ナイジェリア・ローアアナンブラかんがい稲作計画

短期専門家報告書（Ⅰ）

平成４年４月

国際協力事業団

ナイジェリア・ローアアナンブラかんがい稲作計画

短期専門家報告書（Ⅰ）

平成４年４月

国際協力事業団

序　文

国際協力事業団は昭和64年１月１日から，５年間にわたり，ナイジェリア国における稲作生産性向上のための適正な灌漑稲作栽培技術の確立・移転を目的としたプロジェクト方式技術協力「ナイジェリア　ローア・アナンプラかんがい稲作計画」を実施しています。

本報告書は，平成２年度に本プロジェクトに派遣された林宣夫（病害虫）野中邦彦（土壌）両，短期専門家の報告をとりまとめたものであります。

本報告書が，残された期間の事業推進に当たり，両国関係者の間で活用され，この計画が更き円滑かつ効果的に実施されることを願う次第です。

最後に本報告書の執筆に当たられた専門家のご苦労に感謝するとともに，プロジェクトに御協力を頂いた関係各位に深甚なる謝意を表します。

平成４年４月

国際協力事業団
農業開発協力部長
有　川　通　世

ローア・アナンブラ(ナイジェリア)灌漑稲作における病害虫雑草防除に関する調査報告書

短期専門家総合報告書

林　　宣　夫

派遣期間　　平成３年１月10日から
　　平成３年３月24日まで
指導科目　　病害虫

目　　次

はじめに

ローア・アナンブラ灌漑稲作において，1991年1月11日から3月21日の期間，雑草及び病害虫の発生調査及びその防除対策に関する試験を行った。

本調査及び試験は，調査期間が短かったこと及び調査期間中，一般ほ場では水稲の栽培が行われていなかったことから，主に，LAIP-JICAのExperimental farm内において実施した。

本報告書は，今回実施した調査並びに試験結果と栽培の長期専門家及びカウンターパートからの聞き取り調査及び討議の結果に基づき作成した。

報告書の作成に当たり，御指導，御協力をいただいたチームリーダー井上淳二氏，栽培専門家礒川林蔵氏，調査並びに試験に御協力いただいたカウンターパートMr. Ufondu, Mr. Oniyji, Mr. Okekeに対して深謝の意を表する。

I　活動の概況

1991年1月10日に成田を出発し，11日にナイジェリアに入国した。翌日，在ナイジェリア日本大使館を表敬訪問し，同日，滞在地であるEnugeu市に向かった。

1月14日に現地入りし，まず，プロジェクト地域内の概況及び問題点について，チームリーダー，栽培の専門家及びカウンターパートから説明を受け，調査並びに試験計画を作成した。

調査は主に雑草及び病害虫の発生について行った。防除試験は，雑草に関しては，手取り防草，Hand weeder及び除草剤の効果，害虫に関しては，各種害虫に対する殺虫剤の効果について検討した。

なお，本調査及び試験のほか，農民の研修生を対象にした病害虫及び雑草防除に関するテキストの作成と講義を行った。

3月に入り，調査及び試験結果並びに熱帯稲作に関する各種報告書に基づき報告書を作成し，1991年3月22日に帰国の途についた。

II　本地域内における主要な問題点

本地域の稲作における主要な生産阻害要因は，水田の不均平，不十分な水管理，土壌に起因すると思われる各種障害，肥料不足，雑草及び害虫類の発生である。これらの要因は相互に密接に関係していた。

植物防疫の分野においては，雑草の発生が最も大きな生産阻害要因であり，ついで，害虫類の発生であった。病害の発生は，現状ではほとんどなく，防除の必要は認められなかった。

雑草防除における問題点としては，除草剤の流通量がきわめて少ないこと，農民の除草剤購入の資金力に乏しいこと，手取り除草，畦畔の除草などの作業意欲が低いことなどが挙げられる。技術的には，トラクターの稼働台数不足とオペレーター技術の未熟による水田の不均平が最も大きな問題である。現状では，ロタリー耕の後，水田に水を入れ，代かきをせず移植する場合が多く，こうした場合，雑草の生育が水稲の生育速度を上回り，極めて防除困難な状態になる。一部の農家では，発芽前処理の除草剤が使用されているが，均平でない水田や代かきを実施しない圃場ではその効果が半減している。また，実際の稲作が始まる前から，雑草の発生量が極めて多くなっているため，手取り除草も困難な状況にある。

害虫防除に関しては，本プロジェクトの事前調査で，Case worm, Stem borer 及び Gall midge の被害が報告されていた。しかし，これらの害虫の発生消長及び被害については明らかでなかった。また，現状では，本地域内の農民はほとんど農薬散布器具を有しておらず，実際には十分な害虫防除は行われていなかった。

病害の発生はほとんどなく，その被害は雑草および害虫類に比べ極めて小さかった。

III　雑草防除

1．調査及び試験結果

(1) 本地域内における主要発生雑草

＊ Ischamum rugosum

本雑草は，現地の言語で "Aba" と言われる雑草で，草だけ 0.6～1.2m の極めて生育旺盛なイネ科の植物である。

＊ Cyperus difformis (Small flower umbrella plant)

本雑草は草たけ 20～70cm の 1 年性のカヤツリグサ科の植物である。草型は直立し，葉の表面は滑らかで，群生する。

＊ Fimbristylis milliacea (Morning glory)

本雑草は草たけ 20～70cm の 1 年性のカヤツリグサ科の植物である。草型は直立し，群生する。本地域の優占雑草である。

＊ Sphenoclea zeylanica (Sole plant)

本雑草は草たけ 0.3～1.5m の直立した 1 年性，広葉雑草である。表面平滑で，強固な中空の茎を有している。

(注)　なお，上記雑草を中心に，研修用乾燥標本12点を作成した。

(2)　雑草の発生量調査

1)　1991年12月に移植した水田における雑草の発生量

移植後37日の１月25日に，雑草の種類と 3.3m 当たりの生重と本数を調査した。

結果は表１に示した。本調査ほ場においては，カヤツリグサ科の C. difformis と F. milliacea，１年性，広葉雑草である S. zeylanica が主な発生雑草であった。F. milloacea の生重と本数が最大で，その次は S. zeylanica であり，このほ場では F. milliacea が優占種であった。雑草は低地（水深の深い場所）を除き，ほ場全体に生しており，水稲の大きな減収要因になるものと思われた。

表１　１９９１年１２月に移植した水田における雑草の発生量

調査項目	雑草の種類		
	C.difformis	I.milliacea	S.zeylanica
本数/3.3m²	19.5	708.0	19.0
生重(g)/3.3m²	16.0	171.0	24.5

調査項目	雑草の種類	
	Other grass weeds	Other Broadleaf weeds
本数/3.3m²	0.5	9.0
生重(g)/3.3m²	0.1	14.0

2)　1991年１月31日に移植した水田における発生量の推移

移植後20及び27日に雑草の発生量を調査した。調査は各調査区の全雑草を抜きり，Sedges, Grasses, Broad leaves に類別し，それぞれの生重を調査し，合わせて優占種である Sedges の草たけとイネの草たけを測定した。

結果は表２に示した。優占雑草は Sedges で，その他の Grasses 及び Broad leaves の発生は極めて少なかった。Sedges は移植後27日で，ほ場全面に発生し 4 m 当たりの生重は 3600g に達した。草たけは 28.6cm になり，イネの生育量を上回るようになった。

本調査結果によると，手取り除草の実施時期または Hand weeder の使用時期として１回目が移植後14日，２回目が28日頃が適当と思われた。

表２　１９９１年１月３１日に移植した水田における発生量

移植後日数	雑草の種類(生重/4m²)			Sedges 草たけ	Rice 草たけ
	Sedges	Grasses	Broad leaves		
	g	g	g	cm	cm
20日	412	5	1	15.4	31.4
27日	3600	3	5	28.6	42.3

(3) 除草剤による防除試験

1) 生育期処理剤の効果

雑草発生ほ場において，Basagran, 2.4-D及びPropanilの標準量を2月11日に散布し，散布8日後に達観により，その効果の判定を行った。結果は以下の通りである。

Basagran：本剤処理区では，一部薬剤の到達が不十分であった部分を除き，生育の進んだSedgesに対して高い殺草効果が認められた。その効果は，2.4-D及びPropanilに優った。生育の進んだ広葉雑草に対しての雑草率は30%以下あった。

2.4-D：生育の進んだSedgesに対する効果はPropanilよりも優ったがBsagranに比べると劣った。したがって，本剤は雑草の生育期間に散布することが必要である。なお，Ischemum rugosiumと広葉雑草に対しては全く効果が認められなかった。

Propanil：生育の進んだSedgesに対しては，効果が認められなかったが，広葉雑草に対しては優れた効果を示した。

以上の結果から，Sedgesに対してはBasagranの効果が最も優れ，広葉雑草に対してPropanilが優れていると結論される。

2) 雑草の発芽前及び発芽後処理剤の組み合わせ処理による防除効果

雑草の発芽前及び発芽後処理の組み合わせ処理による防除効果について検討した。

処理区は以下の通りである。Ronstar及びBsagran, Dercut及びBasagran，無処理Ronstarは移植前4日に，500ml/ha, Basagranは移植後20日に5 liters/700 litters water/ha, Dercutは移植前4日5 liters/haそれぞれ処理した。

結果は表3に示した。無処理区における雑草の生育は，移植後31日では場全面に認められ，水稲の生育量を上回った。RonstarとBsaguran及びDercutとBasagran処理区は全く雑草の発生が認められず，極めて防除効果が認められた。

表3 除草剤の体系処理による雑草防除試験結果

処理	雑草の種類(生重g/m²)		
	Sedges	Grasses	Broad leaves
	g	g	g
Ronstar及びBasagran	0	0	0
Dercut及びBasagran	0	0	0
無処理	1258	4.5	8.8

a)調査は、移植後31日の1991年3月7日に行った。

(3) 総合防除試験

除草剤の散布，手取り除草及びhand weederの使用を組み合わせた，体系防除について検討した。

処理区は以下の通りである。

＊ Ronstar の移植 4 日前処理及び移植後25日に手取り除草

＊移植後14日に Hand weeder 処理を行い，移植後20日に Basagran 処理

＊移植後14日に Hand weeder 処理を行い，移植後20日に手取り除草

＊無処理

移植後31日の 3 月 7 日に雑草の発生量を調査した。結果は表 4 に示した。無処理区における雑草の発生は，移植後31日でほ場全面に認められ，水稲の生育量を上回った。Ronstar 及び手取り除草区は全く雑草の発生が認められず，極めて高い防除効果が認められた。Ronstar 処理の効果が高く，Ronstar を処理した区では手取り除草も容易であった。Hand weeder の処理では株間の雑草が残ったが，Basagran を散布することにより，残存した雑草を完全に防除することができた。Hand weeder と手取り除草を組み合わせた区は，手取り除草後，雑草の再生が認められ，除草剤を使用した区に比べ防除効果は低かった。したがって，移植後40日頃に再度，手取り除草を行うことが必要であった。

以上の結果と当地域の現状を考慮すると，Ronstar と手取り除草の組み合わせが最も有効な手段と思われる。

表 4　総合防除試験における雑草の発生量

処理	雑草の種類(生重g/m²)		
	Sedges	Grasses	Broad leaves
	g	g	g
Ronstar及び手取り	0	0	0
Hand weeder及びBasagran	0	0	0
Hand weeder及び手取り	233	0.5	10.8
無処理	1612	5.8	66.3

a)調査は、移植後31にちの1991年 3 月 7 日に行った。

(4)　考察

本地域内には，問題となる数種の雑草が発生していた。カヤツリグサ科の雑草が優占種で，現地の言葉で通称“Aba”と言われるイネ科雑草も発生していた。しかし，この雑草の発生は代かきを行ったほ場では少なかった。

カヤツリグサの中では F. milliacea が主に発生しており，試験場内ほ場では，移植後27日でその発生量は生重で 3600g/4m² に達した。本雑草の防除を実施しなかった場合は，水稲の収量は著しく減少するものと思われた。

広葉雑草の中では，一般名 Sole plant と言われる Sphenoclea zeylanica が優占種であった。本種は強健な雑草で，イネの生育後期にはイネの草だけを上回り，水稲の収量制限要因になっていた。水田内の高い場所では，低い場所（水深の深い場所）に比べ雑草の発生量が

多く，防除も極めて困難であった。

現在，手取り除草，Hand weeder 及び除草剤の使用等の雑草防除法がある。これらの防除効率は，水田の均平化と適切な水管理により高まる。

現在，本地域内は極めて雑草の発生量が多く，手取り除草には多くの時間を必要とするため，手取り除草だけの雑草防除は困難である。

Hand weeder の使用は，手取り除草に比べると効果的であるが，現在この地域では条植えが一般的でないため，現状では使用できない。

一部の農民は除草剤を使用しており，本試験においても，発芽前処理剤である Ronastar と Dercut は極めて効果的であった。また，生育期処理剤では Basagran の効果が 2.4-D と Propanil に比べ高かった。Ronstar と Dercut は希釈の必要がなく，薬液の入ったビンを振ることにより薬剤散布ができ，極めて散布方法が容易である。

本地域では，移植前に Ronstar あるいは Dercut を処理し，移植後は手取り除草や Hand weeder あるいは Basagran を使用する体系が最も適した防除法と思われる。

2. 防除方法

(1) 個別防除技術

1) 手取り除草

＊除草時期

1回目—移植後14日

2回目—移植後28日

3回目—移植後40日に必要に応じて実施する

＊乾燥状態の水田では手取り除草は極めて困難である。すなわち，軟らかい雑草は途中できれてしまい，短期間に再生してくる。

＊除草を容易かつ完全にするため，除草作業の2日前に水田に水を入れ，土を軟らかくしておく。

＊抜き取った草は，集めてほ場外へ持ち出す。

＊収穫期に雑草が認められる場合は，イネ籾への雑草種子混入と次作の伝染源を少なくするために除去する。

2) Hand weeder の利用

機械的な防除は，簡単な機械である Hand weeder を利用して行う。この方法は，当地域では，現在実際的ではないが，将来は有効な防除手段になると思われる。

＊ Hand weeder を利用する場合の条件は以下の通りである。作業実施前2日に水田に水を入れ，土を軟らかくしておき，作業時の水深は2～3 cm とする。

＊本機では，イネ株周辺の雑草が防除できないので，株周辺の雑草は手取りあるいは Basagran の散布により防除する。

＊除草時期

1回目―移植後14日

2回目―移植後28日

3回目―移植後40日に必要に応じて実施する

3) 除草剤の利用

① Ronstar または Dercut

1年生のイネ科，カヤツリグサ科，広葉雑草を対象に代かき時に使用する。

② Basagran

1年生及び多年生カヤツリグサ及び広葉雑草を対象に，移植後20～30日に使用する。

③ 2.4-D

1年生及び多年カヤツリグサ及び広葉雑草を対象に，移植後35～40日に使用する。

(2) 体系防除

雑草の発生量や農民の経済力，労力事情等により，除草剤，手取り除草及び Hand weeder を組み合わせた体系で防除を行う。

1) 手取り除草

1回目―移植後14日

2回目―移植後28日

3回目―移植後40日に必要に応じて実施する

2) Ronstar の使用と手取り除草の組み合わせ

代かき時に Ronstar を散布

移植後20日に手取り除草

移植後40日に必要に応じて手取り除草を行う

3) Hand weeder の使用と手取り除草

移植後14日に Hand weeder を使用

移植後21日に手取り除草

移植後28日に Hand weeder を使用

移植後35日に手取り除草

移植後40日に必要に応じて手取り除草を行う。

4) Ronstar と Basagran あるいは 2.4-D の使用

代かき時に Ronstar を散布

移植後20～30日に Basagran を散布するか，2.4-D を移植後35～40日に使用する。
移植40日に必要に応じて手取り除草を行う。

3. 雑草防除の将来方向

雑草防除においては，代かきと適切な水管理は最も有効な手段である。したがって，トラクターの稼働台数の確保とオペレイター技術の向上は最も重要な課題である。雑草の防除効率は水田の均平化と適切な水管理により高まる。

現在，ランダム移植が一般的であるが，本移植法は，条移植に比べ，手取り除草，Hand weeder の使用及び生育処理の除草剤散布において非効率的である。したがって，条移植の早期普及が必要である。

Hand weeder の普及には二つの方法があり，一つは，日本からの導入であり，一つは現地での生産である。本機は極めて簡易な機械であるため，ナイジェリアにおける生産が望まれる。除草防除において，除草剤の散布は最も効果的な防除法である。しかし，雑草の防除体系は，農民の経済力や労働力事情により決定されるべきである。なお，除草剤については，当面，日本からの供与が望まれる。

将来，本地域において水田の均平化が図られると，粒剤タイプの除草剤の使用はきわめて効率的である。粒剤は手まきあるいは簡易な散粒器により散布することができ，散布作業が極めて容易である。したがって，試験ほ場内での検討が必要である。

また，次作の除草発生源を少なくするため，ほ場衛生，すなわち畦畔雑草や休耕期間中の雑草防除などの考えを農民に理解させることも大切である。

IV 害虫防除

1. 調査及び試験結果

(1) 本地域内における主要発生害虫

1991年1月11日から3月11日まで苗床及び水田において発生する害虫の種類と被害について調査した。

結果は表5－6に示した。本調査期間内に Stem borer, Rice hispid, Grasshoppers, Lady beetle 及び Leaf hopper の発生を確認した。Grass hopper 及び Stem borer はおもに水田で発生し，Rice hispid 及び Lady beetle は主に苗床で発生していた。

Grass hoppers の発生が最も多かったが，これは調査期間内に一般ほ場ではイネの栽培が行われていなかったために，周辺雑草地からの飛び込みが多かったことによるものと思われた。

Stem borer の被害茎率は移植後34日で12.2%に達し，経済的被害水準をこえていた。Rice hispid と Lady beetle の苗床における被害葉率は 4 ～11%であったが，実害は比較的少なかった。しかし，これらの害虫についても，今後の発生動向には注意が必要である。

表 5　調査期間内における主要発生害虫

般名	学名	主な発生場所
Stem borer	Diopsis thoracica	本田
Rice hispid	Irichipa sericea	苗床及び本田
Grass hopper	Oxya spp.	本田
Lady beetle	Henosepilachna sp.	苗床及び本田

表 6　掬い取りによる害虫発生調査結果

調査時期	Stem borer	Grass hopper	Leaf hopper	Lady beetle
1991年 1 月23日	1	29	11	0
1 月31日	10	27	4	0
2 月 5 日	6	23	1	0
2 月13日	8	11	0	1

a)結果は 2 0 回振りによる頭数
b)本調査ほ場は1990年12月19日の移植である。

表 7　本田における害虫の被害調査

害虫の種類	調査時期	調査結果
Stem borer	1 月23日	被害茎率　12.2%
Rice hispid	1 月23日	被害葉率　10.5%

a)本調査ほ場は1990年12月19日の移植である。

表 8　苗床における害虫の被害調査

害虫の種類	調査時期	調査結果
Rice hispid	1 月23日	被害葉率　4.3%
Lady beetle	2 月20日	被害葉率　11.1%

a)各調査は異なるほ場において、それぞれ播種後 2 0 日に行った。

(2)　殺虫剤による防除試験

1)　Stem borer 及び Grass hopper に対する効果

数種殺虫剤の効果について検討した。供試薬剤は Sumithion, Bassa 及び Diazinon で1991年 2 月 6 日に1000倍液を 500L/ha 散布した。調査は散布前日，散布翌日及び 7 日後に掬い取りによって行った。

結果は表 9，10に示した。Diazinon 及び Sumithion は Bassa に比較し Grass hopper 及び Stem borer に対して高い防除効果が認められた。

表9　Grass　hopperに対する効果

調査時期	Sumithion	Bassa	Diazinon
散布前日	42	51	37
散布翌日	10	25	6
散布7日後	8	47	6

a)表中の数値は、掬い取り20回振りによる頭数

表10　Stem borerに対する効果

調査時期	Sumithion	Bassa	Diazinon
散布前日	10	15	11
散布翌日	0	7	1
散布7日後	1	8	0

a)表中の数値は、掬い取り20回振りによる頭数

2)　Lady beetle に対する効果

虫体浸漬法により，数種殺虫剤の効果について検討した。供試薬剤は Dimecron, Sumithion, Bassa 及び Diazinon の1000倍液で，各区7頭の成虫を供試した。供試虫を薬液に30秒間浸漬し，5.30及び60分後に死虫数を調査した。

結果は表11に示した。Bassa 処理区では浸漬5分後に5頭が死に，極めて速効的であった。ついで Diazinon の効果発現が速く，Dimecron と Sumithion は比較的遅効的であった。しかし，いずれの薬剤とも殺虫効果が認められたことから，本虫の防除薬剤として使用可能と思われた。

表11　虫体浸漬法による数種殺虫剤のLady beetleに対する効果

調査時期	Dimecron	Sumithion	Bassa	Diazinon	Water
浸漬 5分後	0	0	5	2	0
浸漬30分後	1	1	7	6	0
浸漬60分後	7	7	7	7	2

a)表中の数値は死虫数で示した。

(3)　考察

1991年の1月中旬から3月中旬にかけて，LAIP-JICA の試験ほ場内に発生する害虫について調査した。その結果，すでに発生が報告されていた Stem borer 及び Grass hopper のほか Rice hispid 及び Lady beetle の発生を初めて確認した。しかし，本地域で重要害虫として報告されていた Case worm と Gall midge の発生は本調査期間内では確認できなかった。したがって，Grass hopper, Stem borer, Rice hispid 及び Lady beetle に関して行った調査並びに試験結果について考察する。

Grass hoppersは高密度に発生していたが，これは，調査期間中，一般ほ場では水稲の栽培が行われていなかったため本調査ほ場への周辺雑草地からの飛び込みが多かったことによるものと思われた。Grass hopperは数種確認されたが，種の同定には至らなかった。薬剤防除試験の結果，SumithionとDiazinonに高い防除効果が認められた。本害虫は葉を食害し，葉面積の減少をもたらすため，本試験ほ場のような発生状況では，薬剤による防除が必要であった。

1月中旬の調査でStem borerによる“Dead heart”の症状を確認した。1月の末に被害茎率は12.2%に達した。日本で発生する類似害虫であるRice stalk borer (Chilo suppressalis) に関する報告から判断すると，移植後30日で被害茎率が10%を越えた場合は，薬剤防除が必要と思われる。防除薬剤としては，SumithionとDiazinonの効果がBassaに比べ高く，効果的であった。

Rice hispidとLady beetleは主に苗床で発生しており，水田における被害は軽微であった。しかし，将来的には，これら害虫の発生と被害の関係についての調査が必要である。Dimecron, Sumithion及びDiazinonのこれら害虫に対する効果は高く，苗床において播種後2週間の時期に株あたり3頭以上の発生が確認されたら薬剤防除が必要と思われる。

本地域では重要害虫とされていたCase wormとGall midgeの発生は確認できなかった。これは，両害虫が主に雨季に発生する害虫であることによるものと思われる。

ほ場における薬剤散布試験で，ナップサックタイプの散布器を用いた結果，1ha当たり，延べ18人で5時間を要した。このようにナップサックタイプの散布器を用いた薬剤散布は極めて重労働であった。したがって，効率的な農薬散布機の導入が必要である。また，農薬散布作業において，ランダム移植ほ場は条移植ほ場に比べ，非効率的であった。

なお，本調査は乾季作において実施したものであり，雨季作における調査が必要である。

2. 主要害虫の防除

本地域の水稲栽培において，害虫の発生は大きな問題点の一つである。主要な発生害虫はStem borer, Rice hispid, Case worm, Grass hopper及びLady beetleである。その他，本地域の周辺の村であるAdani, Omasi等では，Gall midgeの発生が確認されている。本害虫は近年まで重要害虫ではなかったが，西アフリカの国々においては，最近，水稲の大きな減収要因になっている。したがって，将来，本害虫はこの地域内でも重要な害虫になるものと思われる。本地域において発生する害虫の経済的被害許容水準，被害の実態，生活史，殺虫剤の散布適期等に関する知見はきわめて少ない。しかしながら，今回の調査及び試験結果と数種の報告に基ずき以下に主要害虫の防除法について記した。

なお，現地の指導者は主要発生害虫の被害，生活史等の情報を有していない。したがって

英文の報告書では，数種の論文を引用し，これらの情報も含めて記載したが，本報告書で省略した。

(1) Stem borer

＊学　名　Diopsis thoracica

＊一般名　Stalk-eyed Fly (Stalk-eyed Borer)

＊防除法

移植後30日の時点で被害茎率が10%を上回った場合は，薬剤防除が必要である。有効薬剤はSumithion, Diazinon, Gammalin 20 Dimecron等である。薬剤散布をする時は，水田から水を排水し薬剤がイネ体の基部まで十分到達するようにすることが必要である。

(2) Rice Hispid

＊学　名　Trichipa sericea

＊一般名　Rice Hispid

＊防除法

苗床において10株当たり3頭以上の寄生を確認したら，薬剤防除が必要と思われる。現在，有効薬剤に関する情報を有していないため，今後，有効薬剤の探索が必要であるが，Sumithion及びDiazinonは有効と思われる。

(3) Case worm

＊学　名　Numphula depunctalis

＊一般名　Rice Caseworm

＊防除法

2～3日間水田から排水することにより，幼虫の防除が可能である。防除薬剤としてはSumithion, Diazinon及びDimecronが有効である。

(4) Gall midge

＊学　名　Orseolia oryzae

＊一般名　Rice stem Gall Midge

＊防除法

本害虫の被害は移植時期に注意することにより回避できる。分けつ期を過ぎると被害は少なくなる。本虫は，水田周辺のイネ科植物で増殖し，それが発生源になる。薬剤防除の効果を上げるためには，成虫の発生時期と薬剤散布の時期を一致させることが重要である。一般に，移植後14あるいは28日の時点で，被害茎率が5%を越えた時が薬剤防除の適期である。なお，本害虫の常発地では，移植10日前の苗床における薬剤防除が必要である。

薬剤としてはフラダン粒剤が有効である。本剤の残効期間は14から20日である。粉剤，

液剤，水和剤の散布は効果がない。

本虫は主に雨季に発生する害虫であり，乾季における発生は極めて少ない。雨季の始まりの1か月前に移植をした場合は，被害は少なくなる。これは，乾季では本虫の密度が長期間の乾燥により著しく抑制されるためである。

(5) Grass hoppers 及び Crikets

＊学　名　Oxya spp. (Grasshopper)

Crikets (Euscytus concinnus)

＊防除法　Sumithion または Diazinon の散布が有効である。

(6) Lady beetle

＊学　名　Henosepilachna sp.

＊一般名　Lady beetle

＊防除法

Rice hispid と同様，苗床において10株当たり3頭以上の寄生が認められた時は薬剤防除が必要である。Bassa, Diazinon 及び Sumithion の散布が有効である。

(7) 殺虫剤の使用法

＊ Sumithion, Diazinon Bassa 及び Dimecron

希釈倍率：×1000

散 布 量：1000～1500L/ha

＊ Furadan granule (A.I. 3％)

施 用 量：16.6kg/ha（苗床）：33.3kg/ha（本田）

3. 害虫防除の将来方向

植物防疫の分野において，害虫の発生は，雑草の問題についで重要な問題である。本地域内において発生する害虫の種類は明らかになっているが，経済的被害許容水準，被害程度，発生時期等に関する知見はほとんどない。

現在，本地域では作期が定まっていないが，早期に最も適した作期を決定し，それぞれの作期における害虫の発生調査を行うべきである。具体的には，パイロットファーム内に20から30の調査ほ場を設置し，決められた定点ほ場において，15日間隔の定期的な害虫発生調査を実施すべきである。また，Experimental farm 内に誘蛾灯を設置し，害虫類の発生を定期的調査する必要がある。これらの調査結果は，害虫の発生を予察するうえで極めて有用である。

害虫防除において，殺虫剤による防除は主要な防除手段である。しかし，現在，ナイジェリアでは農薬の流通量が極めて少ない。また，農民はナップサックタイプの散布器具しか有

していないため，殺虫剤の散布作業は重労働であり，その防除効果も不十分である。したがって，殺虫剤と高性能散布機の日本から供与が望まれる。

また，個々の農民が散布機を持つのは，非効率的であり，この地域内に共同防除組織の設立を勧めたい。

V　病害防除

現在，本地域では Sheath blight と Sheath rot を除き病害の発生は確認されておらず，病害の発生は重要な問題ではない。これは，本地域の灌漑稲作の歴史が浅いこと，十分な施肥が行われていないことなどによるものと思われる。しかし，将来，灌漑稲作の歴史が長くなり，さらに，肥料事情が好転してくると，数種の熱帯地域の病害の発生が予想される。例えば，Bacterial leaf blight, Sheath blight, Blast 等である。

現在，本地域内における病害の発生と防除に関する知見は全くない。したがって，害虫の場合と同様，定点ほ場における定期的な病害の発生調査が必要である。

病害防除において，抵抗性品種の利用は最も効果的な防除手段である。したがって，品種の選定と合わせて，Blast および Bacterial leaf blight を対象にした抵抗性品種の検討が必要である。また，アナンブラ州内の他地域では，Blast と Brown spot の発生が確認されており，本地域内においても，両病害を対象にした種子消毒が必要になるものと思われる。

なお，英文の報告書では，発生が予想される数種の病害について，伝染方法，病徴及び簡単な防除法について記載したが，本報告書では省略した。

VI　参考文献

1. Ray P. A. (1982). Your guide to identifying some arable land weeds of south eastern agricultural zone of Nigeria. Extention Research Liaison Service National Root crops Research Institute, Umudike, Nigeria.
2. International Rice research Institute (1983). Fields problems of tropical rice. Manila, Philippines.
3. Dennis Hills (1975). Agricultural insect pests of tropical and their control.
4. Hidaka, I. and Widiarta, N. (1986). Strategy of rice gall midge control. Tropical Agriculture Research Center, Ministry of Agriculture, Forestry and Fisheries Japan.

REPORT
ON
PLANT PROTECTION OF RICE
IN LAIP, OMOR, NIGERIA

MARCH 1991

BY NOBUO HAYASHI
SHORT TERM EXPERT

CONTENT

PREFACE

Occurrence of weeds, insect psets and diseases was investigated and their control methods were examined in LAIP, Omor from Jan. 11 to Mar. 21, 1991.

This investigation and experiment were mainly conducted in Experimental farm of LAIP-JICA, because term of working was short and there were no cultivation of rice in general fields on my working term.

I made report by results of investigations and experiments, and discussions from expert on rice cultivation in JICA and my C/P.

I express sincere gartitude to Team leader Mr. J. Inoue, Expert on rice cultivation Mr. R. Isokawa, C/P, Mr. Ufondu, Mr. Oniyji and Mr. Okeke for thier kind support to present investigations and experiments.

I OUTLINE OF ACTION

I left Narita, Japan on Jan. 10, 1991, and enterd Nigeria on Jan. 11. On the next day I visited Japanese Embassy in Nigeria to greet an Ambassador, Mr. Kurokawachi and arrived at Enugeu on the same day.

After I was explained about outline and problem in this project area by Team leader, Expert on rice cultivation and my C/P, I made plan of investigations and experiments.

Weeds, insect pests and diseases occurred in Experimental farm were investigated and control methods were examined such as effects of hand pulling, use of hand weeder and application of herbicides in weeds control and effect of insecticides application in the insect pest control. Outline of rice production in swamp around this area was invetigated too.

I had a lecture for trainee farmers on plant protection of rice from Mar. 5 to 7. 1991.

From early March, I began to make report based on results of investigations and experiments, hearing from our stuff and several reports relating to plant protection in tropical rice.

I brought forward this report to team leader and left Nigeria on Mar. 22, 1991.

II MAIN PROBLEMS IN THIS AREA

Main inhibitiing factors of high rice yield in this area are poor leveling of paddy fields, unsuitable water management, mixed variety, soil injuary, lack of appropriate fertilizer application, occurrence of weeds and insect pest. These

problems were very much close to one another.

In the branch of plant protection, rice high yield was inhibited strongly by occurence of weeds, next to it, insect pest. Occurrence of diseases was very few, therefore, there is no need of control in disease.

Problems on the control of weeds are as follows; Cirulation quantity of agrochemicals is very few. Farmers can not buy enough quantity of agrochemicals and they are short of will to working , i.e. hand pulling of weeds, and cutting weeds on the bund. On the agro-technicaly, the biggest problem in weeds control poor leveling of paddy fields caused by lack of number of available tractors an inexperienced tractor operaitors.

Generaly , after proughing, water is supplied in the paddy fields and seedlings were transplanted without puddling. In this case , growth of weeds is more than rice and weeds control will be very difficult. A few farmers have been using pre-emergence herbicide, but the effect of herbicides application is reduced by half caused by poor leveling and no puddling of paddy fields, and weeds control by hand weeding is very difficult because plenty weeds are established ever before the actual crop.

In the insect pest control, the damage caused by Case worm, Stem borer and Gall midge were reported in pre-investigation report of JICA. But the rise and fall of their occurrence , and damage in rice were not clear. Control of them was not scarcely conducted in this area. Majority of farmers in this area have no spraying machine for agrochemicals.

Occurrence of diseases are very few, therefore damages caused by diseases is smaller than that of weeds and insect pest.

Ⅲ CONTROL OF INSECT PESTS

1. Results of investigation and experiment

(1) Main insect pests occurring in this area

We investigated kinds of insects and damage on rice plant in the nursery bed and paddy fields during Jan 11 to Mar.11 1991.

Results showed table 5-8.

In this investigation time,we confirmed occurrence of Stem borer,Rice hispid Grass hoppers,lady beetle and leaf hopper.Grass hopper and Stem borer occurred in paddy field,while Rice hispid and Lady beetle occurred mainly in nursery bed.We found out that both insect pests cause serious leaf damage by eating up photosynthetic area of the leaf.

Grass hoppers occurred more than other insect pests.In this investigation time,there are no rice cultivation in general fields,therefore it seems that is insect pest gatherd from around weeds.Number of Grass hoppers were the biggest but the damage of rice was comparatively little.

No. of damaged tillers by Stem borer reached at 12.2%,34 days after transplanting.This occurrence was over economical injury level of rice.

No. of damaged leaves by Rice hispid or lady beetle were 4-11 % in nursery bed.It seemed that this damages are not essential,but it is better that we take notice of these insect pests occurrence from now.

Table 5 Kinds of insect pest occurred in this area on Jan.to Mar.1991

Common name	Scientific name	Main place of occurrence
Stem borer	Diopsis thoracica	Paddy field
Rice hispid	Trichipa sericea	Nursery bed and Paddy field
Grass hopper	Oxya spp.	Paddy field
Lady beetle	Henosepilachna sp.	Nursery bed and Paddy field

Table 6 Number of insect pests caught by sweeping method in the paddy field

Date	Kind of insect pests			
	Stem borer	Grass hopper	Leaf hopper	Lady beetle
Jan.23 1991	1	29	11	0
Jan.31	10	27	4	0
Feb 5	6	23	1	0
Feb 13	8	11	0	1

a)Results showed number of insect pests by sweeping method by 20 swings.

b)This field was transplanted on Des.19,1991.

Table 7 Damaged by insect pests in paddy field

Kind of insect pest	Investigation date	Result	
Stem borer	Jan.23	No. of damaged tillers(%)	12.2
Rice hispid	Jan.23	No. of damaged leaves(%)	10.5

a)This field was trasnplanted on Dec.19 1990

Table 8 Damaged by insect pest in nursery bed

Kind of insect pest	Investigation date	Result	
Rice hispid	Jan.23	No. of damaged leaves(%)	4.3
Lady beetle	Feb.20	No. of damaged leaves(%)	11.1

a)Each investigation,was carried out 20 days after seeding.

(2) Chemical control of insect pest

1) Effect of insecticides to Stem borer and Grass hopper

We investigated to determin the effectiveness of some insecticides. Treatment are as follows;

Sumithion,Bassa and Diazinon were applied Feb.6 1991.Each insecticides was applied 0.5 liters prepare with 500 liters water per ha.We investigated number of insect pest by sweeping method on one day before,one day and 7

days after application.

Result showed Table 9.10

Diazinon and Sumition have proved more effective than Bassa in the control of Grasshopper and Stem borer. This experiment shows that Bassa should not be recommended for control of Grasshopper in heavey infested field.

Table 9 Number of Grass hopper by sweeping method with 20 swings

Time of investigation	Sumithion	Bassa	Diazinon
	Number of Grass hopper		
One day before application	42	51	37
One day after application	10	25	6
Seven days after application	8	47	6

Table 10 Number of Stem borer by sweeping method with 20 swings

Time of investigation	Sumition	Bassa	Diazinon
	Number of Stem borer		
One day before application	10	15	11
One day after application	0	7	1
Seven days after application	1	8	0

2) Effect of insecticides to lady beetle

We screened efficacy of 4 kinds of insecticides with Lady beetles by dipping method.

Treatment are as follows;

Dimecron, Sumithion, Bassa and Diazinon were tested. 0.2 ml of each insecticides mixed with 200 ml water. Adult Lady beetles were dipped in each preparedinsecticides for 30 seconds. We counted the number of dead insect pest at 5, 30 and 60 minutes after dipping.

Results showed Table 11.

From this table, Bassa has the quickest action while Diazinon and Sumithion have gradual and steady action. However the three insecticides killed off all the specimen 60 minutes after dipping them in the prepared insecticidal liquids.

In view of this data, the three insecticides are recommended to farmers for use against Lady beetle invasion.

Table 11 Screening of the efficacy of 4 kinds of insecticides with lady beetle by dipping method

Time of investigation	Dimecron	Sumithion	Bassa	Diazinon	Water
	Number of dead insect				
5 minutes after dipping	0	0	5	2	0
30 minutes after dipping	1	1	7	6	0
60 minutes after dipping	7	7	7	7	2

a) Seven lady beetles were tested in the each insecticides.

(3) Discussion

Kinds of inset pests ocuurred in the experimental farm -JICA were investigated on the middle Jan. to middle Mar. 1991. I confirmed occurrence of Stem borer, and Grass hopper which was already reported the occurrence. Occurrence of Rice hispid and Lady beetle were found for the first time in this area. Occurrence of Case worm and Gall midge which were reported important insect pests in this area was not confirmed during this investigatin period. Therefore I will discuss about results of investigation and experiments on Grass hopper, Stem borer, Rice hispid and Lady beetle.

Grass hoppers have occurred in high density because they were fling into the fields from weeds around. There are several kinds of Grass hoppers, Longhorn grass hopper and Shorthorn grass hopper, but I could not identify these species Sumithion and Diazinon were very effective in the field experiment. These insects feed on rice leaves and leaf area of rice plant was reduced, therefore these insect pests are controled by application of insectcides in this area.

I found symptom of "Dead heart" caused by Stem borer on the middle Jan., and damaged tillers of "Dead heart" reached at 12.2% on the last Jan. Judging from report about Rice stalk borer(Chilo suppressalis) in Japan, if 10% of damaged tillers(Dead heart) is over 30 days after transplanting, the application of some effective insecticides against Stem borer infestation may be necessary. Sumithion and Diazinon were very effective against this insect rather than Bassa.

Rice hispid and lady beetle were found mainly in the nursery beds. Damage in paddy fields was very little, but in future relation to damage and occurrence of insects must be investigated in the paddy field. Application of Dimecron, Sumithion or Diazinon was very effective. These insecticides must be applied, if over 3 adults per 10 hills occurred 2 weeks after seeding in nursery bed.

Occurrence of Case worm and Gall midge which were reported important insect pests in this area, we can not confirmed these occurrence in this investigation. It seemed that both insects pest occur in rainy season.

In the field application test, 5 hours with 18 person per ha were needed in application of agrochemicals by Knapsack sprayer.

Application of agrochemicals by Knapsack sprayer in the paddy fields is a ver hard work. Therefore effective application machine must be introduced in this area. Agrochmicals are more efficient in line transplanted paddy than in random transpanted paddy.

2. Ecology and control of insect pests in this area

In this area(IAIP), we found that pests constitute a big problem. Some of the common insect pests around are Stem borer, Rice hispid, Case worm, Grass hopper Lady beetle etc..

However, towns around the project area such as Adani, Omasi etc. have recorded attack of rice insect pest called Gall midge. Gall midge has not been regarded as an important insect pest of rice until recent occurrence of this pest in the past few years.

Gall midge has consistently reduced rice yield in some countries of west Africa. In future Gall midge may become an important rice insect pest in this area.

Few information about insect pest in this area are available such as economic injury level, extent or degree of damage, time of occurrence, the most important time of insecticides application and life cycle of insect pest.

However, the ecology and control of the insect pests are showed based on result of investigation or experiment and by citing from several reports.

(1) Stem borer

* Scientific name Diopsis thoracica
* Common name Stalk-eyed Fly(Stalk-eyed Borer)
* Host Main:Rice and Sorghum
  Alternative:Wild gasses

* Damage

The maggot feeds on the central shoot of the young rice plant, causing "Dead -heart". Later generation of larvae feed on the flower before it emerges. "White head" is caused after flowring.

* Life history

The eggs are 1.7 ×0.4mm, white, boat-shaped. Each female lays about 20 eggs over a 10 days period. The eggs are laid upper surface of young rice leaves.

The larva on emergence moves down inside the leaf sheath and feeds on the central shoot above the meristem. Later larve feed on the flower head before it emerges. Larval development takes 25-33 days.

The pupal period is 10-12 days. The adults are typical diopsid flies with characteristic eyes and antennae bore on the ends of long lateral stalks.

* Control

If 10% of damaged tillers(Dead hearts) is over 30 days after transplanting, the application of some effective Insectcides against stem borer infestation

may be necessary. Where necessary, spray Sumithion, Diazinon, Gammalin 20 and Dimecron etc..

Spray the leaves and base of the plants thoroughly. When spray, water is drained off from the paddy field.

(2) Rice Hispid

* Scientific name Trichipa sericea
* Common name Rice Hispid
* Host Main:Rice
Alternative:Species of wild gasses

* Damage

Attacked plants have irregular pale brown patches and narrow whitish streaks on the leaves. The pale brown patches are the larval mines, and the whitish streaks are the feeding scars produced by the adults.

An important pest in rice nurseries, sporadically serious on the transplantig rice.

* Life history

Eggs are laied singly in slits in the leaf made by the adult beetle, the wound being covered by a spot of excreta. Hatching takes place after 3-4 days.

The larva is a slender, yellowish grub which when fully grown is about 6 mm long. It feeds inside the leaf, the mine being visible externally as a pale brown blotch. The larval period lasts about ten days.

The adult is a dark grey beetle covered with upright spines. It is about 3-4 mm long. Adult feamales live for about two weeks and may lay more than 100 eggs during this period. Adult feed externally on the leaves, the damage being visible as whitish streaks parallel to the veins.

* Control

If over 3 adults per 10 hills occured, insectcides application will be needed

We have no information about effective Insectcides in Nigeria. From this time on, we must be screening effective insectcides against Rice Hispid. But Sumithion and Diazinon may be effective.

(3) Case worm

* Scientific name Nmphula depunctalis
* Common name Rice Caseworm
* Host Main:Rice
Alternative:Various grass species

* Damage

The caterpillar cut off the tips of leaves to construct the case in which it lives, the case is changed as the caterpiller grows. In heavily infested, crops the loss of photosynthetic tissue can be critical and seedlings may die.

Older plants generally are more tolerant of damage, and mature plants are seldom attacked.

The larvae feed mostly on the lower side of leaves lying flat on the water, or on submerged portions of the leaves.

* Life history

The eggs are laid singly on the leaves, they hatch in 2-6 days, and after a few days the first larvae construct the first cases. On female moth usually lays about fifty eggs. The caterpiller is semi-aquatic in nabits and withstand prolonged immersion the case is always filled with water.

The larval stage lasts for 15-30days. The fully grown caterpiller is 13-20cm long. Pupation takes place inside the last larval case which is fastened to the base of the stem. It may take place under water but more usually above water level.

The adults emerge after 4-7 days and can live for up to three weeks. The adults are small, delicate, snowy-white moth with pale brown spots on the wings , they have a wingspan 15-25mm.

* Control

Draining the water from infested fields for 2-3days succefully kills the caterpillars.

The more successful insecticides used are Sumition, Diazinon, and Dimecron.

(4) Gall midge

* Scientific name Orseolia oryzae

* Common name Rice stem Gall Midge

* Host Main:Rice

Alternative:Wild species of oryzae and grasses

* Damage

The severity of damage is related to the time of attack. The larvae move down between the leaf sheath until they reach the apical bud or one of the lateral buds. There they lacerate the tissue of the bud and feed until pupation. The feeding causes formation of a gall called a "silver" or " onion " shoot .

In some areas this is a very serious pest causing crop losses of 30 -50% with some regularity and occasionally loss of 100%.

* Life history

Fertilized females start eggs-laying within a few hours of emergence. They lay 100-300 eggs each. The eggs are elongate, tubular and white, pink or red in colour. Inccubation takes 3-4 days or more.

The larve are 1 mm long on hatching, with a pointed anterior end, and a pale colour. They eventually grow to 3mm long and become red. Pupation takes place at the base of the gall and the pupa is 2.0-2.5mm long and 0.6-0.8mm broad. Before the adult emerges the pupa makes a hole in the top of the gall with its spines and projects halfway, the skin splits and the adult emerges. Pupation takes 2-8 days. The adult is a delicate little midge, 3.5mm long, with long strong legs.

The whole life-cycle takes 9-26 days on rice. After one or two generations on garsses the midge generally moves to rice.

* Control

Careful timing of planting can avoid damage by this pest. Once post tillering stage, the plant is not suitable as a host.

Considerable build-up of midge populations can occur on grasses near the rice crop. The succes of chemical control is very much dependent on accurate spray-timing to coincide with the emergence of each brood of midges.

Timing of insecticidal application is 14 and 28 days after transplanting at the rate of 1 kg active ingradient per ha when damaged tillers(%) are over 5% On the other hand, insecticidal control is also needed in seedling-bed in the endemic areas of the rice gall midge. Insecticidal application to seedling -beds is made 10 days before pulling out of seedlings at the rate of 0.5(A.I.)kg per ha.

Effective insecticide is known to be carbofuran 3% of furadan granule.

In general, this granule insecticid exerts this effectiveness for a period of 14 to 20 days after application.

The following formulae of insectides i.e. powder, emulsified concentration, and liquid are not effective in paddy fields.

The rice gall midge is known to be a serious rice pest in the wet season, while the insect infestation in the dry season is extremy low. If rice seedling is transplanted one month before begining of rainny season, the damage will be decreased. The reason why the insect damage is low in the early transplanting is considered attributable to low population of the insect which was strongly depressed by the long drought.

(5) Grasshoppers and Crikets

* Scientific name Oxya spp. (Grasshopper)
  Crikets(Tuscytus concinnus)

* Host Main:Rice
  Alternative:Species of wild gasses

* Damage

Grasshopper:Defoliates rice plants by removing large section near the edges of leaves

Crickets :Feed on leaves, leaving holes while keeping leaf margins intact. Leaves appear ragged.

* Control

Sumithion and Diazinon are effective to Nymphs and adult. They have strong stomach poison as well as contact action.

(6) Lady beetle

＊Scientific name　Henosepilachna sp.
＊Common name　Lady beetle
＊Host　Main:Rice
　　Alternative:unknown
＊Damage
It is a biting mouth type. It feeds on seedling leaves and left behind white and transparent patches which later turn yellow and dry up. The insect reduces photosynthetic feeding area of seedling thereby lowering photosynthetic activity of plant. In severe infestation, this pest causes serious damages on rice seedling in nursery stage, hence damage in paddy field is neglegible.
＊Physical feature
Beetle like insect. It has yellow to orange colour with about 12 black spot, (1 mm diameter) on the outmost hardwings. The beetle seldomly fly. When it flies, the inner yellow and fibous wings are unfolded and flies for a short distance. Adult is 2-5 mm long.
＊Control
This pest can be controlled by application of either of these insecticides, Bassa, Diazinon and Sumithion.

(7) How to use Insecticides
＊Sumithion, Diazinon Bassa and Dimecron
Dilution: ×1000 (1 ml preparations with 1000 ml water)
Quantiy of spray liquid:1000-1500L/ha
Notice:Avoid mixing Sumithion with propanyl-type herbicides and Sumithion can not be applied within 10 days after application of these herbicides, because it can cause phytotoxicity. (Damage of plants by mixing chemicals)
＊Furadan granule(A.I. 3%)
Quantiy of application:16.6kg/ha in seedling-bed
33.3kg/ha in paddy field

3. Future insect pest control in this area

Insect pest occurrence is next to weeds occurrence in importance in the plant protection.
Kinds of insect pests occurred in this area are clear, but few information about them in this area are available such as economic injuary level, extent or

degree of damage, time of occurrence, the most important time of insecticides application and life cycle of insect pest.

Now in this area time of cultivation is not decided. Therefore most suitable cropping pattern must be decided early, and several investigation must be carried out on insects in each cropping pattern.

In the concrete, 20-30 fields for investigation are set in the pilot farm and occurrence of insect pests must be investigaited at intervals of 15 days in fixed fields.

light trap is set in the experimental farm and number of insects trapped by it must be counted. these data are very useful for forcasting of insect pest occurrence.

Chemical control is main methods in the control of insect pest. But now circulation of agrochemicals is very few in this coutry and farmers have no spray machine except knapsack type sprayer. Application of insecticides is inefficient, not effective and very tedious work. Therefore it is advisable that Japan supports Nigeria in the importation of insecticides and highly efficient spray machine. I recommend to set up cooperative pest control in this area.

Ⅳ COTROL OF WEEDS

1. Result of investigation and experiment

(1) Main kinds of weeds occurring in this area

* Ischaemum rugosum is aggressive, erect or stragging tufted annual garass 0.6-1.2 m tall. (Common name is "Aba" in Igbo lunguage)
* Cyperus difformis(Small flower umbrella plant) is an erect, smooth, densely tufted annual sedge 20-70 cm tall.
* Fimbristylis milliacea(Morning glory) is an erect, tufted annual sedge 20-70 cm tall. This weed is dominant in this area.
* Sphenoclea zeylanica(Sole plant) is an erect annual broadleaf with smooth stout, fleshy hollow many-branched stem 0.3-1.5 m tall.

(2) Quantity of weeds occurring in this area

1) Occurrence of weeds in the Experimental farm field transplanted on Dec. 19, 1990.

Number and fresh weight/3.3m in each kinds of weeds were investigated on Jan. 25, 1991, 37 days after transplanting.

Results showed table 1.

C. difformis and F. milliacea of sedges weeds and S. zeylanica of broad leaf weeds were mainly weeds found in this field.

F. milloacea was the biggest in the number of weeds and fresh weight, next t it, S. zeylanica. Therefore F. milliacea was dominant weed. This weed occurred in all place of paddy field except at low place in paddy field. It seems that occurrence of this weed will strongly inhibit rice yield.

Table 1 Occurrence of weeds in the Experimental farm field transplanted on Dec. 19, 1990

Item	Kind of weeds		
	C. difformis	F. milliacea	S. zeylanica
No. of weeds/3.3m^2	19.5	708.0	19.0
Fresh weight(g)/3.3m^2	16.0	171.0	24.5

Item	Kind of weeds	
	Other grass weeds	Other Broadleaf weeds
No. of weeds/3.3m^2	0.5	9.0
Fresh weight(g)/3.3m^2	0.1	14.0

2) Development of Quantity of weeds occurred in the paddy field transplanted Jan. 31, 1991

Quantity of weeds occurred in the paddy field was investigated 20 and 27 days after transplanting. Height of Sedges and rice plant were measured on each investigation date.

Results showed Table 2.

From our observation, Sedges are the dominant weeds as against Grasses and Broad leaves. It showed that 27 days after transplanting, Sedges recorded 3600 g(fresh weight) and 28.6cm high.

Sedge development is faster than rice since Sedge number and fresh weight in a given area is also higher.

This data indicates that hand weeding and hand weeder are best applied 14 and 28 days after transplanting.

Table 2 Development of fresh weight of weeds occurred in the paddy field transplanted Jan. 31, 1991

Date after transplanting	Kind of weeds(fresh weight/4m²)			Sedges height	Rice height
	Sedges	Grasses	Broad leaves		
	g	g	g	cm	cm
20 days	412	5	1	15.4	31.4
27	3600	3	5	28.6	42.3

(3) Chemical control by several herbicides application

1) Effect of application of post-emergence herbicides

Post-emrgence herbicides applications were tested in a heavily weedy field Treatment are as follows;

Application of Basagran, 2.4-D and Propanil were applied by standard method on the Feb. 11, 1991. Eight days after application, a close analysis was carried out. The following are the findings.

Basagran: It is more effective on overgrown Sedges because it knocked down the Sedges completely leaving behined only few Sedges that were omitted during application of herbicide. This herbicid seems more effective on Sedges than 2.4-D and Propanil.

On broadleaves efficancy is less than 30%.

2.4-D : It was discovered that 2.4-D is partially effective on overgrown

Sedges, however, less effective than Basagran but more effective tha Propanil.

Broadleaves are untouched. They seem even more healthy after application of 2.4-D. It is believed that more successful result may be achieved when applied at a tender age of the weeds.

The only grass species found in the given area is Ischemum rugosium " Aba" in Igbo laungage). This aggressive grass was untouched by 2.4-D herbicide.

Propanil: It was observed that Propanil is not very effective on overgrown Sedges. This herbicide did not knock down Sedge completely. The already affected Sedges seem to be recovering from shock of herbicide applied. S. zeylanica of broad leaf was badly knock down.

From the resuls of this experiments, it is obseved that Basagran is more effective on grown Sedges than 2.4-D and Propanil. It is also observed that best result would have been obtained if these herbicides were applied between 21-30 days after transplanting. Propanil was found more effective on broad leaves than 2.4-D and Basagran.

2) Effect of combination application with Pre- and Post-emergence herbicides

We investigated to determin the effectiveness of herbicides application system with Pre- and Post-emergence application herbicides.

Treatments are as follows:

Ronstar and Basagran, Dercut and Basagran, Control

Ronstar was applied 4 days before transplanting, with 500ml/ha. Basagran was applied 20 days after transplanting, with 5 liters/700 litters water/ha. Dercut was applied 4 days before transplanting, with 5 liters/ha.

Results showed table 3.

It was observed that no treatment plots showed absolute weed infestation 31 days after transplanting. The weeds will over grow rice hills due to over population of weeds. Ronstar and Dercut gave the best results so for in weed control. The plots are perfectly clean.

Basagran application shows complete weed eradication 31 days after transplanting.

Table 3 Occurrence of weeds in the test of chemical control by several herbicides application on 35 days after transplanting.

Treatments	Kind of weeds(Fresh weight/ ㎡)		
	Sedges	Grasses	Broad leaves
Ronstar and Basagran	0	0	0
Dercut and Basagran	0	0	0
Control	1258	4.5	8.8

a)Investigated on Mar.7,1991 31 days after transplanting.

(4) Control by combing Hand weeding,Hand weeder and Herbicide application

We determined the best method of weeds control by integration of chemical control,hand weeding and hand weeder.

Treatments are as follows;

* Ronstar applied 4 days before transplanting and Hand weeding 25 days after transplanting.
* Hand weeder was used 14 days after transplanting and Basagran applied 20 days after transplanting.
* Hand weeder was used 14 days after transplanting and Hand weeding 20 days after transplanting.

Occurrence of weeds was investigated on Mar. 7 1991, 31 days after transplanting.

Results showed Table 4.

It was observed that no treatment plots showed absolute weed infestation 31 days after transplanting. The weeds over grow rice hills due to over populati of weeds.

Ronstar and man power have proved the best result by reducing weed infestation. Application of Ronstar makes hand weeding very easy. It also showed the most economical approach to weed control.

Hand weeder and Basagran showed a perfect control of weeds. Whatever weeds in-between hills are taken care by Bsagran application.

Hand weeder and Hand weeding allows weeds infestation,hence remains weeds after application of Hand weeder are hand weeded 40 days after transplanting

Ronstar and Hand weeding is here by recommended to farmers in this area because Ronstar is cheap,effective and can be applied directly without much labour. Hand weeding is applied to pick up few weeds that might have emerged after application of Ronstar herbicide.

Table 4 Occurrence of weeds in the Integrated control test

Treatments	Kind of weeds(Fresh weight/ m^2)		
	Sedges	Grasses	Broad leaves
	g	g	g
Ronstar and Hand pulling	0	0	0
Hand weeder and Basagran	0	0	0
Hand weeder and Hand pulling	233	0.5	10.8
Control	1612	5.8	66.3

a)Investigated on Mar.7,1991,31 days after transplanting.

(5) Discussion

Several kinds of weeds have occur in this area. Sedge weeds were dominant. Grass weed which farmers called " Aba in Igbo lungauge occurred, but its occurrence is very few in puddled fields.

Plenty of Sedge weeds that is Cyperus difformis occurred. Occurrence of quantity of them reached 3600 g of fresh weight/4m 27 days after transplanting the experiment farm field. If control of this weed is not carried out, Rice yield will be reduce drastically.

In the broad leaf weeds, Sole plant that is Sphenoclea zeylanica was dominant. This weed is stout and higher than rice plant in the later rice growing stage. Therefore occurrence of this weed will inhibit high yield of rice.

There were plenty of weeds at the high place rather than at low place in the paddy field. In high places, weeds control was very difficult.

Now there are three control methods of weeds, hand weeding, use of hand weeder and herbicides. It seems that efficiency of control methods will be improved by levelling and suitable water management in the paddy fields.

Hand weeding is time consuming. We can not control the weeds only by hand weeding, because there are plenty of weeds in this area now.

Use of hand weeder is more efficient than hand weeding. But this method can not be used now in this area, because now line transplanting is not popular in this area.

Some farmers have been using herbicides. In this experiments, pre-emergence herbicides, Ronstar and Dercut were very effective. In the post emergence herbicides, Basagran was more effective than 2.4-D and Propanil. Ronstar and Dercut can be applied only by swinging chemical's bottle left and right in a flooded field after puddling. Therefore these application is very easy.

It seems that Ronstar or Dercut application before transplanting and Hand weeding, use of hand weeder or use of Basagran after transplanting are most suitable weed control methods in this area

2. Control methods

(1) Individual control method

1) Hand weeding

* Time of hand pulling

First - 14days after transplanting

Second- 28days after transplanting

Third - 40days after transplanting(If need arises)

* Weeding in dry plot is very difficult and inefficient. This is because as you pull down weeds, definitely tender shrubs or weeds cut, only to regencrate after a short time.
* Water should be introduced into the plot 2 days before weeding to soften the soil for easy and thorough weeding.
* Weeds pulled out should be gathered together and caried out of the plot. This can be achieved by putting uprooted weeds in bags and later emptied on the bunds.
* Hand weeding operation should be done twice. First weeding - 14 days and 2nd weeding - 28 days after transplanting. However, if weeds come up again third weeding should be carried out at about 40 days after transplanting.
* In case weeds are seen during harvesting, the weeds should be uprooted to avoid rice seeds contamination. Where otherwise weeds seeds contaminate soil and this encourages heavy weed infestation in subsequent seasons.

2) Utilization of Hand weeder

Mechanical weeding is application of simple machine to weeding in paddy field. This method has not been in practice here in IAIP, Omor. But this method will be useful in the future.

* Condition for application of mechanical weeding is as follows

The paddy field must be level. Depth of water must not be less than 2-3cm. Water should be supplied into the paddy field 2 days before weeding to soften the soil for easy and thorough weeding.

* Weeds around rice hills can not be weeded mechanically, therefore hand weeding or application of Basagran should be carried out weeds around the hills.
* Time of treatment

First-14days after transplanting

Second-28days after transplanting

Third-40days after transplanting(If need arises)

3) Utilization of herbicides

Utilization and characteristic of herbicides

① Ronstar and Dercut

* Kinds of weeds controlled by herbicides:Annual grasses,annual sedges, annual broadleaves
* Type of Herbicide:Pre-emergence application
* Time of treatment:Just before puddling

In Nigeria,Omor,normally Ronstar application is after puddling.After application,Ronstar,water and soil mixed with small wooden plank to increase efficency.

:Rice seedling must be transplanted 4days after application

* Term of residual effect:About 30days after application
* Mode of action:Weeds germination is inhibited.
* Application method:

:Flood plot to a depth of 5-6cm

:Walk across the plot and spray after 5-6 steps by swinging the bottle once on your right and left hand

:One swing of Ronstar releases 5ml,therefore 100 swings equals 500ml (1 bottle of Ronstar)

:Each swing covers 3-4m,Right and left swings cover a total length of 10 m

:3 days after application,maintain water depth to 3-4cm

:Transplant on the fourth day and maintain water depth to 3-4 cm

② Basagran

* Kinds of effective weeds:Annual and perennial sedges,
  Annual and perennial broadleaf weeds
  (Not effective on grass weeds)
* Type of Herbicide:Post-emergence application
* Term of residual effect:About 30days after application
* Mode of action:Weeds are killed afetr this chemical is absorbed from weeds root,leaves and stem.
* Time of treatment:20 ~30 days afetr transplanting
* Quantity:5 literes/ha to 700-1000 literes of water
* Application method:

:Before application of Basagran,the paddy field should be drained of water,this is because water reduces the effect of Basagran.Basagran

can knockdown weeds when it has direct contact with the weeds.
:After application, the paddy field should be left dry for 2-3 days before water is re-introduced into the paddy field.
:Where weeds are seen in patches, spot application is advised because is more economical
* Best results are achieved on sunny day, while poor results have been witnessed on cloudy and rainny days

③ 2.4-D Amin(A.I.49.5%)
* Kinds of effective weeds:Annual and perennial sedges,
Annual and perennial broadleaf weeds
(Not effective on grass weeds)
* Type of Herbicide:Post-emergence application
* Term of residual effect:About 30days after application
* Mode of action:Weeds are killed after this chemical is absorbed from weeds roots, leaves and stems.
* Time of treatment:35 ~40 days afetr transplanting
* Quantity:8-10 literes to 700-1000 literes of water/ha
* Application method:
:The paddy fields should be drained 2-3days before application
:Don't supply water in the next 2-3 days after application.

(2) Integrated control
Different farmers have differet methods of weed control. Integrated control means application of herbicides, mechanical and hand weeding with the aim of controlling weeds in rice paddy field.
Field condition in terms of weed density determines the type of weed control method to be used. Farmer's financial background and labor availability also determins weed control method to be adopted.

1) Hand weeding only
Hand weeding-14days after transplanting
Hand weeding-28days after transplanting
Hand weeding-40days after transplanting(if need arises)
2) Ronstar and hand weeding
Ronstar application just after or before puddling
Hand weeding-28 days after transplanting
Hand weeding-40days after transplanting(if need arises)

3) Hand weeder and hand weeding

Hand weeder -14days after transplanting

Hand weeding-21days after transplanting

Hand weeder -28days after transplanting

Hand weeding-35days after transplanting

Hand weeding-40days after transplanting(if need arises)

4) Ronstar and Basagran or 2.4-D

Ronstar applicaation after or before puddling

Basagran or 2.4-D application after transplanting

Hand weeding 40 days after transplanting(If need arises)

3. Future weeds control in this area

Puddling, levelling and suitable water management were very effective method in the weeds control. Therefore keeping of tractor and improvement of its operation techinques are very important subject. Efficiency of weeds control will be improved by levelling and suitable water management.

Now, random tarnsplanting is popular. Random transplanting is more inefficient rather than line transplanting in utilization of hand weeding, hand weeder and post-emergence herbicides. Therefore it is necessary at the early stage that the spread of line transplanting be promoted.

There are two methods in the spread of hand weeder; one is production in Nigeria another is introduction from Japan. It is advisable that hand weeder is produced in Nigeria, because this machine is very simple.

Application of herbicides is most effective method in the weeds control. It is advisable that Japan supports Nigeria in the importation of herbicides.

If in future, paddy fields are level, use of garnule herbicides is very convenient, and it is applied easily by hand or simple granule applicator. Therefore in this experimental farm, glanule herbicides must be examined.

It is important that farmers must understand field sanitation, that is cutting weeds on the bund and weed control during off season of rice cultivation for the purpose of decreasing weed seeds in the paddy fields.

V CONTROL OF PLANT DISEASES

1. Main diseases forecasted occurrence in future

Now rice diseases occurrence in this area(IAIP) is not important problem. We can not find diseases occurrence except of Sheath blight and Sheath rot. But if in future, too much fertilizer condition and other poor cultural methods will encourage several diseases occurrnce, for instanse, bacterial leaf blight, sheath blight and blast.

We have no information on occerrence and it's control of diseases in this area therefore we show characteristics and control methods of main rice diseases in tropical rice plant by citing from several reports.

(1) Bcterial leaf blight

* Pathogen Bacteria
* Scientific name Xanthomonas campestris pv. oryzae
* Dissemination Water transmission
* Symptom

Yellow to white lesions begin as water-soaked stripes at the margin of leaf blade. lesions may start one or both edges of a leaf, or at any point start on one or both edges of a leaf, or at any point on injured blades, and advance to cover the entire blade.

Bacteria invade the vascular system of rice plant during transplanting, when seedling are pulled from the seedling bed or when damaged. When blight bacteri cells invade rice plant through the basal stem, plant kresek. leaves or entire plants will during seedling to early tillering stages.

Sources of bacteria are diseased strow, stubble of infected plants, and weeds host.

Blight is spread by dew, irigation water, rain flooding and strong winds. Bacteria cells form small beads in the morning, which harden and adhere the leaf suraface of a host plant. Moisture on the leaf surface dissolves the beads and bacterial cells spread freely.

High nitrogen fertilizer rates favor blight epidemics, especially where susceptible cultivars are grown.

* Control

Utilization of resistant variety

fungicides application at the begining of occurrence(e. x. Shirahagen wp. or dust).

Avoid application of too much nitrogen fertilizer

(2) Sheath blight

* Pathogen Fungi
* Scientific name Rhizoctonia solani
* Dissemination Soil transmission
* Symptom

First symptoms are greenish gray that develop on the leaf theaths near the waterline. The ellipitical or oval, about 1 cm long spots enlarge, lengthen to 2 or 3 cm, and join. The border each lesion and the colour variation of lesions give a distnct pattern to the infected area.

Under favarable humid conditions, leaf blades in contact with adjacent infected stems also become infected.

Symptoms are usually distinct during flowering or maturing stages. Severe infection results in poor grain filling.

* Control

Avoid too much nitrogen fertilizer application
Aviod too much high density transplanting
Application of fungicides, e.x. Polyoxin, Monseren, Moncut etc.

(3) Blast

* Pathogen Fungi
* Scientific name Pyricularia oryzae
* Dissemination Seed transmission and air transmission
* Symptom

This fungus can infect rice plant at any growth stages.

Typical leaf lesions are spindle-shaped-wide in the center and pointed toward end. Large lesions(1 to 1.5×0.3 to 1.5 cm) usually develop gray centers. Leaves of susceptible variety may be killed. Pinhead-size brown lesions, indicating a resistant reaction, may be difficult to distinguish from the symptom of brown spot.

Rice blast may attack the stem at the node. The sheath breaks easily.

Lesions may occur on the panicle neck. Infected necks turn blackish and break over. When neck rot occurs, few or no seeds in the panicle fill.

High nitrogen levels and wet leaves favor infection.

* Control

Seeds disinfection by Benlate I WP
Utilization of resistant variety
Avoid too much nitrogen fertilizer application
Grand application by Hinosan, kitazin P, Kasgamicin etc.

(4) Brown spot

* Pathogen Fungi
* Scientific name Helminthosporium oryzae
* Dissemination Seeds transmssion and air transmission
* Symptom

The most conspicuos symptoms are found on leaves and glumes. Typical spot on the leaves are oval, about the size and shape of sesame seeds. They are relatively uniform and fairly evenly distributed over the leaf surface. Young spot are small, circular, 0.05 to 0.1 cm in diameter, and usually dark brown most have a light-yellow halo around their margins

* Control

Application of phosphate and silicate fertilizer
(This disease occurrence is promoted by lack of phospate in soil)
Seed disinfection by Benlate T WP
Groud application by Hinosan

(5) Sheath rot

* Pathogen Fungi
* Scientific name Sarocladium oryze
* Dissemination Air transmission
* Symptom

Infection occurs on the uppermost leaf sheath at late booting stage. Early symtoms are oblong to irregular spots, 0.5-1.5 cm long, with gray centers and brown margins or gray brown throughout.

Lesions enlarge, often connect, and may affect the entire leaf sheath. Severe infection may cause panicles to be only partially exserted. Unemerged panicle are rotted and show aboundant powdery fungaus growth inside the leaf sheath. Partially emmerged panicles may produce poorly filled grains.

* Control

We have no information about control methods of this diseae.
This disease occurrence is promoted by stem borer damage, therefore the control of Stem borer is one of the control methods.

2. Future diseases control in this area

Occurrence of diseases is not important problem in this area now. It is caused by short term history of irrigation rice cultivation and lack of appropriate fertilizer application. After many years of irrigation rice cultivation,

several tropical diseaes will occurr. Therefore investigation of diseases occurrence must be carried out in the fixed fields in the case of insect pests.

Use of resistant varieties is most efficient in the diseases control. Therefore I recommend experiments on resistant varieties about Blast and Bacterial leaf blight.

Now, it is no need to control diseases in this area, but occurrence of Blast and Brown spot have been confirmed in this state. Therefore seeds disinfection by fungicides i.e. Benlate T or Supper-homai will be needed in this area.

VI REFERENCES

1. Ray P.A. (1982). Your guide to identifying some arable land weeds of south eastern agricultural zone of Nigeria. Extention Research Liaison Service National Root crops Research Institute, Umudike, Nigeria.
2. International Rice research Institute (1983). Fields problems of tropical rice. Manila, Philippines.
3. Dennis Hills(1975). Agricultural insect pests of tropics and their control.
4. Hidaka I. and Widiarta N. (1986). Strategy of rice gall midge control. Tropical Agriculture Research Center, Ministry of Agriculture, Forestry and Fisheries Japan.

PLANT PROTECTION OF RICE

I CONTROL OF WEEDS

II CONTROL OF INSECT PESTS

III CONTROL OF PLANT DISEASES

IV HOW TO USE AGROCHEMICALS

LAIP－JICA

1991

I CONTROL OF WEEDS

1 Weeds reduce rice yields

2 Weeds compete with rice plant

3 Weeds decrease the effect of nitrogen fertilizer

4 Weeds —differences between grasses, sedges and broadleaved weeds

5 Common weeds in rice fields —grass

6 Common weeds in rice fields —sedge

7 Common weeds in rice fields —broadleaf

8 Differences between grasses and rice plant

9 Common weeds in this area

* Ischamum rugosum is aggressive, erect or stragging, tufted annual grass 0.6-1.2m tall.

* Cyperus difformis(Small flower umbrella plant) is an erect, smooth, densely tufted annual sedge 20-70cm tall.

* Fimbristylis miliacea(Horning glory) is an erect, tufted, annual sedge 20-70cm tall.

* Sphenoclea zeylanica(Sole plant) is an erect annual broadleaf with smooth stout, fleshy, hollow, many-branched stem 0.3-1.5m tall

10 When to weed the rice crop

11 Weeds can be controlled by hand pulling

* Time of hand pulling

  First 14days after transplanting

  Second 28days after transplanting

  Third 40days after transplanting(If need arises)

* Weeding in dry plot is very difficult and ineffective. This is because as you pull down weeds, definitely tender shrubs or weeds cut, only to regencrate after a short time.

* Water should be introduced into the plot 2 days before weeding to soften the soil for easy and thorough weeding.

* Weeds pulled out should be gathered together and caried out of

the plot. This can be achieved by putting uprooted weeds in bags and later emptied on the bunds.

* Hand weeding operation should be done twice. First weeding - 14 days and 2nd weeding - 28 days after transplanting. However, if weeds come up again, third weeding should be carried out at about 40 days after transplanting.

* In case weeds are seen during harvesting, the weeds should be uprooted to avoid rice seeds contamination. where otherwise weeds seeds contaminate soil and this encourages heavy weed infestation in subsequent seasons.

12 Weeds can be controlled by mechanical means

Mechanical weeding is application of simple machine to weeding in paddy field. This method has not been in practice here in LAIP Omor. But this method will be useful in the future.

* Condition for application of mechanical weeding is as follows

The paddy field must be level. Depth of water must be less than 2-3cm. Water should be supplied into the paddy field 2 days before weeding to softten the soil for easy and through weeding

* Weeds around rice hills can not be weeded mechanically, therefore hand should be used to weed around the hills.

* Time of treatment

First-14days after transplanting

Second-28days after transplanting

Third-40days after transplanting(If need arises)

13 Weeds can be controlled by proper water management

14 Weeds can be controlled by crop competition

15 Weeds can be controlled by herbicides

Utilization and characteristic of herbicides

(1) Ronstar(EC)

* Kinds of effective weeds:Annual grasses,annual sedges,annual broadleaves
* Type of Herbicide:Pre-emergence application
* Time of treatment:Just before puddling

In nigeria,Omor,normally Ronstar application after puddling. After puddling,Ronstar,water and soil to be mixed with small wooden plank.

:Rice seedling must be transplanted 4days after application

* Term of residual effect:About 30days after application
* Mode of action:Weeds germination is inhibited.
* Application method:

:Flood plot to a depth of 5-6cm

:Walk across the plot and spray after 5-6 steps by swinging the bottle once on your right and left hand

:One swing of Ronstar EC releases 5ml,therefore 100 swings equals 500ml(1 bottle of Ronstar EC)

:Each swing covers 3-4m,Right and left swing cover a total length of 10m

:3 days after application,maintain water depth to 3-4cm

:Transplant on the fourth day and maintain water depth to 3-4 cm

(2) Basagran

* Kinds of effective weeds:Annual and perennial sedges, Annual and perennial broadleaf weeds (Not effective to grass weeds)
* Type of Herbicide:Post-emergence application
* Term of residual effect:About 30days after application
* Mode of action:Weeds are killed afetr this chemical is

absorbed from weeds root, leaves and stem.

* Time of treatment:20 ~30 days afetr transplanting
* Quantity:5 literes/ha to 700-1000 literes of water
* Application method:
  :Before application of Basagran, the paddy field should be drained of water, this is because water reduces the effect of Basagran. Bsagran can only knockdown weeds when it has direct contact with the weeds.
  :After application, the paddy field should be left dry for 2-3 days before water is re-introduced into the paddy field
  :Where weeds are seen in patches, spot application is advised because is more economical
* Best results are achieved on sunny day. Poor results have been witnessed in cloudy and rainny days

(3)2.4-D Amin

* Kinds of effective weeds:Annual and perennial sedges,
  Annual and perennial broadleaf weeds
  (Not effective to grass weeds)
* Type of Herbicide:Post-emergence application
* Term of residual effect:About 30days after application
* Mode of action:Weeds are killed after this chemical is absorbed from weeds roots, leaves and stems.
* Time of treatment:35 ~40 days afetr transplanting
* Quantity:8-10 literes to 700-1000 literes of water/ha
* Application method:
  :The paddy fields should be drained 2-3days before application

:Don't supply water in the next 2-3 days after application.

16. Integrated control

Different farmers have differet methods of weed control. Integrated control means application of herbicides, mechanical and weeding with the aim of controlling weeds in rice paddy field.

Field condition in terms of weed density determines the type of weed control method to be used.

Farmer's financial background and labor availability also determins weed control method to be adopted.

(1) Hand weeding only

Hand weeding-14days after transplanting

Hand weeding-20days after transplanting

Hand weeding-40days after transplanting(if need arises)

(2) Ronstar and hand weeding

Ronstar application just after or before puddling

Hand weeding-20days after transplanting

Hand weeding-40days after transplanting(if need arises)

(3) Hand weeder and hand weeding

Hand weeder 14days after transplanting

Hand weeding 21days after transplanting

Hand weeder 28days after transplanting

Hand weeding 35days after transplanting

Hand weeding 40days after transplanting(if need arises)

(4) Ronstar and Basagran or 2-4D

Ronstar appliccation after or before puddling

Basagran or 2.4-D application after transplanting

Hand weeding 40 days after transplanting(If need arises)

Ⅱ CONTROL OF INSECT PESTS

In this area(LAIP),we found that pests constitute a big problem.Some of the common insect pests around are Stem borer,Rice hispid,Case worm,Grass hopper Lady beetle etc.

However,around towns the project area such as Adani,Omasi etc.have recorded attack of rice insect pest called Gall midge.Gall midge has not been regarded as an important insect pest of rice until recent occurrence of this pest in the past few years.

Gall midge has consistently reduced rice yield in some countries of west Africa.In future Gall midge may become an important rice insect pest in this area.

Few information about insect pest in this area are available such as economic injury level,extent or degree of damage,time of occurrence, the most important time of insecticides application and life cycle of insect pest.

However,we show the ecology and control of the insect pest which we have now.

1.Stem borer

＊Scientific name　Diopsis thoracica

＊Common name　Stalk-eyed Fly(Stalk-eyed Borer)

＊Host　Main:Rice and Sorghum

Alternative:Wild gasses

＊Damage

The maggot feeds on the central shoot of the young rice plant, causing "dead-heart" .Later generation of larvae feed on the flower before it emerges. "white head" is caused after flowring.

＊Life history

The eggs are 1.7 ×0.4mm,white,boat-shaped. Each female lays about 20 eggs over a 10 days period.The eggs are laid upper

surface of young rice leaves.

The larva on emergence moves down inside the leaf sheath and feeds on the central shoot above the meristem. Later larve feed on the flower head before it emerges. Larval development takes 25-33 days.

The pupal period is 10-12 days. The adults are typical diopsid flies with characteristic eyes and antennae bore on the ends of long lateral stalks.

* Control

If 10% of damaged tillers(dead hearts) is over 30 days after transplanting, the application of some effective Insectcides against stem borer infestation may be necessary. Where necessary, spray Sumithion, Diazinon, Gammalin 20 and Dimecron.

Spray the leaves and base of the plants throughly. When spray, water is droped off from the paddy field.

2. Rice Hispid

* Scientific name Trichipa sericea
* Common name Rice Hispid
* Host Main:Rice
Alternative:Species of wild gasses

* Damage

Attacked plants have irregular pale brown patches and narrow whitish streaks on the leaves. The pale brown patches are the larval mines, and the whitish streaks are the feeding scars produced by the adults.

An important pest in rice nurseries, sporadically serious on the transplantig rice.

* Life history

Eggs are laied singly in slits in the leaf made by the adult beetle, the wound being covered by a spot of excreta. Hatching takes place after 3-4 days.

The larva is a slender, yellowish grub which when fully grown is about 6 mm long. It feeds inside the leaf, the mine being visible externally as a pale brown blotch. The larval period lasts about ten days.

The adult is a dark grey beetle covered with upright spines. It is about 3-4 mm long. Adult feamales live for about two weeks and may lay more than 100 eggs during this period. Adult feed externally on the leaves, the damage being visible as whitish streaks parallel to the veins.

* Control

If over 3 adults per 10 hills occured, insectcides application will be needed.

We have no information about effective Insectcides in Nigeria. From this time on, we must be screening effective insectcides against Rice Hispid. But Sumithoin and Diazinon may be effective.

3. Case worm

* Scientific name Nmphula depunctalis
* Common name Rice Caseworm
* Host Main: Rice
Alternative: Various grass species

* Damage

The caterpillar cut off the tips of leaves to construct the case in which it lives, the case is changed as the caterpiller grows. In heavily infested, crops the loss of photosynthetic tissue can be critical and seedlings may die.

Older plants generally are more tolerant of damage, and mature

plants are seldom attacked.

The larvae feed mostly on the lower side of leaves lying flat on the water, or on submerged portions of the leaves.

* Life history

The eggs are laid singly on the leaves, they hatch in 2-6 days, and after a few days the first larvae construct the first cases. On female moth cesually lays about fifty eggs. The caterpiller is semi-aquatic in nabits and withstand prolonged immersion the case is always filled with water.

The larval stage lasts for 15-30days. The fully grown caterpiller is 13-20cm long. Pupation takes place inside the last larval case which is fastened to the base of the stem. It may take place under water but more usually above water level.

The adults emerge after 4-7 days and can live for up to three weeks. The adults are small, delicate, snowy-white moth with pale brown spots on the wings, they have a wingspan 15-25mm.

* Control

Draining the water from infested fields for 2-3days succefully kills the caterpillars.

The more successful insecticides used are Sumition, Diazinon, and Dimecron.

4. Gall midge

* Scientific name Orseolia oryzae

* Common name Rice stem Gall Midge

* Host Main:Rice

Alternative:Wild species of oryzae and grasses

* Damage

The severity of damage is related to the time of attack. The larvae move down between the leaf sheath until they reach the apical bud or one of the lateral buds. There they lacerate the tissue of the bud and feed until pupation. The feeding causes formation of a gall called a "silver" or "onion " shoot .

In some areas this is a very serious pest causing crop losses of 30 -50% with some regularity and occasionally loss of 100%.

* Life history

Fertilized females start eggs-laying within a few hours of emergence. They lay 100-300 eggs each. The eggs are elongate, tubular and white, pink or red in colour. Inccubation takes 3-4 days or more.

The larve are 1 mm long on hatching, with a pointed anterior end, and a pale colour. They eventually grow to 3mm long and become red.

Pupation takes place at the base of the gall and the pupa is 2.0-2.5mm long and 0.6-0.8mm broad. Before the adult emerges the pupa makes a hole in the top of the gall with its spines and projects halfway, the skin splits and the adult emerges. Pupation takes 2-8 days. The adult is a delicate little midge, 3.5mm long, with long strong legs.

The whole life-cycle takes 9-26 days on rice. After one or two generations on garsses the midge generally moves to rice.

* Control

Careful timing of planting can avoid damage by this pest. Once post tillering stage, the plant not suitable as a host.

Considerable build-up of midge populations can occur on grasses near the rice crop. The succes of chemical control is very much dependent on accurate spray-timing to coincide with the emergence of each brood of midges.

Timing of insecticidal application is 14 and 28 days after transplanting at the rate of 1 kg active ingradient per ha when

damaged tillers(%) are over 5%. Effective insecticide is known to be carbofuran 3% of Furadan granule.

In general, this granule insecticid exerts this effectiveness for a period of 14 to 20 days after application.

The following formulae of insectides i.e. powder, emulsified concentration, and liquid are not effective in paddy fields.

The rice gall midge is known to be a serious rice pest in the wet season, while the insect infestation in the dry season is extremy low. If rice seedling is transplanted one month before begining of rainny season, the damage will be decreased. The reason why the insect damage is low in the early transplanting is considered attributable to low population of the insect which was strongly depressed by the long drought.

5. Grasshoppers and Crikets

* Scientific name Oxya spp. (Grasshopper)
  Crikets(Euscytus concinnus)
* Host Main:Rice
  Alternative:Species of wild gasses
* Damage

Grasshopper: Difoliates rice plants by removing large section near the edges of leaves

Crickets : Feed on leaves, leaving holes while keeping leaf margins intact. Leaves appear ragged.

* Control

Sumithion and Diazinon are effective to Nymphs and adult. They have strong stomach poison as well as contact action.

6. Lady beetle

* Scientific name Henosepilachna sp.
* Common name Lady beetle
* Host Main:Rice
Alternative:unknown
* Damage

It is a biting mouth type. It feeds on seedling leaves and left behind white and transparent patches which later turn yellow and dry up. The insect reduces photosynthetic feeding area of seedling thereby lowering photosynthetic activity of plant. In severe infestation, this pest causes serious damages on rice seedling in nursery stage, hence damage in paddy field is neglegible.

* Physical feature

Beetle like insect. It has yellow to orange colour with about 12 black spot, (1 mm diameter) on the outmost hardwings. The beetle seldomly fly. When it flies, the inner yellow and fiber wings are unfolded and flies for a short distance. Adult is 2-5 mm long.

* Control

This pest can be controlled by application of either of these insecticides, Bassa, Diazinon and Sumithion.

7. How to use Insecticides

* Sumichion, Diazinon Bassa and Dimecron

Dilution: ×1000 (1 ml preparations with 1000 ml water)

Quantiy of spray liquid:1000-1500L/ha

Notice:Avoid mixing Sumithion with propanyl-type herbicides and Sumition can not be applied within 10 days after application of these herbicides, because it can cause phytotoxicity. (Damage of plants by mixing chemicals)

* Furadan granule

Quantiy of application:33.3kg/ha

Ⅲ CONTROL OF PLANT DISEASES

Now rice diseases occurrence in this area(LAIP) is not important problem.We can not find diseases occurrence except of sheath blight and sheath rot.But if in future, too much fertilizer condition and other poor cultural methods will encourage several diseases occurrnce For instanse,bacterial leaf blight,sheath blight,blast and several virus diseaes.

Basic point of disease control are removal of infection source and cutting off the infection chains of pathogen.

We have no information on occerrence and it's control of diseases in this area.

Therefore we show characteristics and control methods of main rice diseases in tropical rice plant by citing from several reports.

1.Bcterial leaf blight

* Pathogen Bacteria
* Scientific name Xanthomonas campestris pv.oryzae
* Dissemination Water transmission
* Symptom

Yellow to white lesions begin as water-soaked stripes at the margin of leaf blade.Lesions may start one or both edges of a leaf, or at any point start on one or both edges of a leaf,or at any point on injured blades,and advance to cover the entire blade.

Bacteria invade the vascular system of rice plant during transplanting,when seedling are pulled from the seedbed or when damaged.When blight bacteria cells invade rice plant through the basal stem,plant kresek.Leaves or entire plants wilt during seedling to early tillering stages.

Sources of bacteria are diseased strow,stubble of infected plants, and weeds host.

Blight is spread by dew, irigation water, rain flooding and strong winds. Bacteria cells form small beads in the morning, which harden and adhere the leaf suraface of a host plant. Moisture on the leaf surface dissolves the beads and bacterial cells spread freely.

High nitrogen fertilizer rates favor blight epidemics, especially where susceptible cultivars are grown.

* Control

Utilization of resistant variety

Fungicides application at the begining of occurrence(e.x. Shirahagen wp. or dust

Avoid application of too much nitrogen fertilizer

2. Sheath blight

* Pathogen Fungi
* Scientific name Rhizoctonia solani
* Dissemination Soil transmission
* Symptom

First symptoms are greenish gray that develop on the leaf theaths near the waterline. The ellipitical or oval, about 1 cm long spots enlarge, lengthen to 2 or 3 cm, and join. The border each lesion and the colour variation of lesions give a distnct pattern to the infected area.

Under favarable humid conditions, leaf blades in contact with adjacent infected stems also become infected.

Symotoms are usually distinct during flowering or maturing stages Severe infection results in poor grain filling.

* Control

Avoid too much nitrogen fertilizer application

Aviod too much high density transplanting

Application of fungicides, e.x. Polyoxin, Monseren, Moncut etc.

3. Blast

* Pathogen Fungi
* Scientific name Pyricularia oryzae
* Dissemination Seed transmission and air transmission
* Symptom

This fungus can infect rice plant at any growth stages.

Typical leaf lesions are spindle-shaped-wide in the center and pointed toward end. Large lesions(1 to 1.5×0.3 to 1.5 cm) usually develop gray centers. Leaves of susceptible variety may be killed.

Pinhead-size brown lesions, indicating a resistant reaction, may be difficult to distinguish from the symptom of brown spot.

Rice blast may attack the stem at the node. The sheath breaks easily.

Lesions may occur on the panicle neck. Infected necks turn blackish and break over. When neck rot occurs, few or no seeds in the panicle fill.

High nitrogen levels and wet leaves favor infection.

* Control

Seeds disinfection by Benlate T WP

Utilization of resistant variety

Avoid too much nitrogen fertilizer application

Grand application by Hinosan, kitazin P, Kasgamicin etc.

4. Brown spot

* Pathogen Fungi
* Scientific name Helminthosporium oryzae
* Dissemination Seeds transmssion and air transmission
* Symptom

The most conspicuos symptoms are found on leaves and glumes. Typical spot on the leaves are oval, about the size and shape of sesame seeds. They are relatively uniform and fairly evenly distributed over the leaf surface. Young spot are small, circular, 0.05 to 0.1 cm in diameter, and usually dark brown most have a light -yellow halo around their margins

* Control

Application of phosphate and silicate fertilizer

(This disease occurrence is promoted by lack of phospate in soil)

Seed disinfection by Benlate T WP

Groud application by Hinosan

5. Sheath rot

* Pathogen Fungi
* Scientific name Sarocladium oryze
* Dissemination Air transmission
* Symptom

Infection occurs on the uppermost leaf sheath at late booting stage. Early symtoms are oblong to irregular spots, 0.5-1.5 cm long, with gray centers and brown margins or gray brown throughout. Lesions enlarge, often connect, and may affect the entire leaf sheath. Severe infection may cause panicles to be only partially exserted. Unemerged panicle are rotted and show aboundant powdery fungaus growth inside the leaf sheath.

Partially emmerged panicles may produce poorly filled grains.

* Control

We have no information about control methods of this diseae.

This disease occurrence is promoted by stem borer damage.

therefore the control of stemborer is one of the control methods.

Ⅳ HOW TO USE AGROCHEMICALS

1. Kinds of Agrochemicals(Classification of action)

Insecticide for Insect pest

-----Dimecron, Sumithion, Diazinon, Furadan etc..

Fungicide for Disease

-----Hinosan, Benlate T, Kasumin, Polyoxin, Kitazin P etc.

Herbicides for Weed

-----Ronstar, Bsagran, 2.4-D, Socopon, Propanil, Dercut etc

2. Kind of Agrochemicals(Classification ofFormulation)

Wettable powder(WP)

This type of agrochemicals is used by dilution with water. Spray liquid of this type agrochemicals is necessary adding sticker

Emulsifiable concentrate(EC)

This type of agrochemicals is ordinarily used by diluting with water except Ronstar 12L and Dercut.

Dust(D)

This type of agrochemicals are applied by duster

Granule(G)

This type of agrochemicals are applied by hand or granule applicator. Before applying, water is supplied in the paddy field(Paddy water application)

After application, granule is resolved in water and absorbed by plant root. Granuler agrochemicals action is systemic.

3. Adjustment of spray liquid

Sumithion EC 0.5 liters preparations with 500 liters of water

0.1 liters preparations with 100 liters of water

? preparations with 20 liters of water

1 liters = 1000 ml

0.5 liters = 500ml

$$? = 500 \times \frac{20}{500} = 20 \text{ ml}$$

? = 20 ml (CC)

Bsagran EC 5 liters preparations with 700 liters of water

? preparations with 20 liters of water

1 liters = 1000 ml

5 liters = 5000ml

$$? = 5000 \times \frac{20}{700} = 142 \text{ ml}$$

? = 142ml (CC)

BenlateT WP 250 g preparation with 1000 liters of water

? preparation with 20 liters of water

4. Precaution

When using agrochemicals, (Insecticides, Fungicides and Insecticides) should be taken with attention to the following particulars;

* You must identify the kind of insect pest,disease or weed.
* Selection of effective agrochemical for the target
* To apply the agrochemicals precisely according to the technical instruction and recommendation,which are generally represented on label attach there.
* In any case,do not apply the agrochemicals under strong wind condition
* If it is rain within 2 hours after application,that application is not effective.
* Wash hand and exposed parts of body or clothes after work.
* Keep the agrochemicals in their original container in a place which is out of reach of children and demestic animals preferably in a place which can be locked as well as dry and shelter from the sun.

短期専門家総合報告書

野　中　邦　彦

派遣期間　　平成３年１月10日から
　　平成３年３月９日まで
指導科目　　土壌

目　　次

ナイジェリア・ローアアナンブラかんがい稲作計画（LAIP）の水田でみられる水稲の生育障害の原因を明らかにするための調査を行った。また，水稲の生産力を向上させるために考えられる対策を提案した。

1. はじめに

この地域では，主に基肥として窒素，リン酸，加里を各30kg/ha施用するだけである。それさえも施用しない農民が多い。石灰，堆肥の施用は皆無に等しい。収量水準は2 t/ha(籾)以下である。目標収量は5 t/ha（籾）である。

調査期間は1991年1月14日から同年2月28日であった。今期は乾季作の開始が遅れ，一般圃場に水稲は作付されていなかった。唯一，試験圃場の一部で稲作が行われており，生育障害の観察等はそこで行った。

時間と実験機材の制約から十分な測定，考察が行えなかった。現地には実験機材は全く無かった。日本からの携行機材は1月29日に着いたものの，必要な試薬類は入っていなかった。その試薬の一部が2月18日に到着したが，残りは最後まで来なかった。試薬類を全て現地調達することは不可能であった。

試験圃場でみた生育障害は次の通りである。

生育むらが激しい。生育の悪い水稲は，分けつ発生が少なく，草丈が低い。また葉は幅がせまく，短く直立し，濃緑色である。古い葉に褐色になって枯死しているものがあった。

聞き取りによると，特に雨季作において，水稲の葉に褐色の斑点が現れ，しだいにその葉全体が褐色となって枯れる。いわゆるブロンジング現象がみられるという。また，前述のものも含めてこれら生育障害は，水深の深いところほど激しいという。しかし，今回の調査は乾季に行ったため，ブロンジングは観察されなかった。

2. 方法及び結果

1) 土壌調査

5圃場を選定し，深さ80cmまでを調査した(1991年2月6日)。

土色は黄褐色（10 YR 6/1, 6/3, 5/3, 5/4。乾土)。土性はCL（埴壌土)。深さ20cm以下は粘土含量が高くなり，極めて密である。れき，腐植は少ない。全層に斑鉄が認められた。W11-060（圃場番号）の50cm以下にグライ層が認められた。表層土は極度に乾燥し，亀裂を

生じ，また極めて堅い。可塑性は強。

ちなみに，試験圃場の水稲作付中の水田20cm以下の層は酸化状態だった(ジピリジル反応は g_1)。

2) 土壌の化学性

土壌調査した圃場から試料を採取し分析した。分析に使用した機器は次の通りである。

① pHメーター（東亜電波，HM-1K）

② 電導度計（東亜電波，CM-1K）

③ 土壌養分検定器（木屋製作所，Dr.ソイル）

第1表に結果を示す。

いずれの土壌もリン酸が特に欠乏している。次いで窒素，カルシウムが欠乏している。加里はやや欠乏状態である。pHはやや酸性である。電気伝導度及びマグネシウム，塩化ナトリウムは問題なしと考えられる。鉄は十分量ある。マンガンが多く，過剰の可能性がある。鉄，マンガンとも上層で多く，上方への水の動きがあったことを示している。

3) かんがい水の分析

pHは6.7。電気伝導度は0.04mS/cm。特に過剰な成分は含まないと考えられる。むしろ地質からみて，かんがい水としてはリン酸，けい酸の供給量が少ないと考えられる。

4) ポット試験

試験圃場の作土を供試し，次の条件で行った。

・土　　壌　　量：7.2Kg/pot（乾土換算）

・ポット面積：0.03m²

・施肥及び代かき：1991年2月5日

・移　　植：1991年2月6日（33日苗。3本1株，2株/ポット）

次の処理を組み合せた。(完全ではない)

・化成肥料施家：① 0g/pot

(15-15-15) ② 6.7g/pot

③ 13.3g/pot

・有機物施用：① 0g/pot

（わら） ② 36g/pot

・水位調節：① −3cm

② +5cm

・石 灰 施 用：① 0g/pot

② 10g/pot

③ 20g/pot

このポット試験では，試験期間が極めて短かったこと，施肥条件等が圃場条件とは異なること等を考慮しなければならない。また，虫害を受けたため正確な草丈，乾物重等の記載ができなかった。

観察されたことは次の通りである。

・化成肥料13.3g/pot の施用で水稲は濃度障害を受ける。

・化成肥料無施用だと藻が生えない。

・石灰施用が有効である。

・化成肥料施用（6.7及び13.3g/pot）と有機物施用（20g/pot）を組み合わせると水稲は障害を受け成長が停滞し，化成肥料13.3g/pot 施用では枯死した株があったが，移植4日目以降水位調節が順調になると－3 cm 区では急速な回復がみられた。

・化成肥料を施用しないと，分けつ発生及び草丈伸長が大幅に遅れた。

・有機物を施用し，水位を＋5 cm に調節したポットの土壌は硫化水素臭を発生した。

5） 二価鉄の測定

土壌中の活性二価鉄と土壌溶液中の二価鉄濃度を測定した。

活性二価鉄は pH 3.0酢酸塩緩衝液で浸出し，ジピリジル反応により定量した。土壌溶液中の二価鉄もジピリジル反応により定量した。

第2表に結果を示す。

6） 第3表に JICA がナイジェリア大学に100点の土壌サンプルを分析依頼した結果を示す。

有効な分析値の数は元素によって異なり，69～100であった。鉄の抽出法は明かでなかった。マグネシウム含量が高すぎると考えられる。その他分析法が日本で標準的に用いられているものと異なるものがあったため，検討は省略した。

3. 考 察

土壌中の二価鉄含量は高いが，これが LAIP における水稲の生育障害の主因とは考えにくい。理由は次の通りである。

・水稲の生育障害の程度と土壌中の活性二価鉄含量あるいは土壌溶液中の二価鉄含量との

間には相関関係がみられないこと。

・文献によると，鉄害を発生するとされる土壌中の二価鉄含量は，本報における活性二価鉄と似た方法で測定した値で数10ppm～数1000ppmにわたっており，二価鉄以外の要因が関与していると考えられること。

・水稲が生育できなくなる土壌溶液中二価鉄濃度はpH5.0で300ppmかそれ以上とされており，測定された値はそれに比べ小さい。また，生育障害との関係がみられないこと。

・ポット試験で得られた土壌溶液中二価鉄濃度は高いが，これはわら10t/haの施用量に相当し，LAIPにおける有機物施用量はこれよりかなり少ないこと。通常，有機物は焼却されている。

従って，LAIPにおける生育障害の発生過程を次のように推定した。

1. リン酸，カルシウム及び加里の欠乏により根の機能が低下する。
2. 還元性の有害物質（二価鉄，硫化水素，有機物の中間代謝産物）の存在によりさらに根の機能が低下する。
3. 機能が低下した根は，二価鉄のような有害物質を過剰に吸収する。

生育障害が水深の深いところほど激しいという理由は次のように推定される。

・この地域は気温が高いため，水稲の呼吸量が多い。また栽培されている水稲はインディカ種であり，酸素要求量が高い。水深が深いところほど，供給される酸素は少ないと考えられる。

・水深が深いところほど，施用された肥料が水に溶けてしまい，土壌との混合率が悪くなる。当地では主に植代施肥が行われている。

・当地では機械の不足から，代かき作業が丁寧には行えない。肥料が混合された土壌が荒い代かく作業により押し寄せられると，土壌が少なくなった所は有効養分保持量が少なくなる。

・圃場の透水性が悪いため，生成した還元性有害物質は土壌中に長く留まる。水深の深いところは常時湛水となるため，還元性有害物質は酸化分解されない。

水稲の生育障害が雨季において激しいとは，かんがい水による養分供給がないことと地下水位が上昇するためと推定される。

このほかにマンガン過剰，その他微量要素の欠乏が発生している可能性も否定できない。雨季における水稲の生育障害の症状はマンガン過剰症と類似している。土壌分析結果はマンガン過剰を示唆する値ではあるが，標準分析法でないため断定できない。これらの微量要素についても正確な分析が望まれる。

次にこれらの問題解決のための具体的手法あるいは対策を示す。

・窒素，リン酸，加里，カルシウムを増施すること。効率的な施肥量を求めるための試験

を実施する必要があろう。

・土壌の腐植含量を増加させること。施用する有機物の量，質及び施用方法，施用時期等について試験する必要がある。

・土壌肥沃度の均一化と水管理を容易にするため，田面の均平化を図ること。

・土壌の透水性に関する試験を実施すること。透水性が改良されれば，有害物質は排除されるであろうが，過度の透水は養分の損失も招きかねない。

・かんがい水は養分を供給するが，当地では地質からみてリン酸やけい酸の供給は見込めない。どの程度養分供給量があるか試験する必要があろう。

・土壌の毛管連絡を切断するため，雨季作後耕起することを検討する必要がある。これによって土壌が極度に乾燥することや有害物質の上昇が防げるのではなかろうか。

以上のことは，LAIPにおける土壌生産力の向上と維持管理のために役立つものであると考えられる。

4. 結　論

以上述べたように，LAIPにおける水稲の生育障害は，養分欠乏と還元障害によるものであると推定した。

さらに詳細な原因解明と対策樹立のためには，より多くの時間と実験環境が必要である。また，土壌に関する専門家の養成も必要であろう。これによって当地における土壌の主要な問題が解決され，LAIP全体が活性化されるであろう。

5. 謝　辞

この土壌調査を実施するに当り，磯川氏はじめ専門家の方々には貴重なご助言を頂き，またMazuka, Onyeokoro両氏にはご協力，ご助言頂き感謝致します。

第1表　土壌の化学分析結果

圃場番号	層 (cm)	pH (H20)	EC (1:5,mS/cm)	NH_4-N mg/100g	NO_3-N mg/100g	P_2O_5 mg/100g	K_2O mg/100g	CaO mg/100g	MgO mg/100g	Fe ppm	Mn ppm	NaCl %
w5-149	0-15	4.8	0.08	<1	<1	<1	15	<50	20	100	40	0.005
	15-30	5.4	0.05	<1	<1	<1	5	<50	50	30	10	0.005
E2-010	0-15	4.7	0.08	<1	<1	<1	20	<50	50	100	30	0.005
	15-30	5.1	0.05	<1	<1	<1	5	<50	1	40	20	0.005
W11-060	0-15	4.9	0.07	<1	<1	<1	10	<50	50	50	80	0.005
	15-30	5.6	0.05	<1	<1	<1	7	<50	30	8	30	0.015
E7-524	0-15	5.0	0.05	<1	<1	<1	15	<50	20	70	20	0.005
	15-30	5.2	0.05	<1	<1	<1	10	<50	25	70	7	0.005
E.F.	0-15	5.1	0.05	<1	<1	<1	15	<50	50	40	100	0.005
	15-30	5.2	0.05	<1	<1	<1	5	<50	50	10	40	0.005
目標値（日本）		5.5 ～6.5				10<	15<	200<	25<			

第２表　試験圃場において水稲の生育が異なる箇所より採取した土壌中の活性二価鉄含量と土壌溶液中の二価鉄含量

水稲の生育	土壌中の活性二価鉄含量 (ppm)	土壌溶液中の二価鉄含量 (ppm)
不　良	1,410	36
中　庸	1,610	36
良　好	1,760	44

第２表（続き）　ポット試験における土壌中活性二価鉄含量と土壌溶液中二価鉄含量

処理				土壌中の活性二価鉄含量 (ppm)	土壌溶液中の二価鉄含量 (ppm)
化肥	有機	水位	石灰		
0.0g	36g	+5cm	0g	1,470	–
6.7g	36g	-3cm	0g	150	–
6.7g	0g	+5cm	0g	80	3
6.7g	0g	+5cm	20g	90	9
6.7g	36g	+5cm	0g	1,720	124
13.3g	36g	+5cm	0g	350	–

化肥：化成肥料施用，有機：有機物施用，水位：水位調節，石灰：石灰施用．
湛水：　2月　5日，測定：　2月20日～22日．

第３表　ナイジェリア大学による土壌分析結果

	平均値及び標準偏差	範囲	分析点数
pH (H_2O)	5.0±0.6	4.1～6.1	100
pH (KCl)	4.0±0.8	3.0～5.4	100
E.A.(meq/100g)	6.1±3.6	1.2～32.8	100
T-N (%)	0.10±0.04	0.04～0.38	100
P_2O_5 (mg/100g) (Bray-2)	6±5	0～18	69
K_2O (mg/100g)	10±7	1～40	98
CaO (mg/100g)	136±113	28～653	100
MgO (mg/100g)	207±163	15～889	100
Fe (ppm)	4700±2900	400～12700	87
Al (ppm)	1300±1100	0～4500	88

現地レポート（土壌，短期）

Soil survey report in Lower Anambra Irrigation Project

This survey was conducted to clarify the causes of rice growth disorders in Lower Anambra Irrigation Project (LAIP), and suggest possible countermeasures for the effective rice cultivation in the project.

1. Introduction

In this area, fertilizer application is mainly basal (N-P_2O_5-K_2O, 15-15-15, each nutrient 30Kg/ha). Many farmars do not even apply lime and compost which has a very sound structural, biological and chemical influence on soil. Yield level is less than 2t/ha (nuhulled rice), as agenst 5t/ha target.

The survey period was from January 14, 1991 to February 28, 1991.

The dry season rice cultivation was delayed and conseqently no rice plant was seen in the general paddy field. Onry a part of the Experiment Farm (E.F.) was prepared and so observations of rice growth disorders were conducted there.

Enough research was not conducted because of the limited time and equipments. The authority had no soil laboratory, therefore no measurment equipment was available. Even so, soil measurment equipment expected from Japan arrived only on January 29 without the necessary chemicals. A part of these chemicals arrived on February 18, while the remaining ones are still being expected. Procuring some of these chemicals for the analysis were impossible in this part of Nigeria.

The growth disorders observed in the E.F. were as follows.

Uneven growth of rice plant was severe. Some of the characteristics of bad rice plants growth observed were small tillering, short plant length, narrow-short-vertical leaf blade, and very dark green leaves. Some of the old leaves were brown and dead.

It was reported in the rainy season brown spots usually appear on some old leaves of rice plants resulting to a phenomenon called Bronzing.

Besides the symptoms appear more severely as the water depth increases.

In this survey the Bronzing could not be observed due to the dry spell during the period of study.

2. Methods and Results

1) Soil survey

The survey was conducted in five plots in the main field up to 80cm depth. (February 6, 1991)

Soil color was yellowish brown (10 YR 6/1, 6/3, 5/3, 5/4, dry soil). Soil texture in the surveyed plots was CL (clay loam). Soil below 20cm depth has higher content of clay, and dense. Gravels and humus were low. Mottlings of iron were observed in whole layer. Gley horizen was observed below 50cm depth only in WII-060 (plot No.). Top soils were extremely dry, cracked, and hard. Plasticity was strong.

The dipyridyl reaction on the soil below 20cm depth in the cultivated E.F. was in the less oxidative phase (g1).

2) Soil chemical analysis

Soil samples were collected from the surveyed plot fields and analyzed.

Measurment equipments are as follows.

- pH meter (Toa Denpa, HM-1K)
- EC meter (Toa Denpa, CM-1K)
- Soil nutrients tester (Kiya, Dr.Soil)

Table I shows the results.

Phosphorus difficiency is severe. Nitrogen and calcium are difficient. Potassium is slightly difficient. pH is slightly low (adequate range is 5.5~6.5). EC and the concentrations of magnesium are generally adequate. Sodium chloride is low. Iron is enough. Possibility of excess manganese level was observed. Both iron and manganese showed higher concentrations in the upper layer and this indicates the water movement was upward within the period.

3) Analysis of irrigation water

pH was 6.7 EC was 0.04mS/cm. It was estimated that the irrigation water did not contein excess elements. It was rather estimated that the water conteined little phosphorus or silicate according to the geological characteristics.

4) Pot culture experiment

Using top soil in the E.F., pot culture experment was conducted.

- Soil weight/pot : 7.2Kg (dry weigt)
- Pot area : 0.03m^2
- Fertilizer application and puddling : Feb. 5, 1991

· Transplanting : Feb. 6, 1991

The following treatments were combined (not complete)

· Fertilizer application (15-15-15) : ① 0g/pot
② 6.7g/pot
③ 13.3g/pot

· Organic matter application (straw) : ① 0g/pot
② 36g/pot

· Water level : ① −3cm
② +5cm

· Lime application ($CaCO_3$) : ① 10g/pot
② 20g/pot

It must be noted that this experiment was a very short one and fertilizer applications were high from the point of view of the field conditions. Simply converted, the fertilizer 6.7g/pot was 1000~2000 Kg/ha and straw 36g/pot was 10t/ha.

Most rice plants got damaged by pest injury, so plant length and weight could not be measured accurately.

Observations were as follows.

· Rice plants got injury at a higher level of fertilizer application.

· No fertilizer, no algae bloom.

· Lim application was very effective.

· First four days of water management was not satisfactory. After improving the water management, the plants treated with water level −3cm recoverd in the pots containing low fertilizer and organic matter together.

· Tillering and elongation of the ribe plants treated with no fertilizer were much delayed.

· The soils treated with water level +5cm and application of organic matter had smell of H_2S.

5) Measurment of Fe^{2+}

Fe^{2+} in soil samples and Fe^{2+} im soil solution were measured. Fe^{2+} in soil was extracted with pH 3.0 acetate buffer and measured by dipyridy reaction. Fe^{2+} in soil solution was also measured by dipyridyl reaction. The soil solution collected was mixed immedeately with $AlCl_3$ solution.

Table 2 shows the results.

6) Table 3 shows the results of soil chemical analysis that JICA requested the University of Nigeria to conduct.

Available value was 69~100 in requested 100 samples. The buffer used in the extraction of iron was not mentioned in the report. Concentration of magnesium was too higt. However their analytical method was different from the standard method normally used in JAPAN. Differences in their result can not therefore be appreciated.

3. Discussion

Though Fe^{2+} in soils was much, this may not be estimated to be the main cause of LAIP rice growth disorders. Reasons are as follows.

- No correlation was observed between growth disorders and Fe^{2+} in soils or Fe^{2+} in soil solutions.
- From literature, the concentration of Fe^{2+} that induce iron toxicity measured by similar method ranged from a few 10 ppm to a few 1000 ppm. Therefore the possibility of another effect is estimated.
- Critical concentration of Fe^{2+} in soil solution is regarded to be 300 ppm or more for rice plant at pH 5,0. The measured values are by far smaller than that.

Fe^{2+} in soil solution in pot experiment was high. But the application of straw coresponds nearly 10 t/ha in the field. In LAIP applications of organic matter are by far smaller than this, especially when these are burnt.

Therefore the factors of rice growth disorders are estimated as follows.

i) Decrease of root activity due to the defficiency of the following nutrients, phosphorus, calcium and potassium.

ii) Presence of harmful substances (Fe^{2+}, H_2S) were identified. Also harmful metabolic intermediates of organic matter such as organic acid were naturally estimated, and so these have contributed to the decrease of the rice root activity.

iii) As the root become inactive, excess absorption of these harmful substances such as Fe^{2+} occurs.

The causes of severe rice growth disorders as the water depth increases are as follows.

The temprature is high in this area, so the respiration is also high. Besides the rice cultivated are Indica type, so the need for oxygen is high. As the water depth increases, the quantity of oxygen available decreases.

Fertilizers dissolve more as the water depth increases, so the mixing ratio to the soil

decreases.

When the fertilized soil surge due to the rough puddling, the available nutrients also decrease.

The field have little water permiability, so the reductive harmful substances stay long in the soil. The part of field where the water depth is high is always flooded, so the reductive harmful substances can not get oxidative decomposition.

The reasons that the symptoms of rice growth disorders are severe in rainy season may be attributed to the fact that there are no suppliment of nutrients by irrigation water and rise of ground water level.

Besides the symptoms of excess manganese, other micronutrients defficiency may be possible.

The appearances of rice growth disorders in rainy season closely resemble the symptoms of excess manganese. However the soil analysis suggests there is excessive manganese in soil, but over emphasizing this may be dangerous since this manganese analysis is not a standard one. Accurate and more detailed analysises of these micronutrients may be needed.

The following shows the concrete methods and countermeasurs to solve the above problems.

Much fertilizers (N.P.K,Ca) are needed. The research should be conducted to recommend the adequate qantity of ferlilizer.

Soil humus should be increased. The research conserning the qualily and quantity of organic matter, and the time and method of application should be conducted.

Leveling should be conducted to make the soil fertility uniform and water management easy.

The reserch conserning permeability should be conducted. If the permiability increases, the harmful substances can be removed. However excessive permiability may aid loss of the nutrients.

Irrigation water supply nutrients. But phosphorus and silicate suppliment may be little in this area according to geology. Research is therefore needed to ascertain their availability.

In order to cut the capillary connection it is also being recomended that plouing is needed after rainy season harvesting. It will surpress the excessive drying of soil and reduce the upward movement of harmful substances.

Finally soil survey of the project may be an asset as it will provide a very good dependable data base for the overall improvement and future management of the project.

4. Conclusion

As mentioned above the rice growth disorders in LAIP were estimated to be caused by nutrient difficiency and reductive injury.

To clarify the problems and suggest countermeasures as required, more time and equipment are needed. It is also necessary that some of the soil scientists in the Authority undergo further training especially as it relates to instrumentation in research oriented programmes. This will further enchance their activity in this project and possibly help reduce the major identified problems.

5. Acknowledgement

The author wishes to thank Mr. Isokawa and other experts for their advices and would like to acknowledge the continuing cooperations and suggestions of Mr. Maduka and Mr. Onyeokoro throughout the period of my stay at LAIP.

Shikoku National Agricultural Experiment Station
Nonaka Kunihiko

農林水産省　四国農業試験場
野　中　邦　彦

Table 1. The results of soil chemical analysis

Plot No.	Layer (cm)	pH (H_2O)	EC (1 : 5, mS/cm)	NH_4−N mg/100g	NO_3−N mg/100g	P_2O_5 mg/100g	K_2O mg/100g	CaO mg/100g	MgO mg/100g	Fe ppm	Mn ppm	NaCl %
W5−149	0−15	4.8	0.08	<1	< 1	< 1	15	<50	20	100	40	0.005
	15−30	5.4	0.05	< 1	< 1	< 1	5	<50	50	30	10	0.005
E2−010	0−15	4.7	0.08	<1	<1	<1	20	<50	50	100	30	0.005
	15−30	5.1	0.05	<1	<1	<1	5	<50	1	40	20	0.005
W11−060	0−15	4.9	0.07	<1	<1	<1	10	<50	50	50	80	0.005
	15−30	5.6	0.05	<1	<1	<1	7	<50	30	8	30	0.015
E7−524	0−15	5.0	0.05	<1	<1	<1	15	<50	20	70	20	0.005
	15−30	5.2	0.05	<1	<1	<1	10	<50	25	70	7	0.005
E.F.	0−15	5.1	0.05	<1	<1	<1	15	<50	50	40	100	0.005
	15−30	5.2	0.03	<1	<1	<1	5	<50	50	10	40	0.005
Objective value in JAPAN		5.5~6.5				10<	15<	200<	25<			

Table 2. Fe^{2+} in soil and soil solution at E.F.

rice growth	Fe^{2+} in soil (ppm)	Fe^{2+} in soil solution (ppm)
bad	1410	36
middle	1610	36
good	1760	44

Table 2 (continued) Fe^{2+} in soil and soil solution at pot culture experiment

treatment				Fe^{2+} in soil (ppm)	Fe^{2+} in soil solution (ppm)
F	O	W	L		
0g	36g	+5cm	—	1470	—
6.7g	36g	−3cm	—	150	—
6.7g	0g	+5cm	—	80	3
6.7g	0g	+5cm	20g	90	9
6.7g	36g	+5cm	—	1720	124
13.3g	36g	+5cm	—	350	—

F : Fertilizer application, O : Organic matter application,
W : Water level, L : Lime application

Table 3. The results of soil analysis conducted by the University of Nigeria

	average and S.D.	Range	number
pH (H_2O)	5.0±0.6	4.1~6.1	100
pH (KCl)	4.0±0.8	3.0~5.4	100
E.A. (meq/100g)	6.1±3.6	1.2~32.8	100
T-N (%)	0.10±0.04	0.04~0.38	100
P_2O_5 (mg/100g) (Bray-2)	6±5	0~18	69
K_2O (mg/100g)	10±7	1~40	98
CaO (mg/100g)	136±113	28~653	100
MgO (mg/100g)	207±163	15~889	100
Fe (ppm)	4700±2900	400~12700	87
Al (ppm)	1300±1100	0~4500	88

JICA