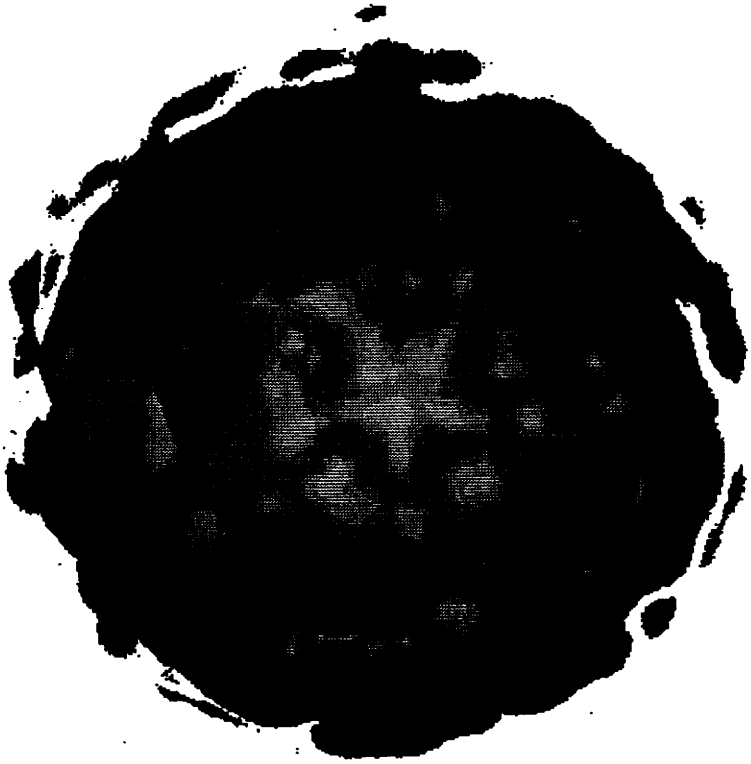
Premier Symposium International sur la Marbrure (RYMV)
Mbé/Bouaké, Côte d'Ivoire
(18-22 septembre 1995)



First International Symposium on Rice Yellow Mottle Virus (RYMV)
Mbé/Bouaké, Côte d'Ivoire
(18-22 September 1995)

West Africa Rice Development Association (WARDA)
01 BP. 2551 Bouaké 01
Côte d'Ivoire

Allocution d'ouverture de
Dr. Eugène R. Terry
Directeur Général WARDA/ADRAO

Mesdames, Mesdemoiselles, Messieurs,
Bonjour,

C'est avec un réel plaisir que je vous dis "Akwaba" en terre Ivoirienne, à Bouaké et à l'ADRAO à la faveur du Premier Symposium International sur la Marbrure (Rice Yellow Mottle Virus - RYMV).

Comparée à cette "célèbre" affection cryptogamique multiséculaire qu'est la pyriculariose, la marbrure est une maladie relativement récente dont le premier signalement remonte vers le milieu des années 60.

Alors que la communauté scientifique internationale en est réduite à développer une stratégie "curative" de la pyriculariose, nous sommes *a contrario* en position d'établir une stratégie préventive de gestion du RYMV à l'échelon continental grâce à une démarche interdisciplinaire intégrée ; en cela, le RYMV constitue par excellence un thème scientifique fédérateur exigeant pour être maîtrisé l'implication d'experts en Entomologie, Génétique, Malherbologie, Pathologie, Physiologie, etc...

Parmi les nombreux éléments qui témoignent de la pertinence de la mise au point d'une démarche systémique de gestion du RYMV, nous nous devons de citer :

- les lacunes qui subsistent dans les domaines de la cartographie spatiale du virus de la marbrure, des facteurs épidémiologiques qui sous-tendent la conservation/dispersion ou les fluctuations saisonnières du niveau de pression de sélection ;

- les insuffisances relatives au déterminisme génétique et à l'héritabilité de la résistance ;

- le rôle qui devrait être dévolu au ressources génétiques locales du type *O. glaberrima* ;

- enfin, le nombre éloquent d'éminents chercheurs opérant sur le sujet de par le monde et dans des domaines différents de la recherche fondamentale et appliquée.

Cependant, au regard des investissements substantiels consentis par la communauté scientifique internationale, il nous a semblé essentiel de promouvoir une "fluidisation" des échanges scientifiques dans le but :

- de cibler les priorités ;
- de minimiser les duplications en exploitant au mieux les avantages comparatifs de chaque partenaire ;
- d'harmoniser les méthodologies afin de faciliter l'analyse et l'exploitation rationnelle des acquis ;
- d'optimiser l'impact des investissements.

Il en résulte nécessairement une démarche harmonisée dont les effets synergiques et la pertinence des orientations n'est plus à démontrer. C'est en cela que l'idée de créer un Groupe International de Travail sur le RYMV constituait à nos yeux une excellente initiative ; peu de temps après sa conception au sein du Groupe d'Action Système de Protection Intégré du Riz (SPIR) impliquant les Systèmes Nationaux de Recherche Agronomiques (SNRA) de l'Afrique de l'Ouest et l'ADRAO (mars 1993), cette idée s'est d'abord traduite par une réunion de concertation au sein d'un noyau dur de 7 chercheurs réunis à Madison, Wisconsin, USA à la faveur du symposium international sur la pyriculariose en août 1993.

Depuis cette date, les choses se sont accélérées et se sont rapidement concrétisées par la mise sur pied effective dudit Groupe International de Travail aujourd'hui fort de 72 membres originaires d'Afrique, d'Amérique du Nord, d'Asie et d'Europe.

A l'issue d'un large sondage, l'organisation d'un premier *forum* scientifique sur le sujet semblait être souhaité par tous les membres du Groupe ; ce défi s'est rapidement concrétisé grâce à l'enthousiasme de la communauté scientifique qui a pu bénéficier du soutien matériel sans réserve de l'ADRAO et de l'USAID.

Nous voici réunis pour cette Grande Première qui suscite tant d'espoir pour les chercheurs mais aussi pour les professionnels de la riziculture en Afrique.

Il est donc essentiel qu'à l'issue de ce premier *forum* international, nous puissions ensemble identifier les "*dimensions majeures*" à privilégier ainsi que l'instauration d'un système de partenariat qui soit basé sur les expertises et avantages comparatifs de chacun. A ce propos, les SNRA d'Afrique ont un rôle exceptionnel à jouer dans la mesure où, c'est de leur degré d'implication effective et de la qualité des informations fournies que dépend l'orientation des recherches fondamentales dont la contribution nous parait essentielle pour l'avènement d'un système de gestion efficace et durable de la marbrure sur notre continent.

La Côte d'Ivoire et l'ADRAO s'honnorent d'avoir été choisis comme Pays et Institution hôtes du Groupe International de Travail sur le RYMV et sont heureux d'en héberger le Premier Symposium International.

Je pense que cette initiative intervient à un moment décisif pour tous ceux qui, parmi nous, sont préoccupés par le problème de la sécurité alimentaire en Afrique sub-saharienne. Au cours des 5 dernières années, l'ADRAO a déployé des efforts considérables dans le but de développer une stratégie innovatrice et durable pour la recherche agronomique en Afrique sub-saharienne. J'ose croire que nous avons réussi, dans une certaine mesure. Aujourd'hui, ce rassemblement de chercheurs experts dans des disciplines variées et tous engagés dans une action conjointe pour juguler les méfaits du virus de la marbrure en Afrique, constitue très certainement la meilleure preuve des progrès enregistrés en l'occurence.

J'espère que votre séjour parmi nous vous permettra de vous familiariser à d'autres aspects de nos mécanismes innovateurs de collaboration institutionnels, notamment, les activités de nos Groupes d'action et celles de notre structure de centre ouvert.

En vous renouvelant mes souhaits de bienvenue en Côte d'Ivoire, à Bouaké et à l'ADRAO, je puis personnellement vous assurer de l'engagement et du soutien de l'ADRAO et des ses partenaires nationaux au travers de ses Groupes d'action.

Du fond du coeur, je souhaite plein succès à vos travaux et déclare ouvertes les assises du Premier Symposium International sur la Marbrure.

Fait à Bouaké le 18 septembre 1995

Dr. Eugène R. Terry
Directeur Général

PROGRAM FOR THE FIRST INTERNATIONAL SYMPOSIUM ON RICE YELLOW MOTTLE VIRUS
(September 18-22, 1995)

12 Sept. 1995

Steering/Organizing Committee

Abdoul Aziz Sy, Chairman, WARDA, Côte d'Ivoire
F.O. Anno-Nyako, CRI, Ghana
Denis Fargette, CIRAD, France
Claude Fauquet, ILTAB, U.S.A.
Sahr Fomba, RRS, Sierra Leone
Alain Ghesquiere, ORSTOM, France
Konaté Gnissa, INERA, Burkina Faso
Jackie Hughes, IITA, Nigeria

Lundi 18 septembre 1995

07:45 - 08:30 Bouaké - Mbé
08:30 - 08:45 Inscription
08:45 - 09:00 Allocution Directeur Général ADRAO
09:00 - 09:15 Adoption de l'ordre du jour
Désignation des présidents de séances (suivant sessions)
Désignation des rapporteurs "*Dimensions majeures*"
* Rapporteur général = Sy
* Rapporteur session (suivant sessions).

09:15 - 10:30 1. GENERAL INTRODUCTION: Major Rice Diseases. Focus on RYMV.
Président : *Fomba* **Rapporteur : *Anno-Nyako, Fomba, Sy***

09:15 - 09:30 **Sy A.A.[1], Séré Y.[2],** [1]WARDA/ADRAO, Bouaké Côte d'Ivoire, [2]INERA, Bobo-Dioulasso, Burkina Faso. *Situation phytosanitaire du riz: Caractérisation des affections majeures* 1

09:30 - 09:45 **Chancelor T.[1], Holt J.[1], Thresh J.M.[1] and Ziegler R.[2],** [1] NRI/UK; [2] IRRI/Philippines. *The comparative epidemiology of the virus diseases of tropical rice.* 2

09:45 - 10:00 **Fauquet[1] C.M.; Brugidou[1] C.; Kouassi[1] N.; Bonneau[1] C.; Ngon A. Yassi[2] M.; Opalka N.[3]; Yeager M.[3]; and Beachy R.[1/3],** [1]ILTAB, University of California,/Riverside; The Scripps Res. Institute. *The Rice Yellow Mottle Virus, a threat to African farmers and a model for plant virologists.* 3

10:00 - 10:30 Discussions ; *Dimensions majeures*

10:30 - 11:00 Pause, contacts informels.

11:00 - 15:30 2. ECONOMIC IMPORTANCE OF RYMV: Spectrum of Action, Site Characterization and Identification of Hot Spots, Yield Loss and Economic Impact.
Président : *Reckhaus* **Rapporteurs : *Coulibaly Y., Reckhaus, SY***

11:00 - 11:15 **Anno-Nyako F.O., Twumasi J.K.,** Crops Research Institute, Kumasi, Ghana. *The threat of RYMV and the future of rice production in Ghana.* 4

11:15 - 11:30 **Rahalivavololona N.(Mrs),** FOFIFA, Antananarivo, Madagascar. *Situation de la virose RYMV à Madagascar.* 5

11:30 - 11:45 **Coulibaly Y.M.,** Office du Niger/Projet Retail, Niono, Mali. *Le RYMV ou mosaïque jaune du riz : une menace pour l'intensification de la riziculture à l'Office du Niger.* 6

11:45 - 12:00 **Hamadoun A.** IER, Sikasso, Mali. *Statut de la panachure jaune du riz (RYMV) au Mali : Cas de l'Office du Niger.* 7

Mardi 19 septembre 1995

07:45 - 08:30 Bouaké/Mbé.

08:30 - 10:00 4. CHARACTERIZATION AND VARIABILITY OF RYMV.
Président : *Fargette* **Rapporteurs : *Fomba, Fargette, Sy***

08:30 - 08:45 **Opalka N.[1]; Fauquet C.M.[1]; Johnson J.[1]; Beachy R.N.[1/2]; and Yeager M.[1].** [1]The Scripps Res. Institute, La Jolla California, USA; [2]ILTAB La Jolla California, USA. *Three-dimensional structure of RYMV by Cryo-Electron Microscopy.* 17

08:45 - 09:00 **Fomba[1] S.N.** and **Taylor[1] D.R.; and Sy[2] A.A.** [1]Rice Research Station Rokupr, Sierra Leone ; [2]WARDA/ADRAO, Bouaké, Côte d'Ivoire. *Effect of three isolates of Rice yellow Mottle Virus on some Oryza spp.* 18

09:00 - 09:15 **N'Guessan[1] K.P., Sy[2] A.A., Fargette[3] D.** [1]IDESSA/ADRAO, [2]WARDA/ADRAO, Bouaké, Côte d'Ivoire; [2]LPRC/CIRAD-ORSTOM, Montpellier, France. *Caractérisation biologique et sérologique d'isolats du virus de la marbrure (RYMV) en Côte d'Ivoire.* 19

09:15 - 09:30 **Fargette[1] D.; Pinel[1] A.; Albar[1,4] L.; N'Guessan[1] P.; Notteghem[3] J-L.; Chesquiere[4] A.P.; Corgier S.; Frutos(2) R.** [1]LPRC; [2]GEPAM; [3]UR Phyma : CIRAD, BP. 5035, 34032 Montpellier cedex 1, France. [4]LRGAPT: ORSTOM, BP. 5045, 34032 Montpellier cedex 1, France. *Assessment of biological, serological and molecular variability of a range of RYMV isolates from different geographical areas.* 20

09:30 - 09:50 Discussions.

09:50 - 10:00 Synthèse : *Dimensions majeures.*

10:00 - 10:30 5. EPIDEMIOLOGY.
Président : *Imolehin* **Rapporteurs : *Johnson, Imolehin, Sy***

10:00 - 10:15 **KONATE G.** INERA/Kamboinse, Burkina Faso. *Les hôtes relais du RYMV au Burkina Faso.* 21

10:15 - 10:30 Discussions.

10:30 - 10:35 Synthèse : *Dimensions majeures.*

10:35 - 11:00 Pause, contacts informels.

11:00 - 16:30 6. GENETIC RESISTANCE OF RICE TO RYMV *(Suite le 21/09/95 ; 09:15 - 12:45).*

11:00 - 13:00 6.1 Screening Methodologies and Identification of Sources of Resistance.
Président: *Masajo* **Rapporteurs : *Goto, Masajo, Sy***

11:00 - 11:15 **Akio Goto.** *RYMV Survey around Grand Lahou.* 22

11:15 - 11:30 **Imolehin E.D.** NCRI, Badeggi, Nigeria. *Efficiency of simple screening methods in the detection of Rice Yellow Mottle Virus.* 23

11:30 - 11:45 **Bouet A.[1], Yoboue N.[1], Valès M.[2].** [1] IDESSA, Bouaké, Cote d'Ivoire; [2] FOFIFA-cirad, Antisirabe. *Méthodes d'inoculation pour le criblage varietal de la résistance du riz (Oryza sativa L.) à la bigarrure jaune (RYMV).* 24

11:45 - 12:00 **Alluri K.[1], Thottappilly G.[1] Sy A.A.[2] and Singh B.N.[2]** [1]IRRI/INGER Africa, Ibadan,Nigeria. [2]WARDA/ADRAO, Bouaké, Côte d'Ivoire. *Genetic resistance of rice varieties from global sources to RYMV.* 25

Mercredi 20 septembre 1995

07:00 - 08:30	Bouaké / Yamoussoukro.
08:30 - 09:00	Pause - Petit déjeuner *(Hotel Président)*.
09:00 - 10:30	Yamoussoukro / Gagnoa.
10:30 - 13:00	Visites : - champs paysans *(Garayo I/II ; Bariho II A/B)* - IDESSA Station *(le cas échéant)*.
13:00 - 13:15	Trajet vers lieu de restauration *(Terrasse)*.
13:15 : 14:30	Déjeuner.
14:30 - 16:00	Gagnoa/Yamoussoukro.
16:00 - 17:00	Escale à la Basilique *"Notre Dame de la Paix"*.
17:00 - 18:30	Yamoussoukro / Bouaké.

Jeudi 21 septembre 1995

08:00 - 08:45 Bouaké / Mbé.

08:45 - 09:15 Discussions centrées sur les posters.

09:15 - 11:15 6.3 Breeding Strategies for Resistance to RYMV.
Président : *Fauquet* **Rapporteurs : *Kumwenda, Fauquet, Sy***

09:15 - 09:30 **Brugidou[1] C.; Bonneau[1] C.; Ngon A. Yassi[2] M.; Holt[3] C.; Beachy[1/3], R.N.; Fauquet[1] C.M.[1]** ILTAB [2]University of California, Riverside, U.S.A.,[3]SCRIPPS. *An infectious full-length cDNA clone of Rice yellow Mottle Virus (RYMV); a molecular tool for engineering virus resistance and developing a viral expression vector.* . 35

09:30 - 09:45 **N. Ahmadi N.[1] and Singh B.N. [2].** [1]IER/CIRAD,Sikasso, Mali. [2]WARDA/ADRAO, Bouaké, Côte d'Ivoire. *RYMV resistance in anther culture doubled haploid and single seed descent derived lines.* 36

09:45 - 10:00 Discussions.

10:00 - 10:15 **Masajo T.M.[1] and Rasoafalimanana M.(2).** [1]Madagascar-IRRI Rice Research Project BP. 4151; [2] Department of Rice Research FOFIFA, BP. 1690; Antananarivo (101). Madagascar. *Breeding for Resistance to Rice Yellow Mottle Virus: Experience at IITA and in Madagascar.* 37

10:15 - 10:30 **Valès M.J.[1]; Yoboué N.[2], Bouet A.[2].** ([1]FOFIFA-CIRAD Antsirabe, Madagascar, [2]IDESSA, Bouaké, Côte d'Ivoire. *Stratégie de sélection pour l'amélioration de la résistance au virus de la bigarure jaune du riz à l'IDESSA en Côte d'Ivoire.* 38

10:30 - 10:45 **Ahmadi N., Cissé F.** IER/CIRAD Sikasso, Mali. *Amélioration variétale pour la résistance au virus de la marbrure jaune du riz: Stratégie de sélection IER/CIRAD au Mali.* 39

10:45 - 11:00 **Singh B.N.** WARDA/ADRAO. *Breeding for RYMV resistance.* 40

11:00 - 11:15 **Fomba S.N. , Monde S.S., Mansaray M.S., Taylor D.R., Jusu M.S. and Jalloh A.B.** RRS, Rokupr, Sierra Leone. *Occurrence of Rice Yellow Mottle Virus in Sierra Leone and breeding for resistance.* 41

11:15 - 11:45 Pause, contacts informels.

11:45 - 12:15 Discussions.

12:15 - 12:45 Synthèse : *Dimensions majeures* Point No. 6.

12:45 - 13:00 Open.

13:00 - 14:15 Déjeuner, contacts informels.

14:15 - 16:15 Sessions restreintes : Steering committee (14:15 - 15:15) ; Activités collaboratives bi-multilatérales (IPM-TF, ...) ; Formulation des Rapports de synthèse par session.

16:15 - 16:30 Pause.

16:30 - 17:15 Mbé/Bouaké.

17:15 - 19:00 Open.

19:00 - 21:00 Buffet / Symposium *(Black & White).*

Vendredi 22 septembre 1995

07:45 - 08:30 Bouaké/Mbé.

08:30 - 10:00 7. NOVEL APPROACHES TO RYMV RESISTANCE.
Président : *Baulcombe* **Rapporteurs : *Brugidou, Baulcombe, Sy***

08:30 - 08:45 **Baulcombe D.C.** The Sainsbury Laboratory. NRP, Norwich, Norfolk, UK. *Novel approaches to natural and genetically engeneered resistance in transgenic plants.* *42*

08:45 - 09:00 **Pinto Y.M.** The Sainsbury Laboratory NRP, Norwich, Norfork. UK. *Genetically engineered resistance to Rice Yellow Mottle Virus.* *43*

09:00 - 09:15 **Albar[1] L.; Ghesquières[1] A.; Fargette[2] D. & Notteghem[3] J-L.** [1]Laboratoire de Ressources Génétiques et d'Améliorations des Plantes Tropicales, ORSTOM, BP. 50445, 34032, Montpellier cedex 1 ; [2]Laboratoire de Pluviométrie des Régions Chaudes ; [3]Unité de Recherche de Pathologie et Malherbologie, CIRAD, BP. 5035, 34032 Montpellier, cedex 1, France. *Identification of DNA markers linked to Loci that confer resistance to RYMV.* *44*

09:15 - 09:30 **Kouassi N.[1], Brugidou C.[1], Chen L.[1], Ngon A Yassi M.[1], Beachy R.N.[2], Fauquet C.M.[1],** [1]ILTAB, [2] SCRIPPS, La Jolla, California, USA. *Towards Rice Transgenic expressing the RYMV coat protein Gene.* *45*

09:30 - 10:00 Discussions.
10:00 - 10:15 Synthèse : *"Dimensions majeures"* Point No. 7
10:15 - 10:30 Pause, contacts informels.

10:30 - 12:00 8. DISEASE MANAGEMENT AND DEVELOPMENT OF AN INTEGRATED STRATEGY.
Président : *Séré* **Rapporteurs : *Reckaus, Séré, Sy***

10:30 - 11:00 **Reckhaus[1] P. ; Andriamasintseheno[2] H.F.** [1]German-Malagasy Plant Protection Project, BP. 869, Antananarivo ; [2]Service de la Protection des Végétaux, BP. 545, Mahajanga, Madagascar. *Development of an IPM strategy to fight RYMV and constraints to its implementation in Madagascar* *46*

11:00 - 11:30 Discussions.
11:30 - 11:45 *Dimensions majeures* Point No. 8.
11:45 - 12:00 Open – Formulation rapport global *dimensions majeures.*

12:00 - 12:15 9. Audition, discussion, adoption rapport *dimensions majeures.*
(rapporteur oral)
Président : *Ghesquières* **Rapporteurs : *Kouassi, Ghesquières, Sy***

12:15 - 12:45 10. Prospectives : Rapport session Steering Committee (Sy)
Président : *Sy* **Rapporteurs : *Ghesquière, Gnissa, Sy***

12:45 - 13:00 Clôture officielle *(Directeur de la recherche).*
13:00 - 14:00 Déjeuner.
14:00 - 14:45 Premier départ Mbé/Bouaké.
14:00 - 16:00 Visite Mbé.
16:00 - 16:30 Pause
16:30 - 17:15 Mbé/Bouaké *(Deuxième départ).*

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

SITUATION PHYTOSANITAIRE DU RIZ : CARACTERISATION DES AFFECTIONS MAJEURES

Abdoul Aziz SY, Yacouba SERE***

Faisant le point sur les connaissance actuelles de l'état sanitaire de l'écosystème rizicole ouest-africain, les auteurs constatent et décrivent la grande diversité de micro-organismes capables de provoquer des maladies du riz.

Une esquisse de catégorisation basée sur les dommages causées aux cultures permet de considérer qu'il existe trois affections majeures : la pyriculariosse provoquée par *Pyricularia oryzae* Cav., anamorphe de *Magnaporthe grisea* (Hebert) Barr, le flétrissement bactérien causé par *Xanthomonas oryzae* pv *oryzae* (Ishiyama, 1992) et la marbrure jaune due à un virus (RYMV). Cependant, l'examen de la diversité des situations spatio-temporelles indique que, dans certaines conditions, des micro-organismes peuvent proliférer dangereusement pour constituer des contraintes non négligeables à la production rizicole. Il s'agit de la maladie des tâches brunes, de l'échaudure foliaire et du flétrissement des graines provoquées respectivement par *Dreschlera oryzae*, plus connu sous le nom de *Helminthosporium oryzae*, de *Gerlachia oryzae* et de *Rhizoctonia solani.*

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* Phytopathologiste Principal et Coordinateur du Groupe de Recherche Système de Protection Intégré du Riz, ADRAO, 01 BP. 2551, Bouaké, Côte d'Ivoire.

** Phytopathologiste et Chef du Programme Nationa Riz, INERA, Station de Farako-Bâ, BP. 910, Bobo-Dioulasso, Burkina Faso.

Signature _____ **Date :** _____
Phone No./*Telephone No.* : _____ **Fax No.:** _____

N.B. : Kindly send the original of your abstract./*Veuillez envoyer l'original de votre résumé.*

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

RICE YELLOW MOTTLE VIRUS: A THREAT TO AFRICAN FARMERS AND A MODEL FOR PLANTS VIROLOGISTS

C.M. Fauquet#, C. Brugidou#, N. Kouassi#, C. Bonneau#, M. Ngon A Yassi**, N. Opalka# +, M. Yeager*@, and R.N. Beachy#*
* Scripps, CA 92037
** University of California, Riverside, USA
@ Scripps, USA - # (ILTAB/ORSTOM TSRI) - + Scripps, USA

Rice Yellow Mottle Virus (RYMV) was discovered in 1973 in East Africa and appeared in 1976 in West Africa. At that time it was considered a rare pathological curiosity rather than a threat to agriculture. From 1990-1994, reports from several countries in western, eastern and southern Africa demonstrated a dramatic increase in the incidence of the disease. Furthermore, RYMV is present in multiple locations in each of the countries where it has been identified, and its spread is only li;ited by the epidemiology of the virus. Our working hypothesis is that this represents a general epidemic in Africa rather than isolated instances of infection. In the 1970's, work focused on the isolation and physicochemical properties of RYMV and in testing rice varieties for viral resistance. Currently, RYMV is being studied by virologists, molecular biologists, breeders, geneticists and phytopathologists in response to the agricultural threat of RYMV as well as for scientific interest.

RYMV is extremely virulent: a rice plant infected within 20 days after planting will certainly die. Infection between 20 and 45 days after planting will cause yellow discoloration and mottling of leaves. After 45 days, plants display resistance and manifest few, if any, symptoms. The virus can replicate at a surprisingly rapid rate: three weeks after inoculating a 21 days old plant, enough virus is generated to contaminate thousands of hectares of rice. Since the virus is environmentally stable and mechanically transmissible, all the rice in Africa could become contamined in a short period of time; however, this has not occured. Possible limitations on the spread of the disease include poor insect transmission, poor alternative hosts and an absence of seed transmission. The insect vectors are chrysomelid beetles, which play an important role in the primary infection. Secondary infection occurs via plant contact. While there are resistant rice varieties, multiple resistance genes have not been identified and are difficult to transfer in breeding programs. Therefore, the disease is currently not controlled and is a real danger to food production in Africa.

The scientific community is proactive in coordinating basic research on the virus and the development of resistant varieties. The International Laboratory for Tropical Agricultural Biotechnology (ILTAB) at the Scripps Research Institute is a team of scientists whose to control the disease by genetic engineering. Thus far, an infectious clone has been produced that will allow carefully controlled functional studies related to the infectious cycle as well as structural studies of the virus particles and of several viral proteins. Molecular biologists are implementing genetic engineering strategies of pathogen derived resistance to control the disease. Others areas being studied include RYMV epidemiology, geographic variation in strains and a search by breeders and geneticists or natural resistance genes.

The synergistic collaboration by all members of this research team should certainly expedite the development of efficient methods to control RYMV.

Signature _____ **Date :** _____
Phone No./*Telephone No.*: _____ **Fax No.:** _____

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(September 18-22, 1995 / *18-22 septembre 1995*)

ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

THE THREAT OF RICE YELLOW MOTTLE VIRUS (RYMV) TO RICE PRODUCTION IN GHANA

ANNO-NYAKO, F.O., TWUMASI, J.K. AND OWUSU-AKYAW, M.
CROPS RESEARCH INSTITUTE, P. O. BOX 3785, KUMASI, KUMASI

ABSTRACT

The rice yellow mottle virus (RYMV) was first observed in the West African sub-region in 1975. Since then, it has assumed an alarming potential that threatens the rice industry. In Ghana, rice production is on the increase, especially in the inland valley bottom ecologies where improved high yielding varieties are cultivated. So far, RYMV has only been observed in GRUG 7 (one of the improved rice varieties grown in Ghana) at Nobewam, a village located at about Lat. 6° 30' and Long. 1° 30' in the Ashanti Region of Ghana. The disease was observed in large patches that made up about 10% of the entire crop at Nobewam in 1994. Preliminary studies have identified several insects, including a high percentage of Coleopterous species associated with the crop at Nobewam. Considering the economic importance of RYMV in some countries in the sub-region, its occurrence in Ghana poses a serious threat that must be curtailed through a regional integrated pest management approach.

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MADAGASCAR

- Region Haut Nord la + infecte
- labour precoce au tracteur
mieux que

JUATTA RA

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LE RYMV OU MASAÏQUE DU RIZ : Une menace pour l'intensification de la riziculture à l'Office du Niger.

Yacouba Mamadou COULIBALY
URDOC/Projet Rail Office du Niger

Depuis quelques années une virose identifiée comme la mosaïque jaune du riz (Rice Yellow Mottle Virus) affecte les rizières de l'office du Niger, Mali. Les surfaces gravement touchées sont passées de 3 ha en 1991 à 200 ha en 1994. En terme monétaire, ces pertes sont estimées à 160 millions de francs CFA dans la zone de Niono en 1994.

Cette nouvelle maladie du riz constitue désormais la plus sérieuse ménace à l'intensification de la riziculture, en plein essor à l'Office du Niger depuis une dizaine d'années. En effet, la variété la plus cultivée, BG-90-2, support de cette intensification, est reconnue comme témoin de sensibilité à la mosaïque jaune du riz

Les réactions des paysans temoignent de leur désarroi face à cette nouvelle maladie. En effet, peu de références sur l'épidémiologie de la maladie et les méthodes de lutte sont actuellement disponibles tant au niveau des services d'appui à la riziculture que de la recherche. D'ores et déjà, l'encadrement recommande les mesures préventives suivantes : diversification des variétés cultivées, entretien correct et régulier des abords des rizières et des canaux d'irrigation. Pour la recherche il s'agit d'identifier des variétés résistantes à la maladie et d'approfondir la recherche sur la biologie des insectes vecteurs.

Le renforcement des liaisons entre Recherche, Développement et paysans, et de la coopération entre les structures nationales (Office du Niger, IER) et instituts internationaux (CIRAD et ADRAO) autour de ce problème phytosanitaire, permet d'envisager des solutions techniques satisfaisantes à moyen terme. La piste variétale parait très intéressante en dépit des difficultés pour trouver des variétés ayant les mêmes performances et les qualités de BG-90-2.

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Statut de la marbrure du riz au mali
Cas de l'Office du Niger

HAMADOUN A.[1], COULIBALY M.[2], COULIBALY M.[3] et AHMADI N.[4]

Résumé: La panachure jaune du riz (RYMV) est en nette progression au Mali et constitue une menace de plus en plus sérieuse pour les périmètres rizicoles aménagés. Depuis 3 ans, des actions de recherches sont entreprises dans plusieurs directions. Elles visent, l'accumulation de données scientifiques nécessaires à l'élaboration d'une stratégie de lutte contre la maladie.

Le suivi de la distribution et de l'évolution du RYMV à l'Office du Niger (50.000 ha) montre qu'entre 1991 et 1994, la maladie est passée du stade de tâches isolées dans certains secteurs, à celui de présence dans tous les secteurs et d'attaque de superficies importantes pouvant atteindre dans certains secteurs 200 ha. Le suivi des dégâts consécutives à la maladie fait état d'importantes pertes de production, pouvant atteindre par endroit 70 %. L'incidence financière de la maladie pour l'année a été chiffrée à 160.000.000 de F CFA.

Les analyse épidémiologiques préliminaires désignent *O. Longistaminata* largement présent sur le périmètre, comme important hôte alternatif et de conservation de la maladie en saison sèche. L'inventaire des insectes vecteurs de la maladie a permis l'identification de chrysomèles dans plusieurs sites de l'Office du Niger.

Enfin, les suivis du niveau d'infestation naturelle, en milieu paysan, de variétés présenties pour vulgarisation, et l'analyse du comportement de ces mêmes variétés en station, sous infestation artificielle, ont permis d'identifier deux variétés moins sensibles que la variété couramment utilisée BG90.2.

Mots clés : Panachure jaune du riz, RYMV, Mali, Incidence, Insectes vecteurs, Variété.

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THE STATUS OF RICE YELLOW MOTTLE VIRUS (RYMV) IN NIGERIA

BY

[1]ABO, M.E., [1]OKUSANYA, B.A., AND [2]IMOLEHIN, E.D.,
[1]Plant Virologists, [2]Plant Pathologist
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ABSTRACT

SINCE W. Bakker first reported the occurence of RYMV on rice fields in 1970 around Lake Victoria, Kenya, the disease has fast become a major limiting factor to rice production for lowland and Irrigated ecosystems in Africa as reported by several workers. In Nigeria, H.W. Rossel, G. Thottilly, I.W. Buddenhagen and several other workers had in 1981 and 1982 reported the occurence of this disease in irrigated rice in traditional rice growing areas near Umuahia and Nsukka in the South-East Zone and Badeggi near Bida in the Middle Belt Zone. A similar disease had been reported earlier in 1978 at the International Institute of Trpical Agriculture (IITA). Further Diagnostic Surveys carried out by other workers have revealed the occurence of this disease in Dadinkowa-Bauchi, Edozhigi-Niger and Kadawa-Kano States. There is clear indication that the disease may increase considering many factors of disease dissemination and movements in the ECOWAS Sub-region and particularly the proximity of Nigeria to Niger Republic which was devastated by RYMV in 1984 and 1985. These factors of disease dissemination are currently under investigation at WARDA. RYMV has become a serious constraint to rice production in many countries in the West African Sub-region and it is now been reported on farmers' fields in Nigeria.

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Incidence Of Rice Yellow Mottle Virus In Zanzibar

Fadhila H. Ali and Zakia M. Abubakar

Ministry of Agriculture, Livestock and Natural Resources, P.O. Box 159, ZANZIBAR, Tanzania.

Zanzibar consists of two islands of Unguja and Pemba with almost similar climatic conditions. Although the conditions are the same, yet there are differences in the incidence of RYMV between the islands. The occurrence of the disease is more sporadic in Unguja and less severe in Pemba, although in both islands, areas with heavy disease infection are either irrigated or rainfed lowland with standing water.

Some varieties were screened for resistance in Unguja and Pemba island. None of the improved cultivated varieties in Pemba is resistant to the disease, while the same varieties show some degree of moderate resistance in Unguja. However in Pemba the severity of the disease is manifested by increased population of the hispa beetle which has reached the pest status.

IPM strategies are being researched, including the study of possible alternative hosts for the hispa beetle in order to look for the plausible means of control affordable to the resource poor farmers in the islands.

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VARIETES MAJEURES SOUS ECOSYSTEME RIZICOLE SAHELIEN: Profils de résistance au virus de la marbrure (RYMV) et réajustement stratégique à court terme.

Abdoul Aziz SY, Yacouba SERE***

L'analyse de l'image de la répartition des principaux cultivars a travers les grands périmètres rizicoles sahéliens montre une faible diversité génétique qui peut être source de graves problèmes phytosanitaires. En effet les variétés les plus populaires (BG 90-2, Jaya) exhibent, en dépit de leurs caractéristiques agronomiques appréciables, des niveaux de sensibilité exceptionnellement éléves à l'égard de certaines maladies comme la marbrure jaune dont l'impact économique est catastrophique comme c'est le cas en zone Office du Niger au Mali.

Ce constat amène les auteurs a proposer une approche méthodologique personnalisée à caractère continental en vue d'un réajustement stratégique en matière de diffusion des cultivars. L'objectif est, a court terme, l'identification, à partir de méthodes appropriées de criblages, des meilleurs candidats aux agriculteurs, et, a long terme, la recherche de matériel à large base génétique à travers un programme concerté, pluridisciplinaire et intégré de diffusion sélective de cultivars sur la base des caractéristiques épidémiologiques des niches écologiques des affections majeures.

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** Phytopathologiste et Chef du Programme Nationa Riz, INERA, Station de Farako-Bâ, BP. 910, Bobo-Dioulasso, Burkina Faso.

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Seasonal Occurrence of Rice Yellow Mottle Virus on the WARDA Research Farm

E. A. Heinrichs, A. A. Sy, S. K. Akator and I. Oyediran
WARDA, B.P. 2551
Bouake, Côte d'Ivoire

To effectively evaluate rice germplasm for resistance to insects and diseases under natural conditions in the field it is necessary to know the time of year that insect populations and disease pressure are greatest. To obtain this information for pests on the Mbe' farm we have followed a rice garden approach with monthly plantings of the rice variety Bouake 189 under lowland irrigated conditions. Regular sampling for insect pests and rice yellow mottle virus (RYMV) infection throughout the year provided information on the seasonal occurrence of RYMV and potential insect vectors. Grain yields varied significantly depending on planting date. Highest yields were obtained in the September and December through February plantings. Leaf feeding damage by the beetle vector of RYMV, *Trichispa sericea*, and percentage RYMV infected plants were both severe in the July and August plantings in 1993. The diopsids, *Diopsis macrophthalma* and *D. apicalis* were distinctly most abundant in the December to March plantings, the leafhoppers, *Cofana spectra* and *C. unimaculata* in the November planting, and *Locris* spp. in the September to December plantings. If continued studies show the trends to be consistent from year to year the data will be used as a guide to select planting dates that give maximum pest pressure in the field screening of rice cultivars for pest resistance.

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ESTIMATION DES PERTES DE RENDEMENT INDUCTIBLES PAR LE VIRUS DE LA MARBRURE (RYMV) SOUS CONDITIONS SEMI-ARTIFICIELLES : Analyse correlative de l'impact du RYMV sur différents organes végétatifs et reproducteurs de *Bouaké 189* et de *Morobérékan*.

Sy A.A. ; Akator K. ; Kamelan Z. WARDA/ADRAO, Bouaké, Côte d'Ivoire

Décrite pour la première fois en 1966 au Kenya, la marbrure (RYMV) tend à s'affirmer comme étant l'une des affections majeures du riz en Afrique sub-saharienne, notamment sous écosystème de bas-fonds (en zone humide, à l'image de la Côte d'Ivoire ou de la Sierra Leone) ou sous celui irrigué de type sahélien (à l'image des périmètres irrigués du Mali ou du Niger).

Nos récentes prospections ont révelés que les pertes de rendement pouvaient être supérieures à 68 % dans certains périmètres de Côte d'Ivoire (Seriho) ou du Mali (Niono) lorsque les conditions épidémiologiques sont optimales. Paradoxalement, on observe que les trois variétés de type irrigué les plus populaires dans la région (Bouaké 189, Jaya, BG 90-2) exhibent une très grande sensibilité par rapport au virus de la marbrure. Dans la présente étude réalisée sous conditions semi-artificielles, nous nous proposons d'estimer les pertes de rendement inductibles par une inoculation artificielle appliquée à 7 puis 42 jours après transplantation (JAT). Les deux variétés cible sont représentées par Bouaké 189 (sensible) et Morobérékan (tolérant). L'expérimentation est déployée suivant un dispositif BCR à 4 répétitions dans deux environnements contrastés (Mbé et Gagnoa).

Lorsque Bouaké 189 est inoculé à 7 et 42 JAT, le taux de réduction de rendement passe de 57,3 à 81,3 % pour le site de Mbé contre 81,3 à 92,7 % pour Gagnoa. Pour le témoin de résistance, le taux de réduction de rendement oscille entre 4,0 % et 5,1 % tous sites confondus.

De même, le poids de 1000 grains est significativement affecté, notamment, pour la variété sensible dont le taux de réduction du poids de 1000 grains passe de 14,3 à 28,1 % à Mbé contre18,2 à 27,7 % pour Gagnoa. Parallèlement, les taux de réduction observés pour Morobérékan varient de 2,1 à 1,5 % pour le premier site contre 1,5 à 1,0 % pour le second.

Par ailleurs, nous avons estimé l'impact des inoculations échelonnées du virus de la marbrure sur le tallage, l'exertion paniculaire, la proportion de panicules pleines et la hauteur moyenne pour laquelle l'estimation a été faite à 24, 38, 52 et 66 JAT. En l'occurrence, le taux de réduction de hauteur de Bouaké 189/Mbé à 66 JAT passe de 41,4 à 2,8 % pour des inoculations administrées à 7 et 42 JAT respectivement contre 42,1 à 7,9 % pour le site de Gagnoa. Relativement à Morobérékan, ces proportions sont de 9,6 et 2 % puis 8,6 et -1,2 % respectivement aux deux sites.

Dans une étude ultérieure, nous nous proposons de sélectionner trois cultivars de type *indica* d'intérêt agronomique établi qui soient dotés de profils contrastés par rapport au virus de la marbrure ; afin de mieux cerner l'impact d'inoculations échelonnées sur les phases végétatives et reproductives, celles-ci seront effectuées en fonction de stades phénologiques précis.

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HISTOLOGICAL CHANGES ASSOCIATED WITH
RICE YELLOW MOTTLE VIRUS INFECTION

Brugidou, C.#o, N. Opalka# +, C. Cheng-ming*, M. Nicoleo, M. Yeager*@, R.N. Beachy+#* and C.M. Fauquet# +o,
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oORSTOM - Institut Francais de Recherche Scientifique pour le Développement en Coopération - 213 Rue la Fayette, 75480, Paris Cedex 10, France.

Rice Yellow Mottle Virus (RYMV) is responsible for the destruction of an increasing portion of the rice crop on the African continent. To better understand the functional properties and pathogenesis of this virus, events in the infectious cycle are being examined by transmission electron microscopy. Infected and control leaves were harvested at time points up to three weeks after incoluation of rice plants. RYMV is first detected on week after inoculation in vascular as well as in leaf mesophyll tissues. Cytological effects include (1) virus-like particles within plasmodsmate; (2) aggregation of chloroplasts which appear to envelop particle clusters; and (3) an increase in vesicles adjacent to the cell walls. Virus particles have been observed in the cytoplasm in all cells examined and may also be present in the nucleus of mesophyll cells. Thin-section electron microscopy combined with immunolabeling of specific RYMV proteins will provide additional details of the mechanism of viral invasion.

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(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

Development of serological techniques for detection of rice yellow mottle virus

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Serological techniques have been developed for the detection of rice yellow mottle virus (RYMV) in particular with respect to estimating the level of resistance. Antibodies raised at IITA have been used successfully for the detection of RYMV using a range of serological tests including agar gel diffusion, direct and indirect enzyme-linked immunosorbent assays (ELISA). Although the sensitivity of RYMV detection is greater in ELISA than in gel diffusion, in these studies gel diffusion tests reliably detected all the RYMV-infected plants. When RYMV was not detected by serological means, back tests to the highly susceptible *Oryza sativa* variety IR5 also failed to indicate the presence of the virus.

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A RAPID DIAGNOSTIC KIT FOR RYMV DETECTION

M. NGON AYASSI, M. GRANIER, M. PETERSCHMITT, M. CHATENET, J.L. NOTTEGHEM

Symptoms due to rice yellow mottle virus (RYMV) are often reliable enough to diagnostic the disease. However a serological test is useful when symptoms can be confused with other yellowings or when infection occurs too late to cause the usual chlorotic mottle. In these cases, a serological test is recommended. The ELISA technic is very convenient when the required equipment is available. Otherwise a similar immunenzymatic test can be carried out using nitrocellulose membranes instead of the ELISA polystyrene plates. Based on this second technique, a diagnostic kit could be developed. This kit can be used in any conditions as it does not require specialized equipment. Such simple, fast and convenient kits were first set up for tropical maize viruses and then adapted for RYMV. We use a polyclonal anti-serum at a dilution of 1/10000. The sensitivity of the nitrocellulose test is equal to that of the standard ELISA test ; it is possible to detect the virus in diseased rice leaf extract at a dilution of 1/500000 corresponding to a concentration of 100 ng/ml of purified virus. The serum reacts with all isolates so far tested originating from 5 countries. The test can be carried out in 8 hours.

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Evaluation of the concentration of rice yellow mottle virus

Albar[1,2] L, Pinel[1], M.L. Caruana[1], Fargette[1] D, Ghesquiere[2] A

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Accurate and reproducible evaluation of the concentration of rice yellow mottle virus is a valuable tool in breeding programs for selection of cultivars resistant to the disease. The evaluation has been optimised in order to get quick and reliable estimates of virus concentration by (1) setting up an appropriate serological test, (2) adjusting the environmental conditions and (3) finding the appropriate stage for the rice plant to be tested.

Various forms of immuno-enzymatic tests have been assessed including Antigen-Coated Plate (ACP-ELISA) and double sandwich (DAS-ELISA) forms of ELISA using polyclonal antibodies from sera prepared against an isolate from Mali or from Madagascar. In addition, a Triple-Antibody-Sandwich (TAS-ELISA) form of ELISA have been successfully applied using a set of monoclonal antibodies prepared against a virus isolate from Mali. Two major problems encountered in RYMV evaluation were overcome when using the adapted test with the appropriate dilution - the non-linear relationship between absorbance and virus concentration and the possible isolate specificity with the homologous serum - and a satisfactory dose-response relationship was obtained. The samples could tested as fresh material or after storage at - 80°C and could be ground either with a mortar and pestle or by mechanical grinding devices.

Controlled environmental conditions with the appropriate (high) temperature and (long and intense) light intensity were found to be critical for virus evaluation, in particular to discriminate between resistant and susceptible varieties. Finally, the stage of the host plant for inoculation and test was also found to be important. Accurate and quicker evaluation was obtained when plants were inoculated at an early stage (one week after germination) and tested one week after inoculation. Inoculation and tests after longer intervals or with insufficient light or temperature results in the blurring of the differences. By contrast, taking together the appropriate tests and conditions allow a quick and reliable estimate of the virus content which was successfully applied in our studies on resistance characterisation and search of molecular markers of resistance.

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PREMIER SYMPOSIUM INTERNATIONAL SUR LA MARBRURE DU RIZ (RYMV)
(September 18-22, 1995 / *18-22 septembre 1995*)

ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

THREE-DIMENSIONAL STRUCTURE ANALYSIS OF
RICE YELLOW MOTTLE VIRUS

N. Opalka#+, C.M. Fauquet#+, J. Johnson@, R.N. Beachy+*, M. Yeager*@
* TSRI Department of Cell Biology, The Scripps Research Institute, 10666
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Rice Yellow Mottle Virus (RYMV) is a single-stranded, positive-sense RNA icosahedral virus and is a member of the Sobemovirus group. Cryo-electron microscopy is a powerful method for determining the low resolution native structure of viruses. Images of frozen-hydrated RYMV have been recorded at 45,000 x using a Philips CM12 electron microscope equipped with a Gatan cold stage, and a preliminary 3-dimensional map has been derived using icosahedral image reconstruction techniques. The 30 A resolution map reveals that RYMV has a surface lattice with T=3 icosahedral symmetry. The closely packed capsid shell is centered at a radius of 144A and has a thickness of 30A. The structure of SBMV, a related Sobemovirus, has been solved at atomic resolution by X-ray crystallography [Celerino et al. (1980) Nature 286:33-39]. SBM has a diameter of 300A with a capsid thickness of 35A. The sequence homology of 46% between the capsid proteins and the comparable symmetry and dimensions for SBMV and RYMV suggest similarity in their 3-dimensional structures. Our goal is to complete the low resolution analysis by cryo-electron microscopy. In addition, microcrystals have been grown in preliminary trials that portend the feasibility of high resolution X-ray crystallography. In the future, recombinant DNA technology can be used to generate functionally important RYMV mutants which can be examined by cryo-electro microscopy. Structural changes at the atomic level can be understood by comparison with the high resolution x-ray structure.

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(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

EFFECT OF THREE ISOLATES OF RICE YELLOW MOTTLE VIRUS ON SOME ORYZA SPP. — A PRELIMINARY REPORT

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(1,2: Rice Research Station, Rokupr, PMB 736, Freetown, SIERRA LEONE, and 3: WARDA/ADRAO, 01 BP 2551, Bouake 01, COTE d'IVOIRE)

ABSTRACT

Six rice cultivars of two Oryza spp. comprising two susceptible O. sativa cultivars, IR 5 and CP 4; two O. glaberrima cultivars, TOG 5681 and TOG 7238 and two traditional, O. sativa landraces, Gbongoi and Moroberekan from Sierra Leone and Cote d'Ivoire were used in the test. These rices were inoculated with expressed sap of RYMV-infected rice plants in a phosphate buffer using finger - rub inoculation technique. The sources of the virus isolates were Coyah Town in Guinea, near Sierra Leone; Rokupr - where the Rice Research Station is located, and also near the border with Guinea and Blama in the southeast of Sierra Leone. These were maintained on the susceptible rice cultivar, CP 4 in plastic buckets at Rokupr. The experimental seeds were pre-germinated in moist petri dishes for 2 weeks and then transplanted in concrete/plastic pots and kept in a tropicalized Rossel tunnel screenhouse. They were inoculated with the virus 2 weeks after transplanting. Visual symptom rating was done fortnightly following inoculation with the virus up to the reproductive growth stage of rice using 0 - 9 standarlized scale range. Plant height and number of tillers per hill more also assessed. Grain yield was determined at maturity. The level of visual rating, percentage height reduction, tillering capacity and grain yield in comparison to the non-virus inoculated test plants significantly varied with the type of virus isolate used. However, the glaberrima cultivars, TOG 5681, TOG 7238 and the sativa landraces, Gbongoi and Moroberekan gave very low scores compared to the recent sativa cultivars, CP 4 and IR 5. On the contrary, there was a significant reduction in tillering capacity, plant growth and grain yield in treated plants. There were significant differences among the various RYMV isolates. On average the Rokupr isolate of RYMV was more aggressive than either the Guinea or Blama isolate.

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(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

CARACTERISATION BIOLOGIQUE ET SEROLOGIQUE D'ISOLATS DU VIRUS DE LA MARBRURE DU RIZ(RICE YELLOW MOTTLE VIRUS-RYMV) EN COTE D'IVOIRE

N'GUESSAN,K.P[1]., SY,A.A[1]., FARGETTE,D[2].[1] ADRAO/WARDA, Bouaké, Côte d'ivoire.
[2] LPRC/CIRAD-ORSTOM Montpellier, France.

La caractérisation biologique et sérologique du virus de la marbrure du riz a été réalisée, respectivement avec treize variétés de riz et par la méthode Elisa (Enzym linked immunosorbent assays), utilisant des anticorps monoclonaux dirigés contre un isolat RYMV de Madagascar.

Les variétés de riz ont été cultivées en condition semi-contrôlée et inoculées mécaniquement avec neuf isolats du virus de la marbrure du riz prélevés dans différentes localités de la Côte d'ivoire.
La chlorose (teinte foliaire) des plants initialement sains a été notée.

On note sur la base de leur profil de réaction que toutes les variétés reconnues sensibles au virus de la marbrure ont développé des symptômes caractéristiques de la maladie, quelque soit l'isolat choisi. Cependant, avec certaines variétés (ITA 212, TOX3211-14-1-2-1-2, Moroberekan (ADRAO), l'apparition des premiers symptômes, après l'inoculation est un processus lent. En effet pour ces trois variétés, les symptômes visuels sont pratiquement inexistants 14 jours après inoculation (JAI). Ils n'apparaitront qu'à partir du 28ème JAI, puis subissent une évolution rapide pour atteindre des valeurs d'intensité plus grande 42 JAI, 56 JAI et 70 JAI.

Dans l'ensemble, les isolats NIMZOU, ABATOU, GONDAL et FARBOC se sont montrés les plus agressifs vis à vis des variétés.

La réaction aux anticorps monoclonaux n'a pas permis de déceller une différence entre les neuf isolats testés. En effet tous les isolats ont réagi positivement aux deux monoclonaux anti-RYMV utilisés.

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

Assessment of biological, serological and molecular variability of a range of RYMV isolates from different geographical areas

Fargette[1] D, Pinel[1] A, Albar[1,4] L, Sadiky[1,2] R, N'Guessan[1] P, Frutos[2] R, Notteghem[3] J-L, Ghesquiere[4] A.

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There is no information on the variability of rice yellow mottle virus, although the virus is present all over Africa where rice is grown. Then, studies were conducted to identify the biological, serological and molecular variability of twelve isolates of rice yellow mottle from various geographical origins. Biological variability was assessed by testing the response (symptom evaluation and concentration estimates) of six of the twelve isolates against a range of varieties with contrasted features of resistance/susceptibility. Serological variability was evaluated by testing each isolate against the other eleven by double-diffusion tests (fusion, spurs...) with two sera prepared against isolates originated from Mali and Madagascar. Serological variability was further tested using a range of monoclonal antibodies prepared against an isolate from Mali. Molecular variability was assessed by comparing the sequence of the coat protein after reverse transcription and amplification by PCR.

The results obtained so far indicate that there are marked differences in virulence among RYMV isolates. In particular, one isolate from Burkina-Faso induced more severe symptoms, had a higher virus concentration in susceptible varieties and reached detectable levels of virus (assessed by ELISA) in varieties resistant to most isolates. This isolates does not have a specific serological pattern and was not associated to a particular area, as less severe isolates from Burkina-Faso were also identified.

Double-diffusion tests reveal that all the isolates were related, but that a high serological diversity among isolates prevailed. There is no apparent relationship between the serotype of the isolate and its geographical origin. Isolates from the same area could be quite different among each other and close to a isolate from a remote country. No variability was apparent with monoclonal antibodies, which suggest that these antibodies are directed against common epitopes. This property would be most useful in breeding programs where non isolate-specific evaluation of the virus content is required.

Comparisons of sequences of the coat protein gene included three isolates from Ivory Coast and one isolate from Mali. They indicate a percentage of nucleotide divergence ranging from 3 to 6.5%. There was no apparent relationship with the geographical origin or with the serological pattern, although this preliminary result remains to be confirmed with more sequences.

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(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

LES HOTES RELAIS DU RYMV AU BURKINA FASO

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BURKINA FASO

Le virus de la panachure jaune du Riz a été décrit par Bakker en 1970 au KENYA. Il appartient au groupe des Sobemovirus. Considéré pendant longtemps comme localisé exclusivement en Afrique de l'Est, il est aujourd'hui présent dans toutes les zones de production du Riz en Afrique. Les pertes de production qu'il occasionne varient de 25 à 100 %.

Les connaissances sur la biologie, moléculaire du RYMV ont considérablement progressé au cours des dernières années. Par contre, les données épidémiologiques restent fragmentaires et leur exploitation pour élaborer des méthodes de lutte laborieuse. L'une des informations épidémiologiques qui demandent à être approfondies concerne les hôtes réservoirs/relais du virus. En effet, quel que soit le mode de transmission du virus, la source d'inoculum est la condition sine qua non du déclenchement et de la propagation de la maladie.

Au Burkina Faso, une large prospection a été effectuée dans les principales zones de culture du riz pendant les mois de Mai et Juin afin d'identifier les sources d'inoculum du RYMV. Les Graminées pérennes et les repousses du riz ont été testées pour la présence du RYMV par la méthode ELISA. Oriz longistaminata a été trouvé infecté dans toutes les zones prospectées. Quant à O. Sativa, 10 à 30 % des repousses contenaient le RYMV. Si sur O. longistaminata des symptômes de marbrure ont pu être observés, il n'en a pas été de même pour O. Sativa où des repousses sans symptômes ont souvent donné des réponses positives en ELISA. Ces résultats indiquent que le riz pourrait constituer le principal hôte relais du RYMV.

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(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

Outbreak of Rice Yellow Mottle Virus disease in paddy rice in Bandama basin of Cote d'Ivoire and its epidemiological causes.

T.Tsuboi[1], A.Goto[1], B.Boua[2] and H.Kato[3]

1) JICA expert, Centre de formation a la mecanisation agricole de Grand-Lahou
2) Instructor, Centre de formation a la mecanisation agricole de Grand-Lahou
3) Former professor of Kobe University, Japan.

In five paddy area out of 14, Grand-Laou, Agboville, Tiassale, Oume and M'be, the outbreak of RYMV disease was found in survey on November 1994. At Oume where spring water is irrigated, about 5% diseased stands were observed in the former crop season and 100% stands were attacked by RYMV in about 0.2ha fields. At Tiassale, 100% stands were diseased after transplanting in the fields where about 50% of diseased ratoon was observed.

To analyze the epidemics, a biological method for identification was developed. Seedlings of rice on 4-6 leaf stage were dipped in water solution with crashed diseased plants(disease-sap), 1g/l for 10min.

i) After a sickle was dipped in disease-sap, 20 stands in row were cut by using this tool on harvesting time. Transmission of disease and appearance of diseased ratoon was proved.

ii) Farmers are used to cut roots before transplanting. The disease appeared when roots or leaves of seedlings were cut and dipped in disease-sap.

iii) When diseased ratoons were mixed with soil, outbreak of disease occurred. Farmers transplant seedlings immediately after plowing soil by a hoe "daba".

One of the control measures, the management of ratoons is considered to be important.

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OCCURRENCE, SCREENING TECHNIQUES AND IMPORTANTS FACTORS IN THE SPREAD AND CONTROL OF RICE YELLOW MOTLE VIRUS (RYMV) IN AFRICA

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ABSTRACT

The Rice Yellow Mottle Virus (RYMV) a sap transmissible Virus causing a mosaic disease on rice is one of the major constraints to economic production of rice in the African Region causing between 10 and 50% yield reduction.

The occurence of the disease has been reported in Kenya, Sierria Leone, Liberia, Ghana, Nigeria, Tanzania, Niger and Guinea. This paper considers screening methods, factors important in the speed of RYMV and methods used in its control in Africa.

Paper presented in the First International Symposium on RYMV WARDA, Bouake. September 18 - 22, 1995.

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METHODE D'INOCULATION POUR LE CRIBLAGE VARIETAL DE LA RESISTANCE DU RIZ (Oryza sativa L) A LA BIGARRURE JAUNE (RYMV)

Alphonse BOUET *, YOBOUE N'Guessan **, Michel VALES ***

* Phytopathologiste, IDESSA/DCV Bouaké Côte d'Ivoire
** Sélectionneur riz aquatique, IDESSA/DCV Bouaké Côte d'Ivoire
*** Sélectionneur riz d'altitude CIRAD-FOFIFA Antsirabé MADAGASCAR

La marbrure ou bigarrure jaune est actuellement le problème pathologique le plus préjudiciable au riz aquatique en CÔTE D'IVOIRE.

Pour contourner les incertitudes liées aux expérimentations en milieu réel, des méthodes et conditions de travail sont développées en milieu contrôlé, afin d'opérer des sélections plus efficace pour la résistance au RYMV.

Deux variétés MOROBEREKAN et BOUAKE 189 respectivement pluviale traditionnelle résistance et irriguée sensible au RYMV, sont inoculées en pots (5 cm de diamètre et 6 cm de hauteur) et en bacs (40 cm x 34cm) à cinq âges (21, 30, 45, 60 JAS). Les plantes inoculées sont soumises à trois conditions d'incubation.

Les choix du meilleur dispositif (pots/bac) et de l'âge optimum sont faits à partir de la notation du jaunissement et/ou la amrbrure des feuilles dix jours après l'inoculation.

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SCREENING FOR RESISTANCE TO RYMV

Alluri K. [1], Thottappilly G. [1], Sy A.A. [2], Singh B.N.[1], Akinsola E.A[1]. and Imoyera M.O. [1],

Screening for Rice Yellow Mottle Virus {RYMV} was carried out in screenhouses at the International Institute of Tropical Agriculture {IITA}, Nigeria. Plants in each entry were individually inoculated twice, at 14 days after transplanting (DAT) and a week later. Visual score for RYMV disease was taken every week upto five - six weeks. Data was also collected on plant height, tiller number, spikelet sterility, grain discoloration, and grain yield. Comparisons were made with uninoculated plants. In general, there was reduction in plant height, tiller number, and spikelet fertility leading to reduction in grain yield in inoculated plants.

From 1992 to 1994, 2,087 entries from various International Network for Genetic Evaluation of Rice in Africa {INGER-Africa} nurseries were screened. Among them, 102 entries scored 1 {resistant}, 429 scored 2 to 3 {moderately resistant}, 430 scored 4 to 6 {moderately susceptible}, and 1,126 had 7 to 9 scores {highly susceptible}. Screening of entries from various global INGER nurseries is in progress. A few *Oryza glaberrima* and *O. barthii* accessions from IITA Genetic Resources Unit have been identified as immune to RYMV. This has been confirmed through ELISA tests.

The resistant genotypes were largely of upland plant type. Among the resistant lowland rice type varieties were Chines Naputo from Mozambique and Mitsangana Raha Hijery from Madagascar, which are also well adapted to rainfed lowland ecology in those countries.

In search for new donors for RYMV resistance, lowland rice germplasm from Bihar, India were screened. Individual plant selections have been made in four resistant lines viz. JBT4, JBT68, JBT91 and JBT109. Likewise, some advanced breeding lines from India, IRRI and CIAT were also resistant to RYMV. The fact that these lines originated from outside of Africa, where RYMV does not prevail, shows that a more thorough search from worldwide germplasm through INGER should enable identification of genotypes as donors for further improvement and perhaps, some with desirable plant type and resistance to RYMV for immediate utilization..

[1]The International Institute of Tropical Agriculture {IITA}, Ibadan, Nigeria; [2]West Africa Rice Development Association {WARDA}, Bouake, Cote d'Ivoire.

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Résistance au champ au virus de la marbrure jaune du riz dans deux populations d'haploïdes doublés issus de croisement *indica/japonica*. Comparaison aux données sérologiques. Déterminisme génétique de la résistance.

AHMADI N.[1] & CISSE F.[2]

1: Sélectionneur CIRAD, IER, BP 183 Sikasso, Mali. 2: Sélectionneur IER, IER, BP 183 Sikasso, Mali.

Résumé : La résistance au virus de la marbrure jaune du riz (RYMV) est étudiée chez 122 lignées haploïdes doublées (HD) du croisement IR 64/AZUCENA ainsi que chez 56 lignées HD et 56 lignées obtenues par sélection "une graine par plante" (SSD) du croisement IRAT 177/APURA; chacun de ces croisements implique une variété *indica* sensible à la maladie (IR 64 et APURA) et une variété *japonica* tropicale assez résistante. L'évaluation du niveau de résistance est basée sur la comparaison au champ de plantes inoculées et plantes non inoculées.

Globalement, l'inoculation se traduit par une réduction du développement végétatif, un allongement du cycle semis-épiaison, une réduction du tallage fertile, une augmentation de la stérilité des épillets et, en définitive, par une forte réduction de la production. Les composantes du rendement, les plus touchées par l'inoculation, permettent la meilleure discrimination entre lignées sensibles et lignées résistantes. La liaison entre la résistance au champ et la résistance mesurée par les techniques sérologiques chez de jeunes plants cultivés en conditions contrôlées n'est pas toujours très bonne.

La distribution de la résistance est similaire au sein des populations de HD des deux croisements et entre les descendances HD et SSD du croisement IRAT 177/APURA. L'allure de ces distributions laisse supposer que les allèles récessifs jouent un rôle important dans le contrôle génétique de la résistance des variétés AZUCENA et IRAT 177. Des lignées de type *indica*, adaptées à la riziculture aquatique et dotées d'un bon niveau de résistance au RYMV sont identifiées.

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(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

Evaluation au champ de matériel végétal de diverses origines pour la résistance du riz (**Oryza sativa L.**) au virus de la bigarrure jaune (RYMV).

YOBOUE, N. (*) et VALES, M. (**).

(*) IDESSA/DCV 01 BP. 635 BOUAKE 01 - Côte d'Ivoire
(**) FOFIFA - CIRAD PB 341, 110 ANTSIRABE - MADAGASCAR

RESUME

Le virus de la bigarrure jaune du riz est actuellement une des principales contraintes au développement de la riziculture aquatique en Côte d'Ivoire. Avec le concours financier de PNUD/FAO, puis de l'ADRAO, environ 700 lignées et variétés fournies par INGER-Africa, ADRAO et le programme Riz Aquatique de l'IDESSA ont été testées pendant 3 années successives à Gagnoa, notre site-clé pour l'étude de cette maladie.

A partir d'observations réalisées au champ, pendant les différents stades phénologiques, puis une notation au stade maturité et enfin la production de paddy, deux principaux groupes de matériel végétal ont pu être constitués : d'une part 44 variétés particulièrement sensibles à la maladie dont Bouaké 189, BG 90-2 et IR5, déjà bien connues et d'autre part 55 lignées très prometteuses.

Le cheminement ayant conduit à ces résultats est discuté.

MOTS CLES : **Oryza sativa**, bigarrure jaune, criblage, variétés prometteuses.

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(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

Etudes préliminaires de la résistance du riz (**Oryza sativa L.**) au virus de la bigarrure jaune (RYMV).

YOBOUE, N. * et VALES, M. **

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RESUME

Le virus de la bigarrure jaune du riz qui cause d'importants dégâts en riziculture aquatique (maîtrise totale ou partielle de l'eau) fait l'objet de plusieurs actions de recherche pour des solutions génétiques.

Vingt descendances impliquant différents géniteurs ont été analysées après inoculation, dans un dispositif comprenant les témoins sensibles connus Bouaké 189 et BG 90-2.

Les résultats obtenus montrent que la technique d'inoculation appliquée est efficace et permet de choisir des ségrégants intéressants.

Cependant un certain nombre de points restent à élucider quant à la progression ou aux manifestations de la maladie sur les plantes infectées, et la lecture des symptômes visibles en fonction de l'âge des sujets.

MOTS CLES : Bigarrure jaune, **Oryza sativa**, résistance, ségrégations.

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

STUDIES ON THE INHERITANCE OF RESISTANCE TO RICE YELLOW MOTTLE VIRUS (RYMV) DISEASE IN LOWLAND RICE, USING GENERATION MEANS BY MODEL FITTING ANALYSIS (GMA)

Mr. M.S. Mansary. Rice Research Station, Rokupr PMB 736 Freetown Sierra Leone.

Hayman's generation means (by model fitting) analysis (GMA), in conjunction with Mendelian genetic analysis were employed to investigate the nature of the genetic control of Rice Yellow Mottle Virus (RYMV) disease resistance in five "indica" and one "japonica" rice varieties. The susceptible lowland variety ITA 212, was used as a female parent and crossed to each the remaining five varieties. Resistance to the disease was measured as visual foliar symptoms scores, based on a zero to nine scale (with 0 -3 being resistance; and 4 -9, being susceptible), and plant height and tiller number reductions obtained as the difference between diseased and healthy plants. Eight generations involving P1, P2, F1, RF1, F2, BCP1, BCP2 in a randomized complete bolck design with three replicates were employed to investigate the nature of genetic control.

The generation mean analysis revealed that dominance and epistatic genetic effects were all in the inheritance of resistance to RYMV disease. However the major portion of the genetic variation was accounted for by the additive genetic affects in all the cases except in cross 2 (i.e ITA 212 x CT 19) where dominance genetic effect were more important. The non-allelic interactions were observed in respect of all the characters and the analysis detected mainly duplicate epistatic interactions in all the crosses except in cross 1 (i.e ITA 212 x TOX 3233-31-6-2-1-2) which was complementary epistatic. Additive genetic variation appeared to be sufficient for the improvement of resistance to RYMV disease by conventional breedings methods.

The best indices od tolerance to RYMV appeared to be the foliar symptoms scores or plant height and tiller number reductions. The F2 distribution in all the crosses showed that RYMV disease resistance was conditioned by a few genes. Two recessive genes conditioned resistance in each of the varieties TOX 3233-31-6-2-1-2, CT 19,and ITA 235; two codominant genes controlled resistance in the vaieties TOS 3554 while LAC 23 could not be fitted into any genetic model with respect to RYMV resistance.

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FIRST INTERNATIONAL SYMPOSIUM ON THE RICE YELLOW MOTTLE VIRUS (RYMV)
PREMIER SYMPOSIUM INTERNATIONAL SUR LA MARBRURE DU RIZ (RYMV)
(September 18-22, 1995 / *18-22 septembre 1995*)

ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

STUDIES ON THE INHERITANCE OF RESISTANCE TO RICE YELLOW MOTTLE VIRUS (RYMV) DISEASE IN LOWLAND RICE USING HAYMAN'S FULL DIALLEL CROSS ANALYSIS METHOD

Mr. Mohamed S. Mansary. Rice Research Station Rokupr, Sierra Leone.

Inheritance of resistance to rice yellow mottle virus (RYMV) disease was studied in a diallel cross of six varieties. Four of the varieties were resistant and one was highly susceptible. Resistance to the disease was measured as visual foliar symptoms scores based on a zero to nine scale (with zero to three being resistant and four and above as susceptible) and correlated to the mature plant character; tiller number; plant height and number of infected leaves per plant. Diallel analysis, as proposed by Hayman (1954, 1957), involving parents, F1s and reciprocal F1s in a randomized complete block design with three replicates, was employed to investigate the nature of genetic control.

Highly significant difference among genotypes were found for resistance to RYMV and mature plant characters. The diallel analysis of variance for additive dominance model for foliar symptoms showed significant additive (a) genetic and dominance (non-genetic) effects. The estimates of genetic parameters confirmed the additive dominance model with additive gene action being significant for all of the characters studied; and appear to be more important than the dominance components. From the Wr.Vr graphic regression anlysis, the presence of an overall partial dominance was indicated for all characters. The variety CT 19 was indicated to posses excess recessive genes with positive effects conditioning resistance to RYMV where as TOs 3554 included excess dominant genes conditioning the inheritance of resistance to RYMV and other mature plant characters. Transgressive segregates were indicated for foliar symptoms score in varieties ITA 235, CT and TOs 3554. Heritability values were very high and estimated to be 67.7, 91.6, 48.1, 59.0 and 31.4 percent respectively for the first and second foliar symptom scores, tiller number, plant height and number of infected leaves per plant.

It was concluded that using the varieties ITA 235, CT 19 and TOs 3554, and early generation selection for resistance to RYMV disease was worthwhile.

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THE INHERITANCE OF TOLERANCE TO RICE YELLOW MOTTLE VIRUS (RYMV) IN RICE (ORYZA SATIVA)[1]

A.S. Kumwenda[2], T. M. Masajo[3], W.E. Peat[4] and K Alluri[5]

Rice yellow mottle virus (RYMV), the only known virus of African origin is known to occur in several Western, Eastern Central and Southern African countries, and of late it has been known to infect both African rice landraces and introduced lowland cultivars. Because of the threat it poses to rice production in Africa, more knowledge on the genetics of resistance to the disease is required a study to determine the inheritance of tolerance to RYMV was therefore, carried out at IITA, Ibadan, Nigeria from 1983 to 1986.

Two tolerant parents (ITA 235 and Lac 23) were, respectively, crossed to 2 susceptible varieties (ITA 212 AND IR2042 - 178 -1) to produce F_1, F_2 and F_3 populations. The F_2 populations in 1985 and F_3 families in 1986 together with the F_1 and parents were seeded, transplanted in a randomised block design in a split plant layout, inoculated with an inoculum prepared from fresh infected leaves, and visually scored for the severity of disease symptoms at 30-51 days after inoculation.

There was adequate variability of disease reaction among F_2 and F_3 generations to select for the desirable tolerant plant phenotypes. Based on Chi-square test, the ratio of tolerant to susceptible F_2 individual and F_3 families when fitted to simple Mendelian genetics strongly suggested that 1-2 recessive pairs of alleles in ITA 235 and 3 dominant pairs in Lac 23 conditioned tolerance to disease. Because the appearance of disease symptoms changed with time it is proposed selection for tolerance to RYMV should be restricted to the reproductive growth phase. At this growth stage, the leaf symptom together with relative reductions in plant height of infected individuals should be used to differentiate the tolerant from the susceptible.

[1] Part of the Ph.D thesis submitted to the University of London, Wye College, England, May 1988.

[2] Senior Agricultural Research Officer, Lifuwu Rice Research Station, P.O. Box 102, Salima, Malawi, 1988.

[3] Plant Breeder, IITA, PMB, Ibadan, Nigeria (1988)

[4] Lecturer, Wye College, University of London, Kent TN 25 5AH, England. 1988

[5] Principal Scientist, IRRI Liaison Office in Africa, IITA, Ibadan, Nigeria. (1995).

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(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

INHERITANCE OF RESISTANCE TO RICE YELLOW MOTTLE VIRUS (RYMV) IN *O. glaberrima* STEUD

C.P. Paul, N.Q. Ng and T.A.O. Ladeinde

The inheritance to RYMV was studied in *Oryza glaberrima* cultivars viz. at IITA, Ibadan, Nigeria. This study was undertaken to identify genes for resistance. The crosses were made between three resistant cultivars viz. Tog 7291, Tog 5674 and Tog 7177, and one susceptible cultivar viz. Tog 7258. The disease reactions of F_1, F_2 and F_3 lines were tested on the basis of visual symptoms under artificial inoculation in the screenhouse. The genetic analysis of the crosses revealed that RYMV resistance was conferred by two recessive genes in each of the resistant parents. However, the variation in gene action for resistance was observed over time.

Keywords : *Oryza glaberrima*, rice yellow mottle virus, recessive, resistance, genetic analysis.

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

Analyse diallèle de la résistance au virus de la marbrure jaune du riz, *Oryza sativa L.*

AHMADI N.[1] & SINGH B.N.[2]

1: Sélectionneur CIRAD, IER, BP 183 Sikasso, Mali.

2: Sélectionneur ADRAO, IITA, Oyo Road, PMB 5320, Ibadan, Nigéria.

Résumé : Le déterminisme génétique de la résistance au virus de la marbrure jaune du riz (RYMV) est étudié dans un dispositif de croisement diallèle 6 x 6 complet et dans des lignées HD et SSD issues de l'un de ces croisements. Parmi les six variétés utilisées, trois (AZUCENA, IRAT 177 et ITA 235), de type *japonica* tropical, sont assez résistantes et trois autres (APURA, BG 90.2 et IM 16), de type *indica*, sont sensibles à la maladie. Le critère de résistance analysé est la coloration foliaire de plantes inoculées.

L'estimation des paramètres génétiques selon les méthodes de Griffing et de Hayman fait état d'un déterminisme génétique quasi-exclusivement additif. L'héritabilité au sens strict est de 0,94. La dominance est partielle, faible et bidirectionnelle ; des gènes dominants à effets positifs et négatifs coexistent dans les génotypes parentaux. La variété IRAT 177 semble concentrer davantage d'allèles récessifs que les deux autres variétés pluviales résistantes. L'analyse de la distribution de la résistance chez des lignées HD et SSD du croisement IRAT 177/ APURA confirme la prédominance d'allèles récessifs dans le contrôle de la résistance d'IRAT 177.

C'est à partir des croisements impliquant AZUCENA et ITA 235 d'une part et APURA et IM 16 d'autre part que l'on pourra obtenir le plus facilement, des lignées de type *indica* pourvues de résistance au virus de la marbrure jaune du riz.

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

Analyse du Déterminisme génétique de la résistance du riz (**Oryza sativa L.**) au virus RYMV : Comportement de 18 descendances impliquant différents types de géniteurs.

YOBOUE, N. (*) ; SY, A.A. (**) ; BOUET, A. (*).

(*) IDESSA/DCV 01 BP. 635 BOUAKE - Côte d'Ivoire.

(**) ADRAO, Station de M'BE, 01 BP. 2551 BOUAKE - Côte d'Ivoire.

La marbrure du riz due au RYMV en Afrique de l'Ouest devient de plus en plus préoccupante. En effet elle est maintenant un facteur limitant majeur pour le développement de la riziculture irriguée et de bas-fond.

Une solution prometteuse est la gestion génétique exploitant les sources de résistance disponibles, tant au niveau des **indica** que des **japonica.**

Dans cette optique, 18 descendances de croisements impliquant des géniteurs appartenant à ces différents groupes sont étudiés par inoculation artificielle suivie d'observations aux différents stades phénologiques et de tests sérologiques pour apprécier le comportement des différents génotypes.

La valeur des descendances pour la riziculture aquatique est discutée.

Mots clés : **Oryza sativa**, RYMV, résistance, **indica, japonica.**

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

An Infectious Full-Length cDNA Clone of Rice Yellow Mottle Virus (RYMV); a Molecular Tool for Engineering Virus Resistance and Developing a Viral Expression Vector.

Brugidou*, C., Bonneau*, C., Ngon A Yassi**, M., Holt***, C., Beachy*/***, R.N., Fauquet*, C.M.

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***The Scripps Research Institute, Department of Cell Biology, Division of Plant Biology, MRC7, 10666 North Torrey Pines Road, La Jolla, CA 92037.

Rice Yellow Mottle Virus (RYMV) causes a severe rice disease in Africa. ILTAB initiated a RYMV genetic engineering resistance project as well as basic research about the mechanisms of insect transmission, particle uncoating, virus replication, viral gene expression, virus movement within the plant and symptom production in order to better know this devastating virus and better define strategies to protect rice.

In order to achieve these goals, the genome of RYMV has been characterized and an infectious cDNA clone has been constructed. The genome is a single-stranded positive sense RNA of 4,550 nucleotides (nt) that is not polyadenylated. The genomic RNA consists of four open reading frames (ORFs). ORF1 (nt. 80 to 553) encodes a protein called P1 of 17.8 kDa and presumed to be the movement protein of the virus. ORF2 (nt. 608 to 3607) encodes for a polyprotein of 110 kDa and contains a putative Vpg, helicase, protease and polymerase. ORF3 (nt. 2092 to 2467), encodes a small protein of 13.7 kDa of an unknown function. The ORF4 (nt. 3447 to 4166) codes for the coat protein (CP) of 26 kDa.

A full-lenght cloned cDNA of RYMV was synthesized and placed adjacent to a bacteriophage T7 RNA polymerase promoter. A representative clone (RYMV-FL5), causes a disease phenotypically identical to that produced by viral RNA, except that symptoms are slower to appear (about 1 week of delay). Visualization of RYMV-FL5 progeny virus by electron microscopy confirmed that typical RYMV particles were produced during infection. Frameshift and deletion mutations introduced into the CP cistron demonstrated that the CP is dispensable for RNA replication (rice protoplast experiments), but it is indispensable for a long-distance movement (plant experiments). We are presently determining if the CP mutants are capable of moving into adjacent cells. To achieve this objective, we have constructed a clone ΔCP-RYMV-FL5 that contains a polylinker to insert reporter genes such as GUS and GFP, or to study host specificity and symptom severity by insertion of different CP sequences from different strains of RYMV or other sobemoviruses. Because we believe that P1 is the cell-to-cell protein, we are attempting to determine the function of this protein in protoplasts (rice and tobacco) and in rice plants. For that purpose we have constructed a ΔMP-RYMV-FL5 that contains an unique site SphI, which is used to clone reporter genes to study the function of the protein, host specificity, virulence, etc... We have also constructed a chimeric vector with a ΔMP-TMV-P1 clone that contains the RYMV ORF1 in place of the TMV movement protein to determine the cell-to-cell movement of RYMV P1 in tobacco and rice plants. For antibody production, a P1 cDNA fragment has been expressed as a fusion protein in *Escherichia coli*, and injected in rabbits to obtain a P1-antibody.

The first study of the biological cycle of the viruses in infected rice has been carried out in growth chamber (controlled conditions) by western-blot analysis, Northern-blot hybridization and electron microscopy. Preliminary results showed that the CP is detectable by western-blot 5 days after inoculation (0.2 mg/g of leaves) to reach a maximum 20 days later (1.3 mg/g). After 5 days the amount of CP decreases in the leaves (around 50% in 7 days). Five days after inoculation we observe the genomic RNA (4.4 kb) and a sub-genomic RNA of about 3.4 kb. A second sub-genomic RNA of about 1 kb is detected about 7 days after inoculation. The correlation of the appearance of this sub-genomic RNA with the increase of CP and its size suggests that the 1 kb RNA is the coat protein sub-genomic RNA. Electron-mircroscopy confirmed that: virus particles are visible within vascular tissues 2 weeks after inoculation; 3 weeks after inoculation some vascular cells are full of particles; and virus crystals can be observed. This study and studies on the physiology of infection will be confirmed by immunolocalization studies using antibodies raised against CP, P1, the polymerase and the protease (in progress).

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

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BREEDING FOR RESISTANCE TO RICE YELLOW MOTTLE VIRUS : EXPERIENCE AT IITA AND IN MADAGASCAR

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Abstract

Breeding for resistance to rice yellow mottle virus was initiated at IITA in response to increasing incidence of the disease and the possibility that it could become a major constraint to increasing rice production in sub-Saharan Africa. Among the resistant parents used in crosses were the upland varieties ITA235, LAC23, and Moroberekan and the lowland variety CT19. Crosses with resistant glaberrima accessions were also made but were not pursued beyond BC1. Following the conventional pedigree method and simultaneous screening for resistance, selections with improved plant type and with resistance to RYMV were available by early 1987. At the closure of the Rice Research Program at IITA in 1990 about 80 selections had been developed. Frequency of agronomically desirable segregants was low among progenies of crosses involving LAC23 and Moroberekan. Most of the promising lines carry the resistance from CT19 and ITA235.

First identified in Madagascar in 1989, RYMV has become a major disease causing serious yield losses in the North West region and is spreading in the country's Mid-East. The North West and Mid-East are the main surplus producing regions supplying rice to the rest of Madagascar. Over 300 varieties both local and introduced have been screened for resistance. All local varieties tested including those grown by farmers were suceptible. A variety from Brazil and several improved lines from IITA introduced to Madagascar through INGER-Africa nursery were found and confirmed resistant. Based on agronomic performance, 5 of the lines from IITA with resistance from CT19 and ITA235 were selected. Seeds were multiplied and distributed for on-farm testing throughout the RYMV affected areas of the North West. Current thrust is to incorporate RYMV resistance to local breeding lines. Of special importance is combining resistance to the virus with tolerance to cold needed in varieties for other regions of Madagascar. The program continues its search for resistance among sativa varieties and is using the perennial wild rice *Oryza longistaminata* to further diversify sources of resistance.

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre* ; Authors/*Auteurs* ; Address/*Adresse*)

Stratégie de sélection pour l'amélioration de la résistance au virus de la bigarrure jaune du riz à l'IDESSA en Côte d'Ivoire

Michel VALES(*), N'Guessan YOBOUE(**) et Alphonse BOUET(**).

(*)FO.FI.FA.-CIRAD Programme Riz d'Altitude, BP 341, 110 Antsirabe Madagascar.
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Résumé

Avec le support financier de l'ADRAO, l'IDESSA développe un programme d'amélioration de la résistance au virus de la bigarrure jaune du riz irrigué.

La résistance au virus provient des riz pluviaux, notamment de variétés traditionnelles. Des croisements deux voies sont exploités. Mais pour ne pas trop s'éloigner du type de plante irriguée, deux autres méthodes sont mises en oeuvre : les rétrocroisements et la sélection récurrente.

Les parents récurrents des rétrocroisements sont les variétés irriguées. La méthode d'inoculation en bacs de culture permet, au stade plantule, de distinguer sans équivoque les plantes F2 résistantes. Tous les géniteurs pluviaux utilisés, en particulier IDSA 85, semblent de bons donneurs de résistance, à l'exception d'IDSA 6.

La population de base utilisée pour la sélection récurrente est IDSA-IRAT 1. Elle possède le gène de stérilité mâle récessif ms. IDSA-IRAT 1 est issue de deux cycles de sélection pour le format du grain de la population CNA-IRAT 5. Vingt variétés fondatrices pluviales et irriguées, ainsi que huit cytoplasmes ont été ajoutés pour former la population IDSA-IRAT 10.

La précocité et le format du grain sont deux autres caractères particulièrement suivis dans ce programme.

Les techniques utilisées, les premiers résultats, ainsi que les perspectives de ce programme sont présentés.

Mots clef : bigarrure jaune, virus, *Oryza sativa*, résistance, rétrocroisement, sélection récurrente.

Summary **Breeding strategy for resistance to rice yellow mottle virus at IDESSA in Ivory Coast.**
M. J. Vales, N'G. Yoboue and A. Bouet.

IDESSA is developing a breeding program for resistance to rice yellow mottle virus with a WARDA financial support.

The resistance to the virus comes from upland rice, particularly traditional varieties. Two ways crosses are exploited. But to maintain the irrigated plant type, two other methods are used : back-crosses and recurrent selection.

Irrigated varieties are used as recurrent parents in back-crosses. Inoculation of young plants cultivated in batches allows to clearly distinguish between resistant and susceptible F2 plants. All the upland genitors, particularly IDSA 85, seem to be good resistance donors, except IDSA 6.

The basic recurrent population used is IDSA-IRAT 1. It has the recessive male sterility gene ms. IDSA-IRAT 1 comes from the upland rice population CNA-IRAT 5 after two screening for seed format. Twenty upland and irrigated varieties and height cytoplasms are added to form the IDSA-IRAT 10 population.

Selection for precocity and grain shape also carried out in this program.

The methods and primary results are presented.

Key words : Rice Yellow Mottle Virus, *Oryza sativa*, resistance, back-cross, recurrent selection.

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Amélioration variétale pour la résistance au virus de la marbrure jaune du riz. Stratégie de sélection IER/CIRAD au Mali.

AHMADI N.[1] & CISSE F.[2]

1: Sélectionneur CIRAD, IER, BP 183 Sikasso, Mali. 2: Sélectionneur IER, IER, BP 183 Sikasso, Mali.

Résumé : Les travaux de sélection pour la résistance au virus de la marbrure jaune du riz (RYMV) conduits par le CIRAD et l'IER au Mali s'inscrivent dans un programme de création variétale pour la riziculture inondée qui a pour stratégie l'exploitation des complémentarités entre les groupes *indica* et *japonica* tropical. Deux schémas de sélection sont mis en oeuvre: la sélection généalogique et la sélection récurrente. L'évaluation du niveau de résistance au RYMV est réalisée au champ par la comparaison du développement végétatif, de la longueur du cycle et de la production de grains de plantes inoculées et plantes non inoculées.

Le schéma de sélection généalogique est appliqué à une centaine de croisements simples *indica/ japonica*. Le criblage pour résistance au RYMV intervient en F4 et F6. Des lignées fixées adaptées à la riziculture inondée et dotées d'un bon niveau de résistance au RYMV pourront être proposées à l'évaluation multilocale dès 1996.

Pour la sélection récurrente, deux populations mixtes *indica/japonica* sont créées par l'utilisation de la stérilité mâle génique. L'amélioration de la résistance au RYMV de ces populations est entreprise par sélection sur familles S1. D'autres critères importants en riziculture inondée, dont la résistance à la submersion au stade jeune, sont aussi pris en compte par l'application d'une sélection massale. La création de lignées fixées associée à ce schéma de sélection est mise en oeuvre dès la fin du premier cycle de sélection récurrente.

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ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

BREEDING FOR RYMV RESISTANCE

B.N. Singh

WARDA Lowland Rice Breeder, IITA Ibadan, Nigeria.

RYMV has become a major problem causing severe yield losses in irrigated lowlands of Niger, Côte d'Ivoire and Mali. It is becoming a potential problem in Burkina Faso, Ghana, Nigeria and Sierra Leone. Screening for RYMV resistance started at IITA , Ibadan in 1978 and crosses were made in 1982 with Moroberekan, 6850, and Tom 1-3 as donors. Subsequently, CT 19, OS 6, and ITA 235 were also used as donors. Most of these donors are moderately resistant and none were found immune. Except CT 19, other donors are upland tropical japonicas.

For developing varieties for irrigated lowlands, crosses were made with semi-dwarfs and the segregating populations from F_2 generation and onwards are artificially inoculated in the screenhouse. Individual resistant plants are selected between and within the lines as per pedigree method of breeding. Evaluation of improved lines with RYMV resistance begun in 1987. Amongst the various donors, OS 6 and CT 19 have been able to provide recombinant lines with high yield potential similar to semi-dwarf cultivars. The fixed lines are screened every year to select those with stable resistance. The resistant plants are bulked for further multiplication. Efforts are also underway to select lines with partial resistance, early maturity, and blast resistance.

Fixed lines are evaluated in regional observational nursery and replicated yield trials. Elite lines from replicated trials are further tested in in-country multi-locational trials and on-farm trials. WITA 7 (TOX 3440-171-1-1-1-1) and WITA 8 (TOX 3440-176-1-2-1) were identified as high yielding lines with RYMV resistance in Côte d'Ivoire. Other elite lines are TOX 3058-1-1 and TOX 3052-46-E2-2-2-4-1. Crosses are now being made with improved donors with semi-dwarf plant type for resistance to RYMV, Leaf blast and other biotic and abiotic stresses.

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(September 18-22, 1995 / *18-22 septembre 1995*)

ABSTRACT OF RESEARCH ACTIVITY / *RESUME D'ACTIVITE DE RECHERCHE*

(Title/*Titre*; Authors/*Auteurs*; Address/*Adresse*)

OCCURENCE OF RICE YELLOW MOTTLE VIRUS IN SIERRA LEONE AND BREEDING FOR RESISTANCE

S.N. FOMBA, S.S. MONDE, M.S. MANSARAY,
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ABSTRACT

Rice Yellow Mottle Virus (RYMV), a potentially destructive disease of rice occurs in all rice ecosystems in Sierra Leone but is especially conspicuous in inland valley swamps. The virus affects the rice plant at all growth stages but more so at the seedling stage. Several resistant/-tolerant cultivars and advanced breeding lines have been identified at Rokupr in the past using the finger-rub seedling inoculation method. Most of these resistant/tolerant rice accessions are traditional upland rice cultivars which often also invariably possess partial resistance to the rice blast disease (*Pyricularia grisea*), the most important rice disease in the country. Current research efforts on the problem at Rokupr aims at developing varieties resistant to both RYMV and blast, among other major diseases in collaboration with WARDA and INGER-Africa. Progress made in this direction in recent years is reported.

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Novel approaches to natural and genetically engineered resistance in transgenic plants.

David C. Baulcombe, The Sainsbury Laboratory, Norwich Research Park, Colney Lane, Norwich , Norfolk, NR4 7UH, U.K.

Natural resistance
To identify DNA markers that are closely linked to genes for disease resistance it is necessary to inspect many DNA markers in large populations of progeny of crosses between resistant and susceptible plants. In an analysis of resistance to potato virus X conferred by the Rx locus we have inspected 80,000 DNA markers in a segregating population of 2700 plants. The closest markers flank the gene and are physically and genetically close to the gene.
Neither of the markers is more than 0.1cM or 50kbp away from the gene.

The procedures used in this analysis identify amplified fragment length polymorphic (AFLP) DNA markers and are based on the polymerase chain reaction. The methodology can be adapted to many plants, including rice, and would be ideally suited to the identification of DNA markers linked to genes conferring resistance to rice yellow mottle virus. These markers would be useful in breeding programmes and as first steps in the isolation of natural resistance genes to RYMV.

Transgenic resistance
To engineer transgenic virus resistance in plants it is necessary only to have sequence homology of the transgene and the inoculated virus. The transgene need not encode essential proteins or indeed any protein at all: resistance is conferred even by mutant transgenes that are not translatable.

The mechanism of this homology dependent resistance is not fully understood except that it is known to be related to a mechanism of homology dependent gene silencing which is observed frequently in transgenic plants. It is currently thought that the central process in plants displaying homology dependent gene silencing and resistance is a sequence specific RNA degradation mechanism. This mechanism suppresses accumulation of both virus (to cause resistance) and transgene RNA to (cause gene silencing).

The best characterised examples of homology dependent resistance are with potyviruses and potexviruses. However there is evidence for this type of resistance against other virus groups and, based on what is known about the mechanism, it is thought likely that it will also operate against RYMV in transgenic rice. The advantage of homology dependent resistance over coat protein or movement protein mediated resistance is that it can completely suppress accumulation of the target virus in the inoculated leaf. This type of resistance does not require expression of functional virus proteins in the transgenic plant and therefore may be the method of choice for protection of plants against virus disease on grounds of effectiveness and environmental safety.

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Genetically engineered resistance to rice yellow mottle virus.

Yvonne M. Pinto, The Sainsbury Laboratory, Norwich Research Park, Colney Lane, Norwich, Norfolk, NR4 7UH, U.K.

Full-length fragments of RYMV-N generated by RT-PCR were cloned into pGEM and subcloned into pUC19 so that only one T7 promoter abutted the viral sequence. *In vitro* RNA transcripts generated from linearized cDNA clones were synthesized with T7 RNA polymerase and were capped. Transcripts (pUC69, pUC610) when inoculated onto rice plants at the 4 leaf stage produced symptoms characteristic of RYMV infection 3-4 days later than those obtained with wildtype RNA inoculated plants. Plants also accumulated virus in inoculated and systemic leaves as shown by northern analysis.

One clone (pUC 610) was sequenced using a PCR based primer-walking strategy, each strand was sequenced four times in each direction. The genome of RYMV-N was 4451 nucleotides long with four open reading frames in the positive orientation. The genome is compact with only 9.4% untranslated. The first open reading frame (ORF) is 17.8 kDa which is very similar to RYMV-IC (Ngon A Yassi *et al.*, 1994) but divergent from other sobemoviral ORF 1 proteins. The protein may be extended to 19.5 kDa by termination at a downstream termination codon. Database searching revealed no identity with other sequences, however this protein may be involved together with the capsid protein (ORF 4) in viral movement. The second ORF is probably translated internally in several sobemoviruses, SBMV, CfMV and RYMV isolates. The ORF 2 protein is 110 kDa and contains highly conserved motifs for a serine protease and an RNA-dependent RNA polymerase common to other sobemoviruses and luteoviruses. ORF 3 is nested within ORF 2 IS 10 kDa and is very similar with other ORF 3 sobemoviral proteins indicating functionality. The translation of ORF 3 is not clear but may be by means of a-1 ribosomal frameshift as in CfMV (MäKinen *et al* .,1995). The capsid protein (ORF 4), is 21 kDa and is highly similar to other sobemoviral ORF 4 proteins but lacks the arm and R domain of the other viruses. The significance of this finding is discussed.

Two strains of RYMV from which infectious RNA can be produced *in vitro* are now available (RYMV-IC, Brugidou *et al.*, 1995). They provide the opportunity for genetically engineered resistance to virus disease by transgenic expression of parts of the virus genome. Recent work in the Sainsbury Laboratory has shown that virus resistance is due to an RNA mediated mechanism in which the target viral RNA is specifically degraded. The attributes of this homology-dependent resistance are that the gene silencing mechanism is active against the virus, the transgene and also against endogenous transgenes. The silencing is a sequence specific RNA degradation mechanism but is only operative against closely related sequences. Sequence comparisons between RYMV isolates and other sobemoviruses have already identified conserved regions of the genome which are suitable for transgene construction and since RYMV-IC and RYMV-N are 93.4% similar at the nucleotide level, transgenes constructed are expected to be effective against a range of RYMV isolates.

Sequence information from these two isolates has also identified conserved regions of the genome which can be used as PCR primers to survey the sequence variation in field isolates of RYMV. A survey of strains of RYMV collected from different locations in Africa will enable effective appraisal of the degree of sequence variation present and will allow the sequence elements of the different strains to be combined into a single transgene allowing comprehensive resistance to RYMV.

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RFLP AND RAPD MAPPING OF RYMV RESISTANCE USING DH POPULATIONS

Albar L.[1], *Ghesquière A*[1], *Fargette D*[2], *Notteghem J-L*,[3]

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Our studies aim at characterising the genetic basis for Rice Yellow Mottle Virus resistance and at mapping resistance genes in rice. They are based on the analysis of two doubled-haploid (DH) populations, derived from crosses between a susceptible *indica* variety and resistant parent : IR 64 x Azucena and IRAT 177 x Apura.

The resistance level of 77 DH lines of IR 64 x Azucena cross and 46 lines of IRAT 177 x Apura cross was estimated using a double antibody sandwich ELISA test. Plants were grown in greenhouse. They were inoculated 2 weeks after sowing and resistance was evaluated 2 weeks after inoculation.

As core RFLP maps were available on these crosses, two complementary methods were used to find resistance markers:

1) QTL, analysis and ANOVA using OD values obtained with ELISA as quantitative trait, followed by a survey of additional mapped RFLP probes to confirm the localization of resistance:

2) Specific mapping of resistance by Bulked Segregant Analysis based on the comparison of RAPD polymorphism of DNA pools of susceptible and resistant lines.

The distribution of resistance among DH lines showed a bimodal pattern, suggesting that a major resistance is acting in these two progenies. A single significant QTL, was detected on chromosome 12, at same place for the two populations. For the cross IR 64 x Azucena, this QTL, is close to the RFLP markers RG341 and RG 869. Seven to ten highly resistant and highly susceptible lines were selected on basis of ELISA evaluations to constitute DNA bulks. Parents were first screened with 300 primers and the 100 primers polymorphic between the parents were tested on the bulks. One RAPD band is linked to RYMV resistance in each population. The RAPD primer 010 was checked on the complete IR x Azucena progeny. The 010-800pb band maps close to RG 341 (< 3 cM) and confirms QTL, analysis.

As major resistance sources are found in upland rice varieties a common genetic basis of resistance is supposed to exist with respect to *indica/japonica* differenciation. This hypothesis is supported by the RFLP structure of chromosome 12 where RFLP markers RG 341 and RG 869 belong to a segment monomorphic in most of the resistant varieties. We plan to confirm this localization in integrating the two complete progenies (180 lines for IR 64 x Azucena and 77 lines for IRAT 177 x Apura) for resistance evaluation and saturation of the target segment with additional RFLP, RAPD and STS markers.

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Towards Rice Transgenic Plants Expressing the RYMV Coat Protein Gene

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** The Scripps Research Institute, Department of Cell Biology, Division of Plant Biology, MRC7 10666 North Torrey Pines Road, La Jolla, CA 92037.

Rice transformation with chimeric constructs comprising the coat protein gene of RYMV and driven by the CaMV 35 S promoter or the Actin promoter from rice were carried out several months ago. To date, unfortunately, no transgenic plants have been produced and most of the bombarded Taipei 309 embryogenic calli cells died during the process of regeneration. Similar constructs were used to transform tobacco and were also unsuccessful. A possible explanation of this failure is the toxicity of the coat protein which contains from aa 3 to aa 22, a putative nuclear targeted signal (NTS).

Based upon these results, we have recently developed new experiments in the hope of obtaining coat protein mediated resistance against RYMV. For rice transformation, four constructs containing the sequence of the coat protein were made. The constructs differ from each other by the presence or absence of the initiation codon (ATG), by the mutation of ATG to AAG in order to obtain a mRNA without a protein product, by deleting the NTS sequence or by the orientation of the coding sequence in the vector. Therefore the following CP chimeric genes are: CP (+) sense orientation; CP (-) sense orientation; CP ΔNTS (3 aa to 22 aa deleted); CP mRNA. These genes have been inserted in a vector and used to transform rice embryogenic calli. As we demonstrated previously that the p35S and the pActin promoters were not very efficient for express in transgenic rice, the genes of the new constructs are driven by the maize ubiquitin promoter (pUbi) containing the first intron of the gene. All the genes were synthesized by PCR and inserted in the *Bam*HI site of the plasmid vector pAHC17 (Ubiquitin promoter and NOS terminator cassette). The sequences of all the CP cDNA above have been checked and no mutations were revealed.

Co-transformation of embryogenic rice calli with the CP plasmids and the plasmid pMON 410 carrying the *hph* gene were performed. The variety of japonica rice Taipei 309 embryogenic calli selected for their high potential of regeneration have been bombarded for transformation with the constructs. At this time the calli are growing and the rice Hyg' plantlets regenerated will be checked for integration of both the hygromycin gene and the pUbi-NOS cassette carrying the CP gene and for plant fertility. We will look for the number of integrated copies, the accumulation of the coat protein and/or RNA and the screening of the plants against RYMV. An update of the results will be presented at this meeting. As soon as the transgenic plants are selected for their resistance against RYMV, the rice variety BG 90-2 (widely used in west Africa and highly susceptible to RYMV) will be transformed for the same purpose with the appropriate construct.

In order to better understand the behavior of the virus in infected cells and the function of the different parts of the CP, we initiate assembly/disassembly and mutation experiments to prove the existence of the NTS. For that purpose the CP cDNA fragments have been expressed as a fusion protein in *Escherichia coli* with the pTrcHisB vector and purified with the Xpress system (Invitrogen Corporation). This set of fusion protein constructs will be used within the putative sequence of the origin of assembly (homologous to the origin of assembly of Southern bean mosaic virus (SBMV), for *in vitro* encapsidation experiments. Transfection of rice protoplasts using the above CP fragments fused with GUS are to be done to show if the putative NTS causes accumulation of the coat protein in the nucleus. Several mutation in this putative NTS will allow us to isolate the essential amino acids in this signal. An update of the results will be presented at the RYMV meeting.

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DEVELOPMENT OF AN IPM STRATEGY TO FIGHT RYMV AND CONSTRAINTS TO ITS IMPLEMENTATION IN MADAGASCAR

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[1]German-Malagasy Plant Protection Project, BP. 869, Antananarivo ;
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Rice yellow Mottle Virus (RYMV), identified for the first time in Madagascar in 1989, is a major constraint to rice production in the North West of the island. Yield losses of up to 100% in rainfed lowland rice caused farmers in recent years to move toward the mountains and slash forests in search of alternative growing space of their virus-infested fields in the valleys. In order to find a solution to the threatening reduction in food production of this area, a cooperative project has been initiated including agricultural research and development. In a three-year research program, virus distribution and incidence, the impact of the infection on yields, virus transmission, and persistence of the disease during rice-free periods were elucidated. At the same time, rice varieties of different origins were tested for their resistance to RYMV. The results were used to define an integrated control strategy. Measures that were proposed to farmers included destruction of crop residues, especially that of stubble and regrowth that serve as first food sources for *Dicladispa gestroi*, the main vector, delaying planting time where irrigation facilities allowed this, the use of tolerant varieties as well as chemical control of the vectors. Several obstacles were identified during the first year of the IPM program which hindered the full acceptance of the measures by farmers, specifically the destruction of infected stubble was not executed for various reasons. This is, however, considered a major step toward the prevention of the spread of the disease. The most promising means of reducing the impact of the disease which is also widely accepted by farmers is the use of less susceptible or resistant varieties.

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