An Analysis of the Research on Sugarcane Yellow Leaf

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Not a Disease, a Syndrome

By

Sizuo Matsuoka

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collected in patches with Amarelinho problem had poor growth (plants in the box on the extreme right). That was additional proof that the problem was in the soil, not with the plant (Meneghin, 1997).

Fig. 12.2.7. Cv SP71-6163 planted in two soil samples collected at Usina Bonfim: sample 1, soil from an area with symptomless SP71-6163, and sample 2, the soil where the same cultivar was showing Amarelinho. Half of each sample was autoclaved and compared: from left to right, soil from area 1, original and autoclaved (A and B, respectively); soil from area 2, original and autoclaved (C and D, respectively). In both soil samples, autoclaving had only a slight effect, which indicates that, apart from a biological problem (soil pathogens), an abiotic problem should also be occurring, probably herbicide phytotoxicity (Meneghin, 1997).

Fig. 12.5.1 Visual illustration of productivity in tons of cane per hectare in three successive cuts of three cultivars in an experiment carried out by Salata, Santi, Benedito, and Demattê (1993); it clearly shows both the high performance of SP71-6163 in plant cane and the sensitive drop of productivity with the advancement of ratoons.

ACKNOWLEDGMENTS

In my long journey as a researcher, I interacted with and received support and encouragement from many people, so it would not be possible to list them all here. To them, my deepest gratitude. However, I must give special thanks to Usina COCAL, which has always understood the value of scientific research and has supported the Sugarcane Genetic Improvement Program since the time of IAA/PLANALSUCAR, continuing with RIDESA/UFSCar, as well as the research with energy cane; As if that were not enough, it also supported the Brazilian edition of this book. Thanks also to my co-worker Silvana Persissato Meneghin for her dedication and performance in researching the syndrome.

ACRONYMS

ACIAR - Australian Center for International Agricultural Research
AMAS - Annual Meeting of Agricultural Scientists, Mauritius
ATAGUA - Sugar Technology Association of Guatemala – Associación de Tecnicos Azucareros de Guatemala
BSES- Bureau of Sugar Experiment Stations, Queensland, Australia
CCA/UFSCar- Center of Agrarian Science/Federal University of São Carlos, Brazil - Centro de Ciências Agrárias/Universidade Federal de São Carlos, Brasil
CENA - Center for Nuclear Energy in Agriculture, Brazil - Centro de Energia Nuclear na Agricultura, Brasil
CENGICAÑA - Guatemalan Center of Research and Training on Sugarcane - Centro Guatelmateco de Investigación y Capacitación de la Caña de Azúcar, Guatemala
CENICAÑA - National Center of Sugarcane Research, Colombia - Centro Nacional de Investigaciones de la Caña de Azúcar, Colombia
CIRAD - Center for International Cooperation in Agronomic Research for Development - Centre de Cooperatión Internationale en Recherche Agronomique pour le Development, France
COPERSUCAR – Central Cooperative of Producers of Sugar of the State of São Paulo, Brazil - Cooperativa Central dos Produtores de Açúcar do Estado de São Paulo
CSR - Colonial Sugar Refining, Australia
ESALQ/USP - Faculty of Agronomy “Luiz de Queiróz”/University of São Paulo, Brazil - Escola Superior de Agricultura "Luiz de Queiróz"/Universidade de São Paulo, Brasil
FAO - Food and Agriculture Organization, Roma, Italay
FAPESP - The São Paulo Research Foundation - Fundação de Amparo à Pesquisa do Estado de São Paulo
IAA/Planalsucar - Sugar and Alcohol Institute/Natitonal Program of Sugarcane Improvement, Brazil - Instituto do Açúcar e do Álcool/Programa Nacional de Melhoramento da Cana-de-açúcar, Brasil
IAPAR - Agronomic Institute of the State of Paraná, Brazil - Instituto Agronômico do Paraná, Brasil

INTA - National Institute of Agriculture and Livestock, Argentine - Instituto Nacional de Tecnologia Agropecuaria, Argentina
ISSCT - International Society of Sugar Cane Technologists
NASA- National Aeronautics and Space Administration, USA
ONU - United Nations Organization
RIDESA - Network of Federal Universities for Development of the Sugarcane Sector -
SASA - South African Sugarcane Association
SP - State of São Paulo, Brazil
STAB - Brazilian Society of Sugar and Alcohol Technologists – Sociedade dos Técnicos Açucareiros e Alcooleiros do Brasil
UFSCar/Ridesa - Federal University of São Carlos/Network of Federal Universities for Development of the Sugarcane Sector, Brazil - Universidade Federal de São Carlos/Rede Interuniversitária para o Desenvolvimento do Setor Sucroenergético, Brasil
UNESP - University of the State of São Paulo, Brazil - Universidade Estadual Paulista, Brasil
UNICAMP - University of Campinas, Brazil - Universidade de Campinas, Brasil
USP - University of São Paulo, Brazil - Universidade de São Paulo, Brasil

1. INTRODUCTION

"*Doubt is the source of wisdom."*
—Rene Descartes

In 1992, in São Paulo, Brazil, sugarcane plantations of the sugarcane cultivar SP71-6163 began to draw attention as the plants turned yellow and showed poor development, especially in ratoons[1]. The first observations reported that the yellowing generally started in spots on the edges of the plots, but that over time, it spread over the entire cane fields. The symptoms of "Amarelinho" (intense yellow)[2], the name by which this anomaly soon came to be known in Brazil, could be observed in the most diverse regions of the state from the middle of that year on, in that cultivar, which already occupied 22% of the area and continued to expand. In contrast to the green coloration of other cultivars, the yellowish cane fields stood out to everyone's eyes, becoming a cause of great concern. As expected, everyone (producers, agronomists, plant pathologists, administrators, and field operators) thought they were facing a new, devastating disease.

Given the general concern, the Brazilian Society of Sugar and Alcohol Technologists (STAB) promoted a meeting to discuss the matter, which took place in the auditorium of the Industrial Technology Department of the "Luiz de Queiróz" Higher School of Agriculture (ESALQ). There, the author argued that the problem was not a disease but a genetic condition known as "Autumn Decline," which in the acute form was called "Autumn Collapse," as described by Hughes in the book *Sugarcane Diseases of the World* (1964, vol. 2, 289). This opinion was not given credence, which was understandable (and predictable) because, in cases like this, everyone imagines they are facing a new disease. Boxes 1.1 and 1.2 give more details of this story.

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[1] References are largely omitted in this introduction to get a more fluid reading, except for the necessary ones.

[2] In Portuguese, "Amarelo" means yellow, and the suffix "inho" is a diminutive. However, in this case, "inho" expresses intensity (Gonçalves, 2006), so "Amarelinho" means intense yellow.

BOX 1.1: How the author met the Autumn Decline

In 1992, sugarcane growers became alarmed by the problem of leaf yellowing in adult cane fields of cultivar SP71-6163. As the harvest season was already in progress, the cane was all harvested, and there was a need for more knowledge about what could have been the cause. From May to June of the following year, the cane fields of that same cultivar started yellowing again, the symptom progressing as time passed. Then, there was a commotion about the possibility of a new and terrible disease in the cane fields of São Paulo. Faced with this concern, STAB (the Society of the Brazilian Sucrose and Ethanol Industry Technologists) convened the sugarcane sector to discuss the issue, the meeting taking place at the Department of Industrial Technology of ESALQ (Faculty of Agronomy "Luiz de Queiróz"), Piracicaba, SP, on July 21, 1993. There, the author refuted the idea that they were facing a disease, and, fully convinced, explained that the problem was the so-called "Autumn Decline," a genetic anomaly. How did he know that? What was his rationale? To answer these questions, let us turn back in time to rescue history.

In January 1968, shortly after graduating from ESALQ, the author began his professional work as a researcher on sugarcane viruses in the Virology Section of the Agronomic Institute of Campinas under the guidance of renowned plant virologist Dr. Alvaro Santos Costa. His task was to research a disease known as Ratoon Stunting Disease (RSD), primarily, but also other viruses of this crop. At that time, the idea was that a virus was the causal agent of RSD. He had to study a lot as a neophyte in the viruses affecting this crop and also the other diseases affecting it, not to mention the overall management of the crop. In 1969, he became a recipient of the publication Sugarcane Pathologists' Newsletter (SPN), which had been started a year earlier by the Standing Committee on Sugarcane Diseases of the International Society of Sugar Cane Technologists (ISSCT). He promply received the third issue as well as the two previous ones. (His name as the recipient is in No. 3, 28). It was an informal magazine publishing notes, reports, small articles, and news by phytopathologists worldwide. He avidly read the issues received and later all the new ones. In #1, he found an account of Dr. C. Ricaud, from Mauritius, on a problem in Africa in 1962, more precisely in Tanzania, and later in Malawi (SPN, 3, 13, 1969; 5, 45–46, 1970), Uganda, South Africa, Mozambique, and Zambia (SPN 4, 33–34, 1970), which they called "Yellow Wilt." Dr. C. Ricaud contributed photos of it (SPN 5, 21-22) to the International Collection of Slides Illustrating Sugarcane Diseases, organized by the same Standing Committee of Diseases referred to above, and organized and maintained by Dr. P.B. Hutchinson at Colonial Sugar Refining Research Laboratories, New South Wales, Australia (Hughes, 1975b). The author received copies of a few slides from that collection, including some concerning the Yellow Wilt.

Going back a bit more, in 1961, the first volume of a monumental and seminal work on sugarcane diseases, Sugar-Cane Diseases of the World, was published, supplemented by a Volume 2 in 1964, whose editors were C.G. Hughes, E.V. Abbott, and C.A. Wismer. The author acquired them, and they came to be his

bedside books. It was a work never equaled, where phytopathologists from the most diverse countries carried out a complete review of each sugarcane disease or anomaly and illustrated it with many black-and-white photos, mainly color drawings, but also a few color photos, which were a rarity at that time. In Vol. 2, in a chapter on "Genetical effects," Hughes (1964) described an anomaly he called "Autumn Collapse" and illustrated it with one of the rare color photographs in the book. That volume, as it deals with minor illnesses and other undetermined anomalies, was supposed to be rarely consulted. Even less read should have been the text on Autumn Collapse inserted in a chapter that brings together several other anomalies and describing the initial symptoms of that anomaly: it corresponded precisely to those of the Autumn Decline.

Nonetheless, the denomination Autumn Decline is absent in the description of Autumn Collapse and any other book or scientific articles published up to that time. The author perceived that the symptoms observed in SP71-6163 corresponded to those described for the initial form of Autumn Collapse and those described for Yellow Wilt. How came that perception? Let us go back to the story again.

In June 1973, the author joined IAA/PLANALSUCAR (a research branch of the Sugar and Alcohol Institute, a federal Ministry) to work in the Phytopathology Section at the Experimental Station of Araras, State of São Paulo. Fortunately, he started working there under the guidance of Hawaiian phytopathologist Dr. C. A. Wismer, one of the editors of Vol. 2 of the aforementioned book, hired as an advisor in phytopathology. The following year, he joined a Brazilian delegation to participate in the 15th ISSCT Congress in Durban, South Africa. Brazil was a candidate to host the next congress, hence the large entourage (Fig. B1.1.1 and B1.1.2). After the congress, he participated in a post-congress trip to Mauritius, organized by the Pathology Committee, whose group included Dr. C. G. Hughes and Dr. C. A. Wismer. Dr. C. Ricaud, who first described the Yellow Wilt, was the guide (see the group caught in a photo by Dr. Hughes, Fig. B..1.1.3).

The author, at the time a young researcher and a beginner in sugarcane pathology, was dazzled and incredulous at being in contact with famous pathologists whom he knew only by name and through correspondence to obtain reprints of articles (at that time, sending a letter was the only means of contact available; there was no telex or fax, much less the moderrn communications means; articles received as reprints were in some cases photographic copies; xerographic reproductions did not even exist). Well then. Yellowed leaves were seen, seemingly symptoms of Yellow Wilt, when we visited a disease testing field. C. Wismer said they were Autumn Decline. The author accepted that without any contest and did not remember if Dr. Hughes, Dr. Wismer, or Dr. Ricaud made any connection between the two things. It was more of an exercise in recognizing symptoms that a phytopathologist does on a day-to-day basis, and it was then an anomaly considered of minor importance. Little did he know the prominence that all this coincidence would take on later.

Returning to Brazil, he began to observe those symptoms in the plots of disease tests of the breeding program and the respective germplasm bank. He also saw them in plants quarantined in the Center-South international quarantine in Anhembi, SP (the other was in the North-Northeast region, in Maceió, AL). All imported materials passed through this quarantine, as did those from the N-NE that came to Center-South. There, he used to see the symptoms of the Autumn decline, mainly in a mild form, which could, in a way, disconcert the less informed and lead them to discard the materials with such symptoms, judging that would be some illness. He remembered that it was usual to observe symptoms in some genotypes from Canal Point, USA (CP and Cl cultivars and clones). Returning to the leaf yellowing issue, the author can affirm that no sugarcane pathologist knew the term Autumn Decline. In Brazil, it became known because the author mentioned it in that first meeting and in all the others that took place afterward. Internationally, researchers also did not realize the connection between the three facts, and Box 2 brings the historical account of what happened.

The author would not have counter-argued with so much conviction that the problem was not a new disease if not for all the antecedents reported. However, when he was already well advanced with this essay, he woke up at dawn with an question in mind: How did Dr. Wismer come up with the term Autumn Decline? How come the author had never thought about this? Unforgivable, even more so for never having asked him. Unfortunately, he had already passed away. Nevertheless, another question soon followed: Why did Hughes come up with the term Autumn Collapse? He reasoned that it could only be that he had seen the phenomenon repeat itself for a few years, always in the fall. Elementary, no? However, how did he not remember reading that in his writings? He got up and immediately went to consult the book. Furthermore, there it was, in the last sentence of the article: he said that the plants regained their standard green color with the rise in temperature in the summer, and the symptoms reappeared more conspicuously when winter approached. Bingo! But, for one moment, not yet. The first question remained: How did Dr. Wismer substitute the term "collapse" for "decline?" The supposition is that they talked and exchanged ideas about the anomaly when editing the book and even afterward. This hypothesis occurred, supposing Wismer would have known about these symptoms in Hawaii while working there.

Behold, the present review presents that the Hawaiian researchers, in a retrospective search, had reached the following conclusion: the alleged disease (they referred to the alleged causative virus) would have arrived at the experimental station between 1960 and 1970 in imported material. (The exact date of "arrival" is irrelevant because the trait would be intrinsic to the plants and not noticed before). So Wismer must have seen the symptoms back then. However, how did he relate it to the Autumn Collapse and give it the name Autumn Decline? The only explanation that came was the following: in Hawaii, the climate is tropical, and there is no clear distinction between seasons, in addition to the fact that the crop there used to receive irrigation in most parts (there is no more sugar agroindustry in Hawaii), so

the symptoms should always be mild (their papers report that symptoms were elusive and inconstant), not collapsing. So, in that discussion between the two, they must have come up with the term "decline," which did not appear in the text referring to the description of the initial symptoms of the Autumn Collapse, but that they matched to those observed in Hawaii, and they decided to call it Autum Decline. That is the explanation that came from the origin of the name. Is it right? No one knows, but it seems reasonable. Now, yes, bingo.

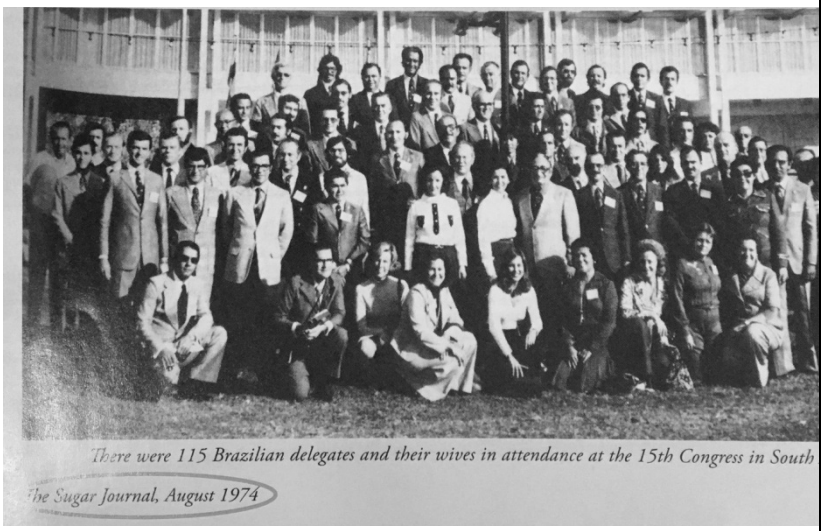


Fig. B1.1.1 Brazilian delegation to the XV Congress of the ISSCT in Durban, South Africa, in July 1974.

BOX 1.2: Clash: Syndrome x Disease

Firstly, it is worth defining the two terms: syndrome and disease. We call a syndrome an anomaly caused by several factors altogether, i.e., one or more factors acting together to produce an effect in a given place and time, and a disease is an illness with a defined etiological agent, disregarding place and time.

Box 1 relates how the author came to know Autumn Decline. He has said that since the first technical meeting (July 21, 1993), he has been of the view that the leaf yellowing of SP71-6163 was not a disease but the syndrome Autumn Decline, an already known genetic anomaly. He then mentioned that Hughes (1964) had described in the book on sugarcane diseases, vol. 2, a disorder called Autumn Collapse, the acute phase of Autumn Decline. Why autumn? It seems an obvious question. He also reported how this term was supposed to have been arrived at. It

was because the symptom always appeared from autumn onwards, cyclically, every year, as it happened at the moment of the meeting mentioned.

However, people ignored that. In their minds, it was effectively a disease. If it was not a disease, why did the ratoon sprout normally, and why did the yellowing occur again in the adult plants the next autumn? The author tried to explain that with the change of season, and with the shortening of the day and the lowering of the temperature, cultivar SP71-6163, which is more sensitive to the photoperiod, reacted in that way. The question of time meant nothing to them. People were concerned with the drop in productivity, which was undoubtedly happening, and everyone blamed the yellowing. It was associated, but not as cause and effect as they thought; it was a coincidence of several factors acting together, including the action of the Pinatubo eruption. Oh, this is too much, people disagreed. The volcano eruption occurred on the other side of the planet! It needs to be clarified. However, as he addressed in the main text, it did make sense, however absurd it might seem. Well, the meeting ended, and everyone turned a deaf ear.

Several meetings followed, and the author always defended the original idea. They follow below:

August 17, 1993: Meeting at the IAC Experiment Station, Ribeirão Preto, SP;
August 25, 1993: Meeting during the 5th STAB National Congress, Águas de São Pedro, SP;
August 31, 1993: 2nd Agronomic Update Course in Western São Paulo, Araçatuba, SP;
February 01, 1994: Symposium on the XVII São Paulo Group of Phytopathology Congress, Araras, SP;
November 08, 1994: 3rd West Paulista Agronomic Update Course, Araçatuba, SP;
June 19, 1995: Seminar, Postgraduate Course in Phytopathology, ESALQ, Piracicaba, SP;
February 13, 1996: Annual Meeting of the RIDESA/UFSCar's Sugarcane Genetic Improvement Program, Araçatuba, SP;
April 15, 1998: 3rd Sugarcane Week in Piracicaba, SP;
May 14, 1999: Center for Agricultural Sciences at the Federal University of Alagoas, UFAL, Maceió, AL.

The chronology above shows that the second meeting occurred less than one month after the inaugural, and the two subsequent ones followed in 8- and 6-day intervals, evidencing that the matter was ebullient. Those three meetings were for people of the sugarcane sector; the next, in 1994, was for pathologists in general, including "virus hunters" researching "Amarelinho," the name by which foliar yellowing came to be known. In Hawaii, they found a similar symptom, thought to be of viral etiology. In 1995, Jorge Vega from UNICAMP had already reported the association of a virus (luteovirus), which, more than ever, led people to believe Amarelinho was viral. However, from 1994 onwards, and especially the following year, he had more arguments due to the research he had carried out, and, in the last

two lectures, he definitively consolidated the argument for the national public. The teammate, Silvana P. Meneghin, had defended his MS thesis at the University of the State of São Paulo, Rio Claro, under his informal guidance and displayed several arguments that supported the syndrome concept, as discussed in the main text. However, in the 1998 meeting mentioned above, A. Sanguino, from Copersucar, made a presentation defending the idea of a possible viral etiology based on the results of studies at UNICAMP and CENA/ESALQ. Therefore, until that date, there was no consensus. The author was an out-of-step soldier, a dissonant element. The controversy, if it existed, was only fed by the author.

However, there was no debate or questioning in all those expositions of the author. The audience listened in silence, except in the most restricted ones, when producers presented their data, contesting all the others, like the one cited in the text concerning a planting done where previously there was a citrus orchard. In that penultimate exposition, the author remembers a listener telling him privately after the presentation that he was right in his opinion. It was the only feedback the author received. It is worth mentioning a debate with by René de Assis Sordi, a former pupil of the author's who later moved to Copsucar, which seemed to reflect the thinking of the great majority. After that last lecture in 1998, he wrote a letter with several arguments against the syndrome concept, among them his casual observations from the field and an internal report of his justifying the viral etiology. He asked the author to consider his arguments carefully. He textually said: "Perhaps I have not been able to be a good student, but it may be that my master has embarked on a wrong line of reasoning that has made him draw erroneous conclusions." The author contested all the points with the same arguments as always, and that the intention was only the scientific truth; that it was not "the desire to show off," as some insinuated, because he knew the author never needed it; it was not his character, and in a scientific matter, he did not use to be "on the fence." After that episode, we never reverted to the subject again.

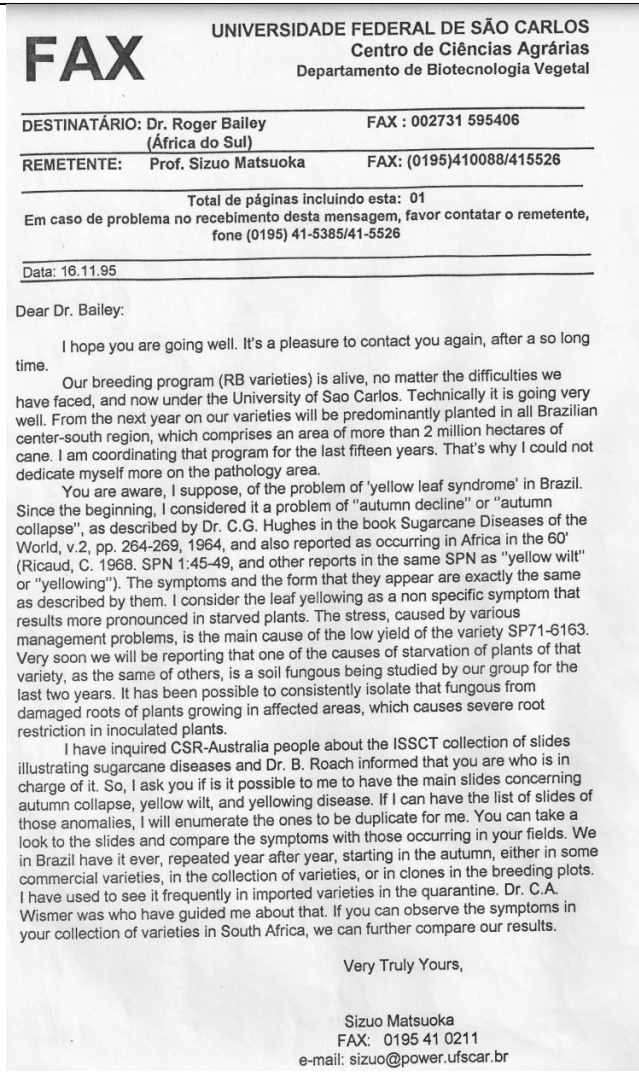
Well, the fact is that for most people, there was no more controversy: Amarelinho was of viral etiology. What happened is that, with the total replacement of SP71-6163 in 1999, producers were no longer worried about it. However, the same cannot be applied to scientists. After all, there was a niche for molecular biologists there, a branch of biological research emerging as a new wave in the world and, by reflex, also in Brazil.

Then, what happened at the international level? It was the same story. We briefly mentioned the call name Autumn Decline in an article from 1994 and another from 1995 (cited in the main text). Still, in 1995, the author faxed the ISSCT Pathology Committee chairman, R. A. Bailey, and C. Ricaud, that the syndrome occurring in Brazil corresponded to Yellow Wilt and the mild form of Autumn Collapse (see Box 1.1). Due to the importance of these correspondences, they are shown here, including all the respective answers (Fig. B1.2.1 to Fig. B1.2.6). When Ricaud studied the Yellow Wilt, volume 2 of the book "Sugar-cane Diseases of the World" had not even been edited (see Box 1) because although he had reported it only in

1970, due to the very opportunity of the emergence of the SPN journal, the problem came out in 1962, no one realizing, I suppose, that the symptoms corresponded to those described by Hughes. Unfortunately, Dr. Ricaud had retired when the author wrote to him in 1995 (Fig. B1.2.2), as Jean-Claude Autrey, his successor, informed in reply and did not answer (Fig. B1.2.3). At that time, there was also a robust international current in defense of the viral etiology of Amarelinho, as Autrey expressed in his answer (see Box 1.3), and perhaps because of this, Ricaud did not want to get involved. However, Bailey, in his response, while reporting on the finding of the occurrence of a luteovirus in SYL plants in Florida, USA, said that he had consulted the old reports on the case of Yellow Wilt in Africa and that the description of the symptoms left no doubt that both were the same thing (Appendix 4). The author then replied (Fig. B1.2.5) that the virus they had found was not proof of being the causal agent and that it could be an innocuous resident that could be found even in asymptomatic plants. At that time, it was a fixed idea for pathologists that the presence of a virus would be a sign of etiology. The author also told Bailey that Ricaud had shown the symptoms of Yellow Wilt in Mauritius on the 1974 post-congress tour (see Box 1.1). In response, he said that he had communicated at a local congress that the SYL and the Yellow Wilt were probably the same thing and that they could not find the luteovirus, but, in contrast, they had consistently found a phytoplasma. He also said: (i) he was unable to correlate with the shortening of the days and the lowering of the temperature (only because the symptom outbreak appeared two months after that event as if the plant would respond instantaneously) and, yes, when it took two months without rain, on clayey soil, the symptoms appeared; (ii) that in the book only found Autumn Collapse and that he found that the descriptions did not exactly agree with those of Yellow Wilt. The important thing is that, from then on, at least all researchers accepted the report in the 1960s and 1970s of the current Amarelinho or Yellow Leaf Disease (YLD) as Yellow Wilt.

In 1999, at the XXIII Congress of the ISSCT, the author presented the summary work of all the holistic arguments about the problem, denying that YLD was caused by the alleged etiological agents, either the virus or the phytoplasma. The title was daring and provocative: "Yellow leaf syndrome and alleged pathogens: a casual and not a causal relationship." The author supposes it must have raised much resentment and a feeling of rejection towards him. Incidentally, the review committee was reluctant to accept the paper. They even asked the author if he would persist in the presentation. He persevered. The congress committee scheduled the presentation for the afternoon, and in the morning, the author came across Ricaud, the general secretary of the ISSCT at the time. Then he asked: You will present the paper today after lunch, wo you? The reply was affirmative. He said something the author could not catch and immediately left. Furthermore, he did not show up for the presentation. I thought he was unwilling to discuss the matter, as he did not express his arguments. Would he be in an awkward position to take a stand against the mainstream? Or, being a gentleman, he wanted to avoid displeasing the author with contrary arguments? Conjectures. After the presentation, no one manifested or sought out for any discussion. Did they prefer to ignore and

disdain the author? It certainly would have been the subject of comment, at least in the disease committee and among congressional reviewers. But what about the audience? If there had been a disagreement, an argument from somebody was to come. It looked like there was already a preconceived idea, and they preferred not to create controversy; it would be more straightforward to ignore. Therefore, there was practically no clash at the international level, mainly because the author distanced himself from the subject afterward. There was a bandwagon embracing the idea of a viral etiology, even overshadowing the other microorganism, the phytoplasma. Let us wait to see what happens after publishing this book.



FAX

UNIVERSIDADE FEDERAL DE SÃO CARLOS
Centro de Ciências Agrárias
Departamento de Biotecnologia Vegetal

DESTINATÁRIO: Dr. Roger Bailey (África do Sul) — **FAX : 002731 595406**

REMETENTE: Prof. Sizuo Matsuoka — **FAX: (0195)410088/415526**

Total de páginas incluindo esta: 01
Em caso de problema no recebimento desta mensagem, favor contatar o remetente, fone (0195) 41-5385/41-5526

Data: 16.11.95

Dear Dr. Bailey:

I hope you are going well. It's a pleasure to contact you again, after a so long time.

Our breeding program (RB varieties) is alive, no matter the difficulties we have faced, and now under the University of Sao Carlos. Technically it is going very well. From the next year on our varieties will be predominantly planted in all Brazilian center-south region, which comprises an area of more than 2 million hectares of cane. I am coordinating that program for the last fifteen years. That's why I could not dedicate myself more on the pathology area.

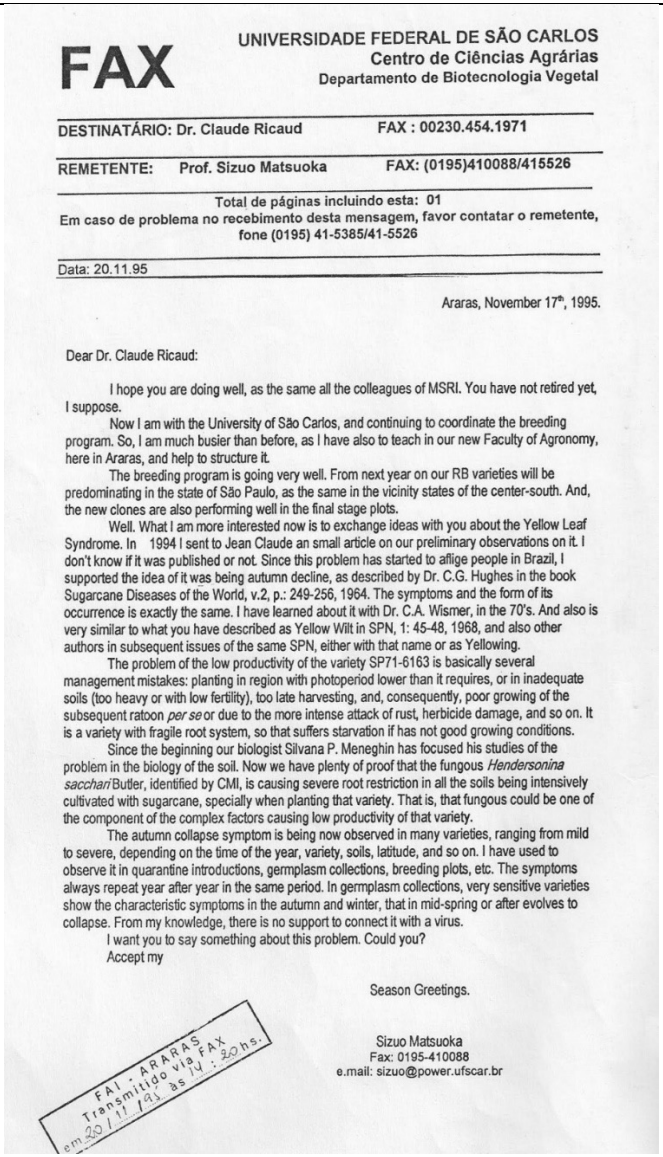
You are aware, I suppose, of the problem of 'yellow leaf syndrome' in Brazil. Since the beginning, I considered it a problem of "autumn decline" or "autumn collapse", as described by Dr. C.G. Hughes in the book Sugarcane Diseases of the World, v.2, pp. 264-269, 1964, and also reported as occurring in Africa in the 60' (Ricaud, C. 1968. SPN 1:45-49, and other reports in the same SPN as "yellow wilt" or "yellowing"). The symptoms and the form that they appear are exactly the same as described by them. I consider the leaf yellowing as a non specific symptom that results more pronounced in starved plants. The stress, caused by various management problems, is the main cause of the low yield of the variety SP71-6163. Very soon we will be reporting that one of the causes of starvation of plants of that variety, as the same of others, is a soil fungous being studied by our group for the last two years. It has been possible to consistently isolate that fungous from damaged roots of plants growing in affected areas, which causes severe root restriction in inoculated plants.

I have inquired CSR-Australia people about the ISSCT collection of slides illustrating sugarcane diseases and Dr. B. Roach informed that you are who is in charge of it. So, I ask you if is it possible to me to have the main slides concerning autumn collapse, yellow wilt, and yellowing disease. If I can have the list of slides of those anomalies, I will enumerate the ones to be duplicate for me. You can take a look to the slides and compare the symptoms with those occurring in your fields. We in Brazil have it ever, repeated year after year, starting in the autumn, either in some commercial varieties, in the collection of varieties, or in clones in the breeding plots. I have used to see it frequently in imported varieties in the quarantine. Dr. C.A. Wismer was who have guided me about that. If you can observe the symptoms in your collection of varieties in South Africa, we can further compare our results.

Very Truly Yours,

Sizuo Matsuoka
FAX: 0195 41 0211
e-mail: sizuo@power.ufscar.br

Fig. B1.2.1 Fax sent on Nov 15, 1995, to Dr. Roger Bailey, a pathologist from South Africa, Chairman, Pathology Committee of the ISSCT, alerting him that the sugarcane yellowing occurring in Brasil corresponded to the anomaly Autumn Decline, the mild form of the Autumn Collapse described by C.G. Hughes in the book "Sugar-Cane Diseases of the World," v.2, 264-269, 1964, and also to the "Yellow Wilt" occurred in Africa in the 1960s, described by C. Ricaud in SPN 1, 45-49.



FAX

UNIVERSIDADE FEDERAL DE SÃO CARLOS
Centro de Ciências Agrárias
Departamento de Biotecnologia Vegetal

DESTINATÁRIO: Dr. Claude Ricaud **FAX : 00230.454.1971**

REMETENTE: Prof. Sizuo Matsuoka **FAX: (0195)410088/415526**

Total de páginas incluindo esta: 01
Em caso de problema no recebimento desta mensagem, favor contatar o remetente, fone (0195) 41-5385/41-5526

Data: 20.11.95

Araras, November 17th, 1995.

Dear Dr. Claude Ricaud:

I hope you are doing well, as the same all the colleagues of MSRI. You have not retired yet, I suppose.

Now I am with the University of São Carlos, and continuing to coordinate the breeding program. So, I am much busier than before, as I have also to teach in our new Faculty of Agronomy, here in Araras, and help to structure it.

The breeding program is going very well. From next year on our RB varieties will be predominating in the state of São Paulo, as the same in the vicinity states of the center-south. And, the new clones are also performing well in the final stage plots.

Well. What I am more interested now is to exchange ideas with you about the Yellow Leaf Syndrome. In 1994 I sent to Jean Claude an small article on our preliminary observations on it. I don't know if it was published or not. Since this problem has started to aflige people in Brazil, I supported the idea of it was being autumn decline, as described by Dr. C.G. Hughes in the book Sugarcane Diseases of the World, v.2, p.: 249-256, 1964. The symptoms and the form of its occurrence is exactly the same. I have learned about it with Dr. C.A. Wismer, in the 70's. And also is very similar to what you have described as Yellow Wilt in SPN, 1: 45-48, 1968, and also other authors in subsequent issues of the same SPN, either with that name or as Yellowing.

The problem of the low productivity of the variety SP71-6163 is basically several management mistakes: planting in region with photoperiod lower than it requires, or in inadequate soils (too heavy or with low fertility), too late harvesting, and, consequently, poor growing of the subsequent ratoon *per se* or due to the more intense attack of rust, herbicide damage, and so on. It is a variety with fragile root system, so that suffers starvation if has not good growing conditions.

Since the beginning our biologist Silvana P. Meneghin has focused his studies of the problem in the biology of the soil. Now we have plenty of proof that the fungous *Hendersonina sacchari* Butler, identified by CMI, is causing severe root restriction in all the soils being intensively cultivated with sugarcane, specially when planting that variety. That is, that fungous could be one of the component of the complex factors causing low productivity of that variety.

The autumn collapse symptom is being now observed in many varieties, ranging from mild to severe, depending on the time of the year, variety, soils, latitude, and so on. I have used to observe it in quarantine introductions, germplasm collections, breeding plots, etc. The symptoms always repeat year after year in the same period. In germplasm collections, very sensitive varieties show the characteristic symptoms in the autumn and winter, that in mid-spring or after evolves to collapse. From my knowledge, there is no support to connect it with a virus.

I want you to say something about this problem. Could you?

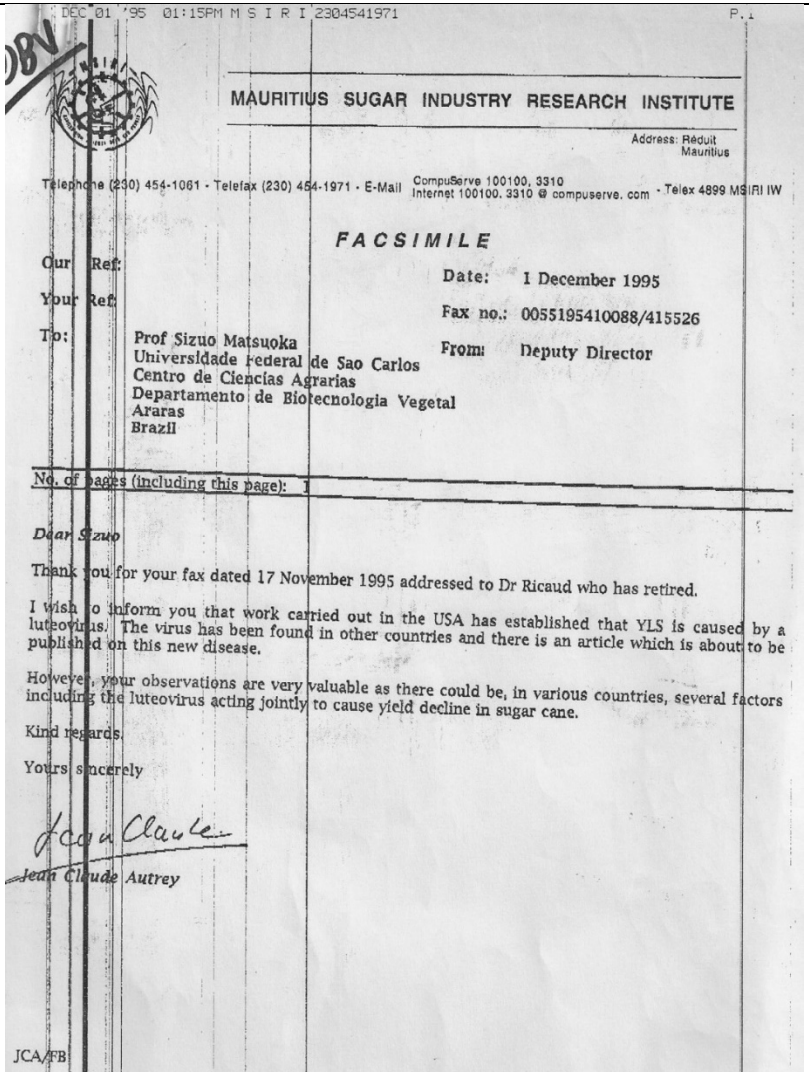
Accept my

Season Greetings.

FAX - ARARAS
Transmitido via FAX
em 20 / 11 / 95 às 14 : 20 hs.

Sizuo Matsuoka
Fax: 0195-410088
e.mail: sizuo@power.ufscar.br

Fig. B1.2.2 Fax sent on Nov 20, 1995, to Dr. Claude Ricaud, a pathologist from Mauritius, communicating him the same information sent to R. Bailey, but adding that an isolated fungous (*Hendersonina sacchari*) was able to induce root damage.



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FACSIMILE

Our Ref:

Your Ref:

Date: 1 December 1995

Fax no.: 0055195410088/415526

To: Prof Sizuo Matsuoka
Universidade Federal de Sao Carlos
Centro de Ciencias Agrarias
Departamento de Biotecnologia Vegetal
Araras
Brazil

From: Deputy Director

No. of pages (including this page): 1

Dear Sizuo

Thank you for your fax dated 17 November 1995 addressed to Dr Ricaud who has retired.

I wish to inform you that work carried out in the USA has established that YLS is caused by a luteovirus. The virus has been found in other countries and there is an article which is about to be published on this new disease.

However, your observations are very valuable as there could be, in various countries, several factors including the luteovirus acting jointly to cause yield decline in sugar cane.

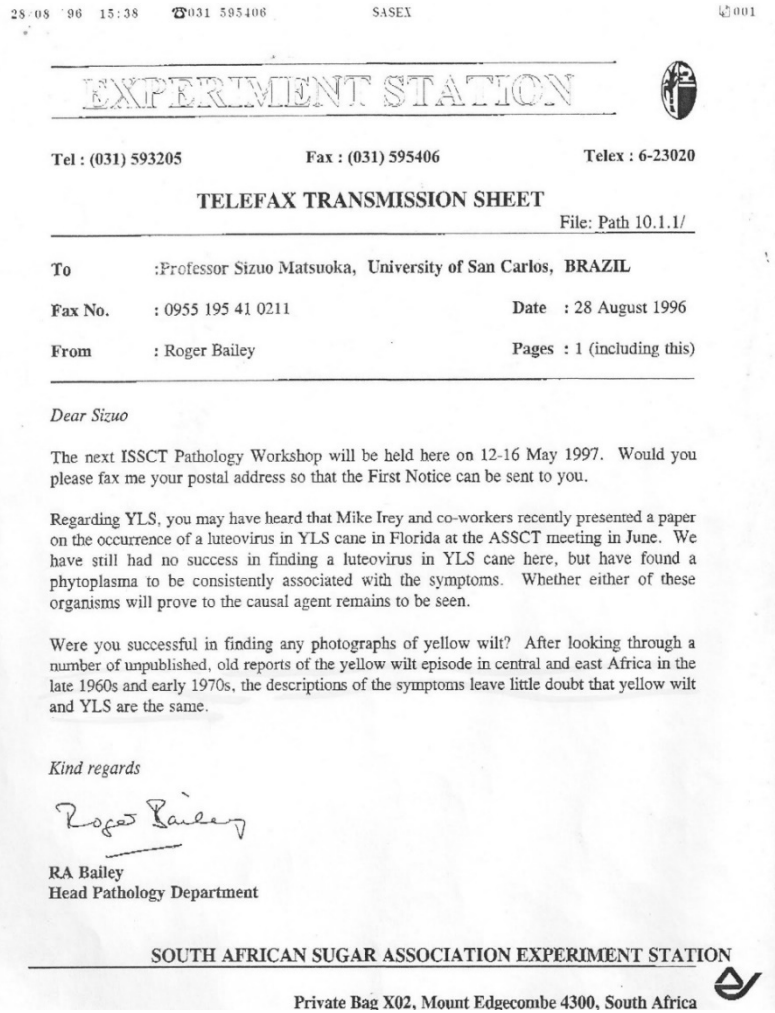
Kind regards.

Yours sincerely

Jean Claude Autrey

JCA/FB

Fig. B1.2.3 Reply from Jean Claude Autrey, a pathologist from Mauritius, on behalf of C. Ricaud (retired), stating that a luteovirus causes the YLS (Amarelinho) according to a study from the USA.



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EXPERIMENT STATION

Tel : (031) 593205 Fax : (031) 595406 Telex : 6-23020

TELEFAX TRANSMISSION SHEET

File: Path 10.1.1/

To :Professor Sizuo Matsuoka, University of San Carlos, **BRAZIL**

Fax No. : 0955 195 41 0211 **Date** : 28 August 1996

From : Roger Bailey **Pages** : 1 (including this)

Dear Sizuo

The next ISSCT Pathology Workshop will be held here on 12-16 May 1997. Would you please fax me your postal address so that the First Notice can be sent to you.

Regarding YLS, you may have heard that Mike Irey and co-workers recently presented a paper on the occurrence of a luteovirus in YLS cane in Florida at the ASSCT meeting in June. We have still had no success in finding a luteovirus in YLS cane here, but have found a phytoplasma to be consistently associated with the symptoms. Whether either of these organisms will prove to the causal agent remains to be seen.

Were you successful in finding any photographs of yellow wilt? After looking through a number of unpublished, old reports of the yellow wilt episode in central and east Africa in the late 1960s and early 1970s, the descriptions of the symptoms leave little doubt that yellow wilt and YLS are the same.

Kind regards

Roger Bailey

RA Bailey
Head Pathology Department

SOUTH AFRICAN SUGAR ASSOCIATION EXPERIMENT STATION

Private Bag X02, Mount Edgecombe 4300, South Africa

Fig. B1.2.4 Fax from R. Bailey from South Africa saying that in their studies, a phytoplasma was consistently associated with YLS, instead of the luteovirus, and that he concluded the Yellow Wilt reported in Africa and YLS were the same.

Dear Bailey:

Thanks for your fax on last August 28. Good that you went through the old reports of the yellow wilt episode in central and east Africa. As you came in, I also have no doubt that the present YLS and that anomaly are the same problem, including the "autumn decline" described by Dr. C.G. Hughes in the vol. 2 of Sugarcane Diseases of the World, 1964. I was introduced to the symptoms by Dr. C. A. Wismer in 1970s. Unfortunately, both are not alive.

You were not present in the 1974 post congress tour to Mauritius? (Photo of the group in SPN, 13/14, p.34). That time Dr. C. Ricaud showed us the symptoms of "yellow wilt". I catch it in slides. And I also have slides of the symptoms illustrated in the International Collection of Slides Illustrating Diseases.

We have in Brazil plenty of evidences that the yellowing is a physiological condition of some varieties manifested in declining photoperiod days, and more evidenced when the plants are under all kind of stresses. It reflects as a disturbance in the basipetal flux of synthetized carbohydrates. Concerning the virus Dr. Irey and associates claim to have found, I am confident that it is a innocuous resident in the plants, that is, there is no proof that its causes the YLS or that it is not present in normal plants. The model and form of field occurrence does not match with the hypothesis of a virus causing it. I am terminating a long paper justifying all our viewpoints on this. Unfortunately in portuguese, this time. I will appreciate very much you make more comments on this matter.

Bellow is my correspondence address you asked for:

Universidade Federal de São Carlos
Centro de Ciências Agrárias
Via Anhanguera, km 174
13600-970. Araras-SP. Brazil.

Email: sizuo@power.ufscar.br

Fig. B1.2.5 My answer by e-mail to the previous fax from R. Bailey concerning our evidence the YLS was a physiological problem instead of a disease.

EXPERIMENT STATION

Tel : (031) 593205 Fax : (031) 595406 Telex : 6-23020

TELEFAX TRANSMISSION SHEET

File: Path 10.1.1/
cr 3.3.1/

To : **Prof. Dr. Sizuo Matsuoka, University of San Carlos, BRAZIL**

Fax No. : (0955) 195 41 0088 **Date** : 17 September 1996

From : Roger Bailey **Pages** : 1 (including this)

Dear Sizuo

Thank you for your address. The first notice about the Workshop will be mailed soon.

Thank you also for the additional comments about YLS. I presented a paper about the distribution of YLS in southern Africa at out local congress in June. In it we state that YLS and yellow wilt are probably the same condition. We are still unsuccessful in finding a luteovirus in YLS cane but have been consistently successful in finding a phytoplasma in material with YLS symptoms (shortly to be published). The phytoplasma is very common and at this stage we are making no claims to pathogenicity. There is no doubt that environmental conditions and the plant's physiological condition are major influences in the expression of YLS symptoms, and there are large differences in varietal reactions. Whether the phytoplasma is involved remains to be seen and will require exhaustive investigation.

Although symptoms are often expressed in the cooler months with short days, I am not sure that declining day length is always necessary. We have had a sudden flush of symptoms recently, after more than two months when day length has been lengthening. Stress of any sort is a major influence. The most striking symptoms recently have occurred on heavy clay soils after about two months without rain and with the plants becoming drought stressed. This fits well with descriptions of yellow wilt. You mention autumn decline in Sugarcane Diseases of the World Vol 2; I can only find Autumn Collapse (p 289) and think that the description of this doesn't agree closely with YLS/yellow wilt.

I am posting some photographs of YLS symptoms to you. They are the same as those reported elsewhere for YLS and yellow wilt. I look forward to seeing your paper.

Regards

Roger Bailey

RA Bailey
Head Pathology Department

Fig. B1.2.6 Fax from R. Bailey reinforces the association of phytoplasma and YLS, admitting the environmental conditions influencing the manifestation of YLS, especially drought conditions. He added he found only "Autumn Collapse" in the book "Sugar-Cane Diseases" and that he did not see the descriptions of symptoms coinciding with that of YLS. He didn't notice the exact matching of the initial symptom development of Autumn Collapse with that of YL.

Sprouting after the harvest happened as usual, but the yellowing intensified when the cane was adult the following autumn. In the meantime, it had become known that there had been a report in Hawaii of an anomaly called "Yellow Leaf Syndrome" (YLS) that was transmitted by vegetative propagation and with the suspicion that it was a disease caused by a virus. Given the similarity of the symptoms reported in Hawaii to those seen in SP71-6163, finding a virus became the focus of the research centers, no matter that the author reiterated that it was not a disease. In February 1994, at the XVII São Paulo State Congress of Phytopathology, one communication described the symptoms, while another reported studies on the roots of SP71-6163, which were constantly depleted in the plants with the problem, and that the soils had restrictive factors for root and plant growth. The presumptive new virus was mistakenly considered the cause for the weakening of the roots. That same year, at the Brazilian Congress of Phytopathology, a colleague reported the occurrence of viral particles in the phloem of affected plants. Colleagues from Copersucar officially communicated in a workshop in Australia, held in April 1994, the occurrence of yellow leaf syndrome (YLS) in Brazil, at which time the same researcher who had reported the event of YLS in Hawaii reiterated the fact. We sent a note about the anomaly, expressing that it was a physiological problem induced by many factors and that the symptoms were similar to "Autumn Decline," the initial phase of "Autumn Collapse," or its mild form. However, due to the impossibility of our attendance, it remained without formal exhibition and was only published in December of that year. Also in 1994, a report registered the occurrence of the syndrome in the USA. It is possible to imagine that, from then on, the idea of a viral disease strengthened. Nevertheless, let us follow the story. In the years that followed, reports of the anomaly came from many countries: for example, Australia, Venezuela, South Africa, Mauritius, Zimbabwe, and Cuba.

It must be apparent, however, that the author had known the symptoms since the 1970s and related them to two anomalies that occurred in the 1960s in East Africa and Australia, described as "Yellow Wilt" and "Autumn Collapse," respectively. However, no other researcher had realized that the YLS or Amarelinho corresponded to those anomalies, perhaps for three reasons:

1. The term Autumn Collapse did not lead anyone to suppose that the symptoms of the initial form of the anomaly led to an exact correspondence to the symptoms observed in the case of Amarelinho.