyoidea) in Taiwan: five new species and plant abnormalities caused by sixteen species. **Zootaxa**, Auckland, v.1829, n.1, p.1-30, 2008.

LICHIAS. Disponível em: <http://www.lichias.com/>. Acesso em: 8 fev. 2016.

MANSON, D.C.M.; OLDFIELD, G.N. Life forms, deuterogyny, diapause and seasonal development. In: LINDQUIST, E. E.; SABELIS, M.W.; BRUIN, J. **Eriophyoid mites**: their biology, natural enemies, and control. Amsterdam: Elsevier, 1996. p.173-183.

MARTINS, A.B.G.; BASTOS, D.C.; SCALLOPI JÚNIOR, E.J. **Lichieira (*Litchi chinensis* Sonn)**. Jaboticabal: Sociedade Brasileira de Fruticultura, 2001. 48p.

MENZEL, C.M.; WAITE, G.K. **Litchi and longan**: botany, cultivation and uses. Queensland: CABI, 2005. 305p.

PICOLI, P. R. F. ***Aceria litchii* (Keifer) em lichia: ocorrência sazonal, danos provocados e identificação de possíveis agentes de controle biológico.** 2010. 75f. Dissertação (Mestrado em Agronomia - Sistemas de Produção) - Faculdade de Engenharia de Ilha Solteira, Universidade Estadual Paulista, Ilha Solteira, 2010.

RAGA, A.; MINEIRO, J.L.C.; SATO, M.E.; MORAES, G.J.; FLECHTMANN, C.H.W. Primeiro relato de *Aceria litchii* (Keifer) (Prostigmata: Eriophyidae) em plantas de lichia no Brasil. **Revista Brasileira de Fruticultura**, Jaboticabal, v.32, n.2, p.628-629, 2010.

SCHULTE, M.J.; MARTIN, K.; SAUERBORN, J. Efficacy of spiromesifen on *Aceria litchii* (Keifer) in relation to *Cephaleuros virescens* Kunze colonization on leaves of litchi (*Litchi chinensis* Sonn.). **Journal of Plant Diseases and Protection**, Stuttgart, n.114, n.3, p.133-137, 2007.

WAITE, G. K. Pests of lychees in Australia. In: MENZEL, C. M.; GREER G. N. (Ed.). **The potential of Lychee in Australia**. Sunshine: Coast Subtropical Fruits Association, 1986. p.42-48.

WAITE, G.K.; HWANG, J.S. Pests of litchi and longan. In: PEÑA, J.E.; SHARP, J.L.; WYSOKI, M. (Ed.). **Tropical fruit pests and pollinators**: biology economic importance, natural enemies and control. Wallingford: CABI, 2002. p.331-359.

WAITE, G.K.; MCALPINE, J.D. Honey bees as carriers oflychee erinose mite *Eriophyes litchii* (Acari: Eriophyiidae). **Experimental and Applied Acarology**, Amsterdam, v.15, n.4, p.299-302. 1992.

WESTPHAL, E. Morphogenèse, ultrastructure et étiologie de quelques galles d' Eriophyides (Acariens). **Marcellia,** Strasbourg, v.39, n.1, p.193-375, 1977.

WHITE, T.C.R. The abundance of invertebrate herbivores in relation to the availability of nitrogen in stressed food plants. **Oecologia**, Berlin, v.63, n.1, p.90-105, 1984.

YAMANISHI, O.K.; MACHADO, J.A.; KAWATI, R. Overview of litchi production in São Paulo state Brasil. **Acta Horticulturae**, Wageningen, v.558, n.1, p.59-62, 2001.