Guyana Rice Development Board

Webinar

on

New Strategies for the Management of Major Rice Diseases in Guyana

will commence

at 10:00 am

NEW STRATEGIES FOR THE MANAGEMENT OF MAJOR RICE DISEASES IN GUYANA.

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Presentation Features

INTRODUCTION

MAJOR RICE DISEASES IN GUYANA

CONDITIONS FAVOURING DISEASE DEVELOPMENT, ECONOMIC IMPORTANCE, SYMPTOMS OF MAJOR DISEASES

SPECIFIC RESEARCH AREAS:

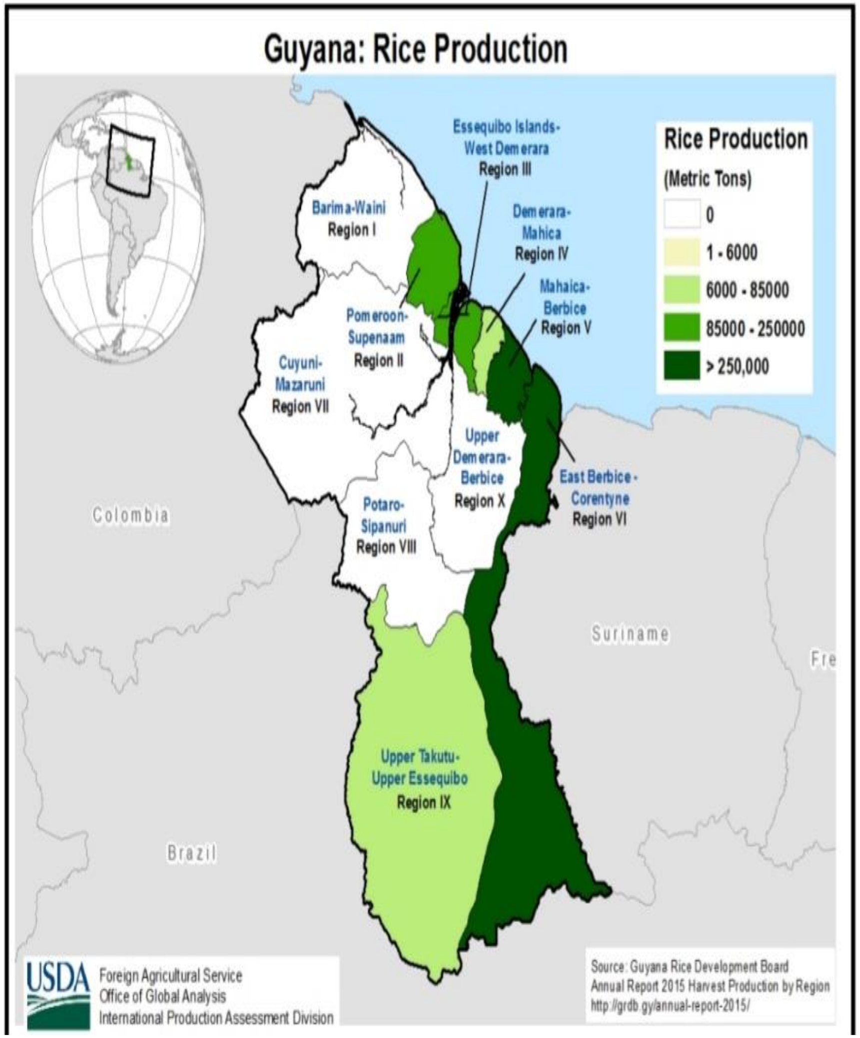
MATERIALS & METHODS, RESULTS & CONCLUSIONS / RECOMMENDATIONS

GENERAL DISEASE MANAGEMENT STRATIGIES:

REFERENCES

Introduction

- **Rice is the most important human food crop in the world.**
- **In Guyana the rice industry is one of the most important agricultural industries.**
- **It is also one of the largest uses of agricultural lands.**

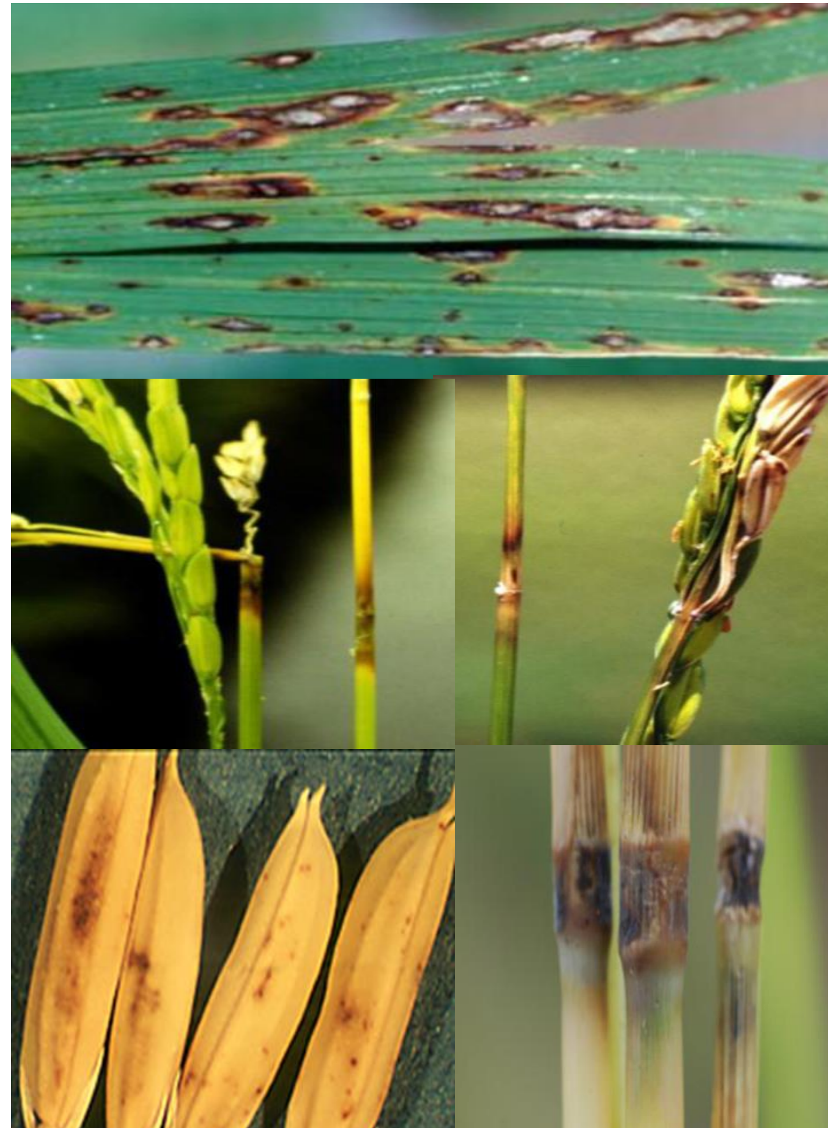


Introduction

- **Major rice diseases:**
  - Blast
  - Brown Spot
  - Sheath Blight
  - Sheath Rot
  - Grain Discolouration
- **Minor/ new emerging rice diseases include:**
  - False Smut
  - Narrow leaf spot
  - Panicle blight

Major Diseases

- **Rice Blast**
  - Causal agent: *Pyricularia oryzae*.
  - Can cause from 5 up to 100% loss.
  - Can affect all above ground parts of rice
  - Can affect all growth stages.



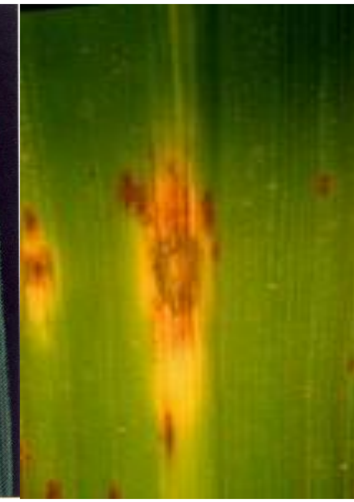
Major Diseases

- **Rice Blast**
  - Favourable conditions:
    - Wherever blast spores are present
    - Low soil moisture
    - Prolong periods of rain
    - Cool daytime temperature

Blast spores called Conidia

Major Diseases

- **Rice Blast – Leaf**
  - Symptoms include:
    - Lesions initially - grey-green, water soaked, dark green border.
    - Older lesions – elliptical/ spindle shaped, whitish to grey center, necrotic border.


Major Diseases

- **Rice Blast – Collar**
  - Symptoms include:
    - Necrosis at area joining the two tissues.

- **Rice Blast – Node/Neck**
  - Symptoms include:
    - Dark brown – blackish lesions.
    - Stem above infection falls over.
    - Unfilled grains.

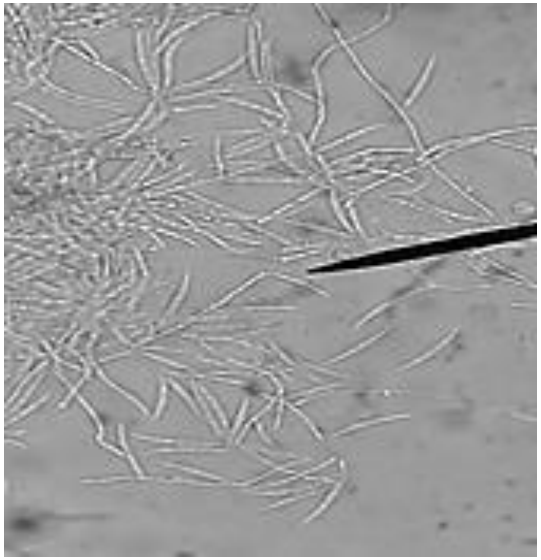
Major Diseases

- **Rice Blast – Panicle**
  - Symptoms include:
    - Lesions found at panicle branches and spikelets.
    - Branches may break at lesion.
    - Empty grains in lower portion of panicle.

- **Rice Blast – Seed**
  - Symptoms include:
    - Brown spot/ blotches.

Major Diseases

- **Brown Spot**
  - Causal agent : *Bipolaris oryzae*
  - Yield loss - from 12% (moderate) to 45% (severe). **Bengal famine-** 50-100% ~ >2M deaths…
  - Infects the coleoptile, leaves, leaf sheath, panicle branches, glumes, and spikelets.
  - Can occur at all stages.



Major Diseases

- **Brown Spot**

  - Favourable conditions:
    - High relatively humidity (86-100%)
    - High temperature 16-36 oC
    - Unflooded and nutrient deficient soil.
    - Leaf wetness for 8-24hrs.

  - **Major sources**
    - Infected seeds
    - Volunteer rice
    - Infected rice debris
    - Weeds

Major Diseases

- **Brown Spot**
  - Symptoms include:
    - **Seedlings** – small circular yellow-brown lesions, may girdle coleoptile.
    - **Tillering stage** – lesions initially small circular and dark brown to purple.
    - **Developed lesions** – circular to oval with light brown to grey center bordered by reddish brown margin.



Major Diseases

- **Brown Spot**
  - Symptoms include:
    - **Susceptible varieties** – lesions are 5-14mm long, leaves wilt and die.

    - **Resistant varieties** – lesions are brown and pinhead-sized.

Major Diseases

- **Brown Spot**
  - Symptoms include:
    - Lesions on leaf sheath similar to those on leaves.
    - Infected glumes and panicle branches have dark brown to oval spots.
    - Infection of florets leads to incomplete grain filling and reduction in grain quality.

Major Diseases

- **Sheath Blight**
  - Causal agent : *Rhizoctonia solani*
  - Affects leaves and young tillers
  - Yield loss - 20 to 50% in susceptible cultivars

Mycelium of Rhizoctonia solani

Major Diseases

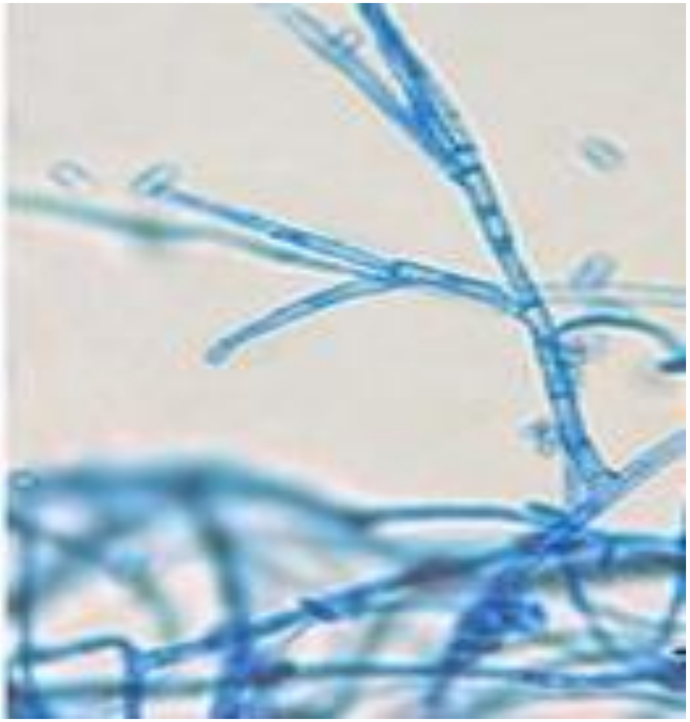
- **Sheath Blight**
  - Favourable conditions:
    - High temperature (28-32oC)
    - High level of nitrogen fertilizer
    - High relatively humidity 85-100%
    - High seed rate

Major Diseases

- **Sheath Blight**
  - Symptoms include:
    - Oval or elliposidal greenish grey lesions on leaf sheath, 1-3cm long
    - Lesions on leaf - irrigular with grey white centers and brown margins.

Major Diseases

- **Sheath Rot**
  - Causal agent : *Sarocladium oryzae*
  - Most destructive before emergence of panicle.
  - Losses - 20% to 85%.



Spores and mycelium of S. oryzae

Major Diseases

- **Sheath Rot**
  - Favourable conditions:
    - Most prevalent during wet seasons
    - Increase planting density
    - High nitrogen fertilizer
    - High temperature and relative humidity

Major Diseases

- **Sheath Rot**
  - Symptoms include:
    - Lesions start on uppermost leaf sheath.
    - Lesions are oblong or irregular spots with dark reddish brown margins and grey center or brownish grey throughout.

Major Diseases

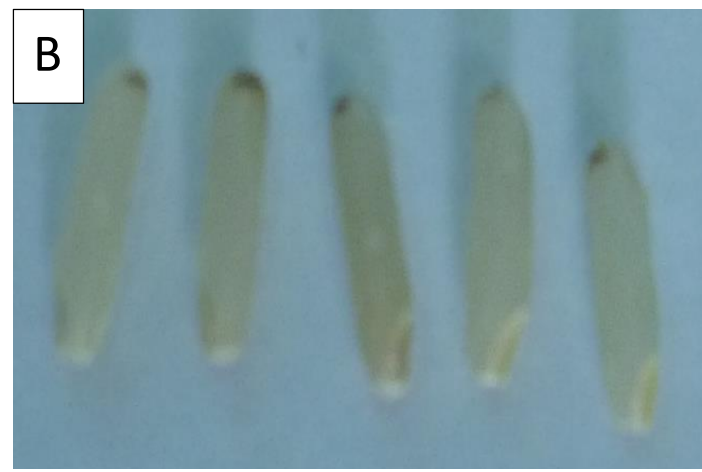
- **Sheath Rot**
  - Symptoms include:
    - Panicles remain in sheath or may partially emerge.
    - Panicles that have not emerged rot and the florets turn red-brown to dark brown.

Major Diseases

- **Grain Discolouration**
  - Causal agent : association of many fungal microorganisms (*Alternaria* spp., *Curvularia* spp., *Fusarium* spp. *Drchslera oryzae*, *Pyricularia oryzae*, *Sarocladium oryzae*, *Sclerotium* spp., *Asperigillus* spp., *Penicillium* spp., *Phoma* spp., *Cercospora* spp.)
  - Discolouration affected grains are often referred as ‘dirty grains’ or ‘black-tip’.

Major Diseases

- **Grain Discolouration**
  - Symptoms include:
    - Small, dark imperfections that occurs on the dorsal surface of rice kernels and has a lesion-like appearance.
    - Unlikely to be detected in the field before harvest.



A. Advance symptoms; **B.** Initial symptom.

Cost Analysis!

- **Based on estimates!**
- 5% of Av. 40 bags/ac= 2bags/ ac. @ $3,000/bag ~ **$6,000**.
- 12% of Av. 40 bags/ac= 4.8bags/ ac. @ $3,000/bag ~ **$14,400**.
- 20% of Av. 40 bags/ac= 8bags/ ac. @ $3,000/bag ~ **$24,000.**
- 50% of Av. 40 bags/ac= 20bags/ ac. @ $3,000/bag ~ **$60,000.**
- 85% of Av. 40 bags/ac= 34 bags/ ac. @ $3,000/bag ~ **$102,000**.
- 100%~ **$120,000.**

- **Estimated cost for disease control per ac.- ranged between $1,000 to $3,000.**

What was done BEFORE?

- **Farmers were heavily relying on the use of chemicals…**

- **No research work was done prior to 1980s on resistant screening …**

- **No information available on any other alternative management options being explored in Guyana prior to 2000s…**

- **No scientific studies on new generation types of fungicides…**

RESEARCH AREAS:

1. **To identify blast and sheath blight disease resistance genotypes from advance rice germplasm in Guyana.**

2. **To evaluate the efficacy of *plant extracts*, *biocontrol agents* and *new generation fungicides* against blast and sheath blight disease under *in vitro* and field conditions.**

3. **To identify the causative agent and to develop strategies for managing rice grain discolouration.**

RESEARCH AREA # 1:

To identify blast and sheath blight disease resistance genotypes from advance rice germplasm in Guyana

Blast screening:

Three 'hot spot' locations:

1. Canje, Gangaram

2. Black Bush Polder

3. Onverwagt Back.

Cropping Seasons:

1. **First (spring) season- (Nov./Dec. to March/April)**
2. **Second (autumn) season- (May/June to Sept./Oct.)**

Seed source:

- GRDB Plant Breeding has approx. 5,000+ rice germplasm accession - from *FLAR*, *CIAT*, *IRRI*, *Brazil*, *Suriname*, *Local crosses etc.*

- One hundred and three (103) rice germplasm selected

Seed Source	#of lines
Observation Yield Trials (OYT),	**50**
Advance Yield Trial (AYT)	**36**
Most popular cultivars and/or varieties	**16**
Susceptible check (Rustic)	**1**

Screening and Scoring for leaf blast:

The method used to conduct blast screening was the *Upland Blast Nursery (UBN)* technique (Ou, 1985; Ghazanfar *et al*., 2009) with a slight modification.

Data recording were done at about 21 to 35 days after seeding, when the susceptible check reach a score of 8 to 9.

Scoring for leaf blast:

Disease rating was done using the *IRRI*, *SES* base on a 0-9 scale (INGER, 2002).

Grade	Disease severity	Host response
0	No lesion observed	Highly Resistant **(HR)**
1	Small brown specks of pin point size	Resistant **(R)**
2	Small roundish to slightly elongated, necrotic gray spots, about 1-2 mm in diameter, with a distinct brown margin. Lesions are mostly found on the lower leaves	Moderately Resistant **(MR)**
3	Lesion type same as in 2, but significant number of lesions on the upper leaves	Moderately Resistant **(MR)**
4	Typical susceptible blast lesions, 3 mm or longer infecting less than 4% of leaf area	Moderately Susceptible **(MS)**
5	Typical susceptible blast lesions infecting 4-10% of the leaf area	Moderately Susceptible **(MS)**
6	Typical susceptible blast lesions of 3 mm or longer infecting 11-25% of the leaf area	Susceptible **(S)**
7	Typical susceptible blast lesions infecting 26-50% of the leaf area	Susceptible **(S)**
8	Typical susceptible blast lesions of 3 mm or longer infecting 51-75% of the leaf area many leaves are dead	Highly Susceptible **(HS)**
9	Typical susceptible blast lesions infecting more than 75% leaf area affected	Highly Susceptible **(HS)**

Where was? and Where now?

S.N.	Variety	WAS- At Release	NOW- 2nd Crop, 2020
1	GRDB 9	R	R
2	GRDB 10	R	R
3	GRDB 11	R	R
4	GRDB 12	R	R
5	GRDB 13	MR	HS
6	GRDB 14	R	R
7	GRDB 15	R	R
8	RUSTIC	HS	HS
9	DIWANI	MS	HS
10	BR444	MR	MS
11	G98-196	R	HS
12	G98-135	R	HS
13	G98-22-4	MR	MS
14	G98-30-3	MR	MS
15	G98-24-1	MR	MR
16	IR 22	MR	MR
17	F7 10	R	MR

KEY:

Grades	Host response
0	HR= Highly Resistant
1	R= Resistant,
2 & 3	MR= Moderately Resistant
4 & 5	MS= Moderately Susceptible
6 & 7	S= Susceptible
8 & 9	HS= Highly Susceptible

Disease rating was done using the *IRRI*, *SES* base on a 0-9 scale (INGER, 2002).

Results for BL resistant screening

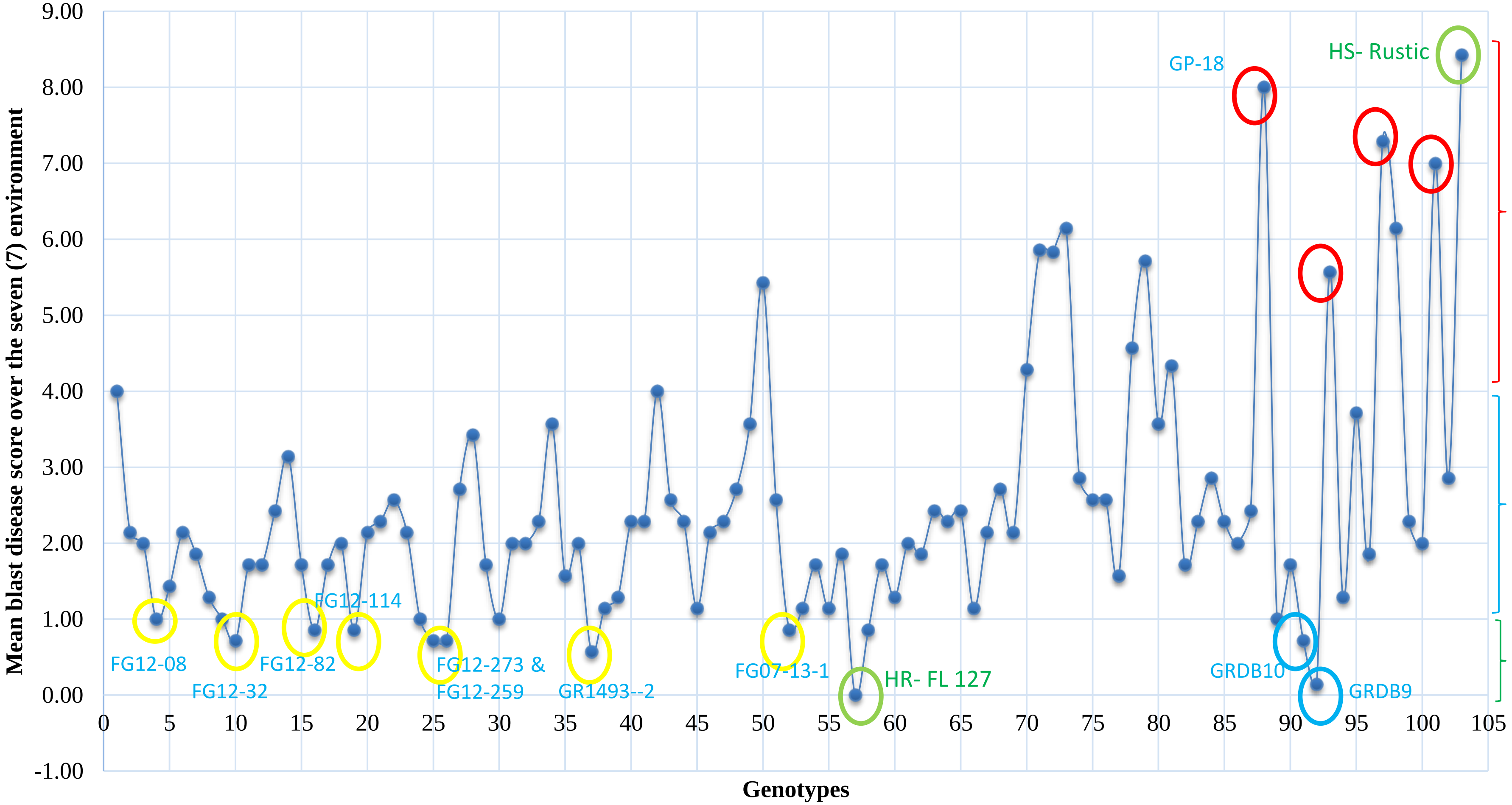


Fig.1: The mean blast disease scores of the 103 genotypes tested over the seven (7) environments.

Table 1: Summary & confirmation of rice blast resistance reaction status of selected genotypes screened.

S.N.	Genotypes / Designation	Parentage	Spring crop, 2015		Autumn crop, 2015			Autumn crop, 2016		*Spring crop, 2017
			Canj.	BBP	BBP	Canj.	Onvt.	Canj.	Onvgt.	Onvgt.
4	FG12-08	FLAR /NA	1	1	1	1	1	1	1	1
10	FG12-32	FLAR /NA	1	1	0	1	1	1	0	1
16	FG12-82	FLAR /NA	1	1	1	1	1	1	0	1
19	FG12-114	FLAR /NA	1	1	1	1	1	1	0	1
24	FG12-273	FLAR /NA	1	1	1	1	1	1	1	1
26	FG12-259	FLAR /NA	1	1	0	1	1	1	0	0
37	GR1493-6-9-1-3-2-2-2-2	FG07-124/G98-135	1	0	1	1	0	1	0	1
52	G07-13-1	NA	1	0	1	1	1	1	1	1
57	**FL-127**	**NA**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
88	GP18 (GRDB 13)	G98-30-3/Basmatti 385	8	8	8	9	8	7	8	6
91	FG05-259 (GRDB-10)	CT8163-9-4-4/FEDEARROZ 50//FL00593-6P-7-1P-M	0	1	1	1	1	1	0	0
92	G04-08 (GRDB-9)	CT10494-1-4/G98-30-3	0	0	0	0	0	0	0	1
93	G98-135	Rustic//G 95-63/Rustic	6	5	5	8	5	5	5	7
97	G98-196	BR 83/Rustic	7	7	7	8	8	7	7	7
101	DIWANI	NA- (Introduction from Suriname)	7	6	7	9	6	7	7	5
103	RUSTIC (Ch.)	Precoz de Machiquos/D55-37///Zenith/Nira//D85-42/4/Century Panta 231/Slo-17	9	8	8	9	8	8	9	8

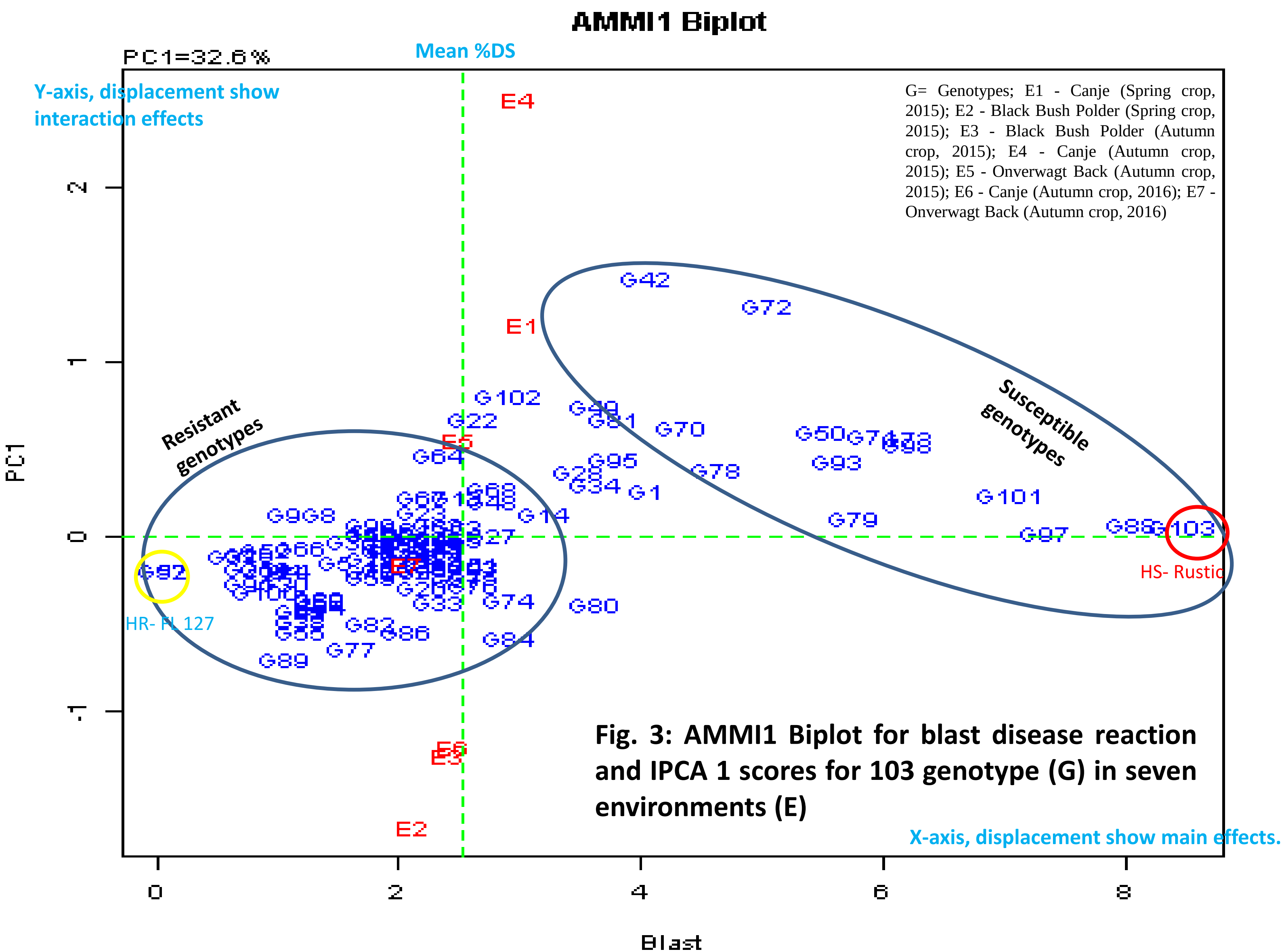


Fig. 3: AMMI1 Biplot for blast disease reaction and IPCA 1 scores for 103 genotype (G) in seven environments (E)

Conclusions / Recommendations

Eleven rice germplasm lines (FL-127, FG12-08, FG12-273, FG12-32, FG12-82, FG12-114, FG12-259, GR1493-6-9-1-3-2-2-2-2, G07-13-1, FG05-259 and G04-08) were identified as highly resistant to resistant against blast disease.

Of the 11, Germplasm **FL-127** over all seasons and all locations consistently expression of high resistance.

Conclusions / Recommendations

And two were popular variety (FG05-259 (GRDB-10) and G04-08 (GRDB-9).

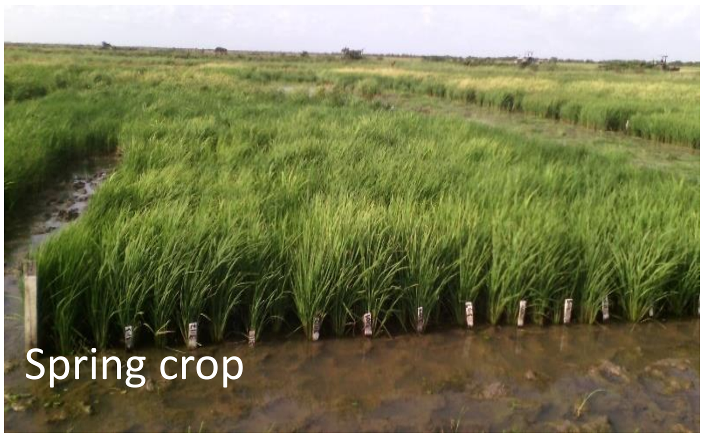
The AMMI analysis revealed that, resistance were dominated by the genotype main effect and the differences of the genotypes across the environment were not substantial.

E 4 (Canje, autumn crop 2015) were observed to be closest to the ideal test environment.

The susceptible check, Rustic recorded the highest blast disease scores in all the blast screening experiments.

Sheath Blight screening :

Under *natural field* condition using the advanced rice germplasms.



Under *artificial inoculated* condition at the BRRS screen house…

Data for Sheath Blight:

The **percent disease severity** were calculated and performance rating were done as per International Standard Evaluation System (SES), IRRI (1988).

The **Area Under Disease Progress Curve** (AUDPC) value were calculated in order to identify the **slow disease developing varieties**. It was calculated by using the formula given by Prescott *et al*. (1986).

Also the **apparent rate of disease development / progress between two observations timing** were also calculated by using the formula described by Vanderplank (1963):

And the **AMMI analysis** was done similar as explained above in BL resistant screening.

Results- SB resistant & slow blighting

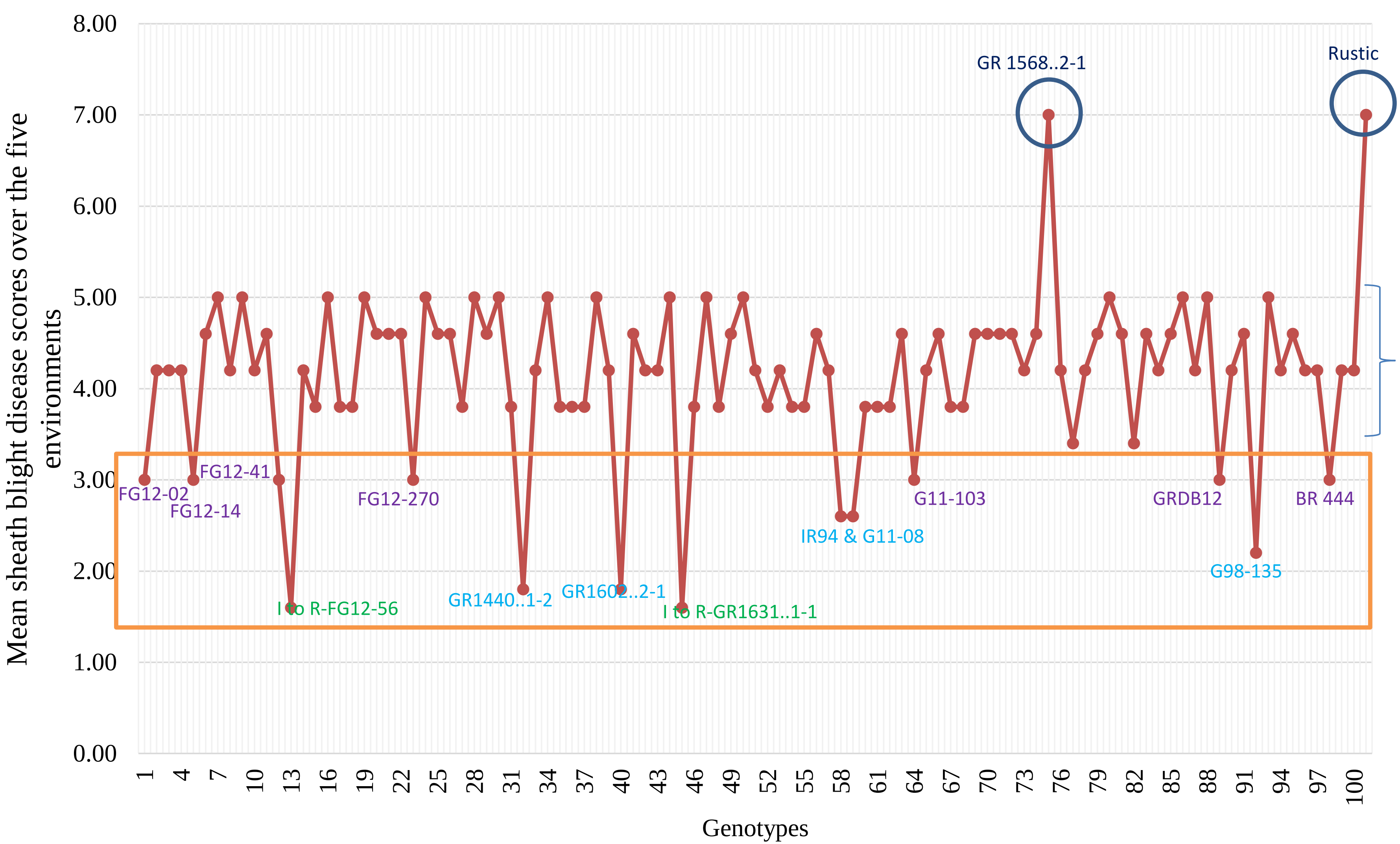


Fig. 1: The mean sheath blight disease scores of the 101 genotypes tested over the five environments tested.

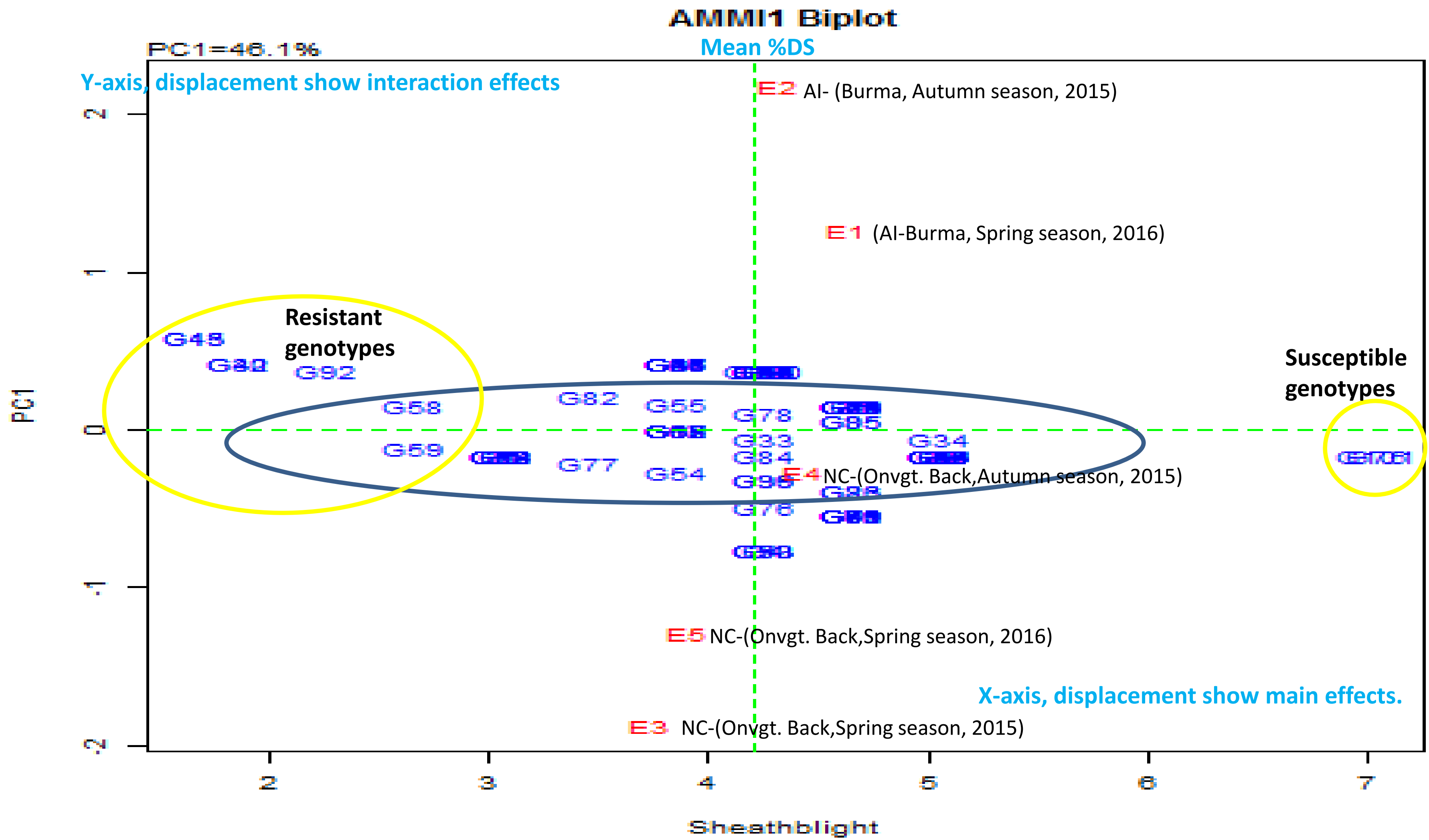


Fig. 2: AMMI1 Biplot display for mean sheath blight disease reaction and IPCA 1 scores of the 101 genotype (G) tested across five environments (E).

Conclusion/ Recommendations:

- ✓ Fourteen genotypes showed resistant status ranged from immune to resistant (FG12-56, GR1631-35-16-1-2-1-1, GR1440-52-23-4-1-1-1-1-2-1-2, GR1602-6-41-1-1-2-1, IR-94, G11-08,G98-135, FG12-02, FG12-14, FG12-41, FG12-270, G11-103, GRDB 12 and BR-444.

- ✓ Thirteen showed slow sheath blight development with relatively low AUDPC value lesser than 99.02.

- ✓ Eleven showed reduction in the apparent rate of disease development at least once to thrice over the trials.

Conclusion/ Recommendations:

- ✓ The AMMI analysis indicated that the differences of the genotypes across the environment were sizeable and resistance appeared to be somewhat influenced by the genotype by environment (G x E) interactions effects.

- ✓ The AMMI analysis appeared to be useful and IPAC1 capturing real signal on the data.

- ✓ E 4 ((NC at Onverwagt Back during autumn season) were observed closest the average and ideal test environment.

- ✓ Genotype GR 1568-31-9-1-1-2-1 and Rustic recorded stable susceptible reactions over all experiment.

RESEARCH AREA # 2:

To evaluate the efficacy of plant extracts, biocontrol agents and new generation fungicides against blast disease under *in vitro* and field conditions.

Table 1: Effect of plant extracts against *Pyricularia oryzae* under *in vitro* condition

Trt.	Plants		Plant extracts (% W/V)					
	Common names	Scientific names	*Mycelial growth (mm)			*% inhibition of mycelial growth		
			5%	10%	15%	5%	10%	15%
T1	Neem	Azadirachta indica	42.67^{C}	40.33^{C}	37.33^{D}	52.59^{F}	55.19^{E}	58.52^{E}
T2	Tulsi	Ocimum basalicum	30.33^{E}	28.67^{DE}	30.67^{E}	66.30^{D}	68.15^{CD}	68.15^{D}
T3	Lemon grass	Cymbopogan flexousus	27.67^{EF}	24.67^{EF}	28.67^{E}	69.26^{CD}	72.59^{BC}	65.93^{D}
T4	Thick leaf thyme	Thymus vulgaris	26.33^{F}	23.67^{EF}	22.67^{F}	70.74^{C}	73.70^{BC}	74.82^{C}
T5	Aloe	Aloe vera	81.33^{B}	77.00^{B}	80.33^{B}	9.63^{G}	14.44^{F}	10.74^{G}
T6	Marigold	Tagetes patula	11.67^{H}	17.00^{G}	18.33^{G}	87.04^{A}	81.11^{A}	79.63^{B}
T7	Black stage	Cordia curassavica	20.67^{G}	12.33^{G}	12.33^{H}	77.04^{B}	86.30^{A}	86.30^{A}
T8	Bael extract	Aegle marmelos	22.00^{G}	18.33^{FG}	17.67^{G}	75.56^{B}	79.63^{AB}	80.37^{B}
T9	Chives	Allium fistulosum	21.33^{G}	12.67^{G}	16.67^{G}	76.30^{B}	84.07^{A}	81.48^{B}
T10	Clove	Syzygium aromaticum	35.33^{D}	33.33^{D}	54.33^{C}	60.74^{E}	62.96^{D}	39.63^{F}
T11	Madar plant	Calotropis gigantean (C. procera)	12.67^{H}	14.33^{G}	16.67^{G}	85.93^{A}	85.93^{A}	81.48^{B}
T12	Control-water		90.00^{A}	90.00^{A}	90.00^{A}	0.00^{H}	0.00^{G}	0.00^{H}
SEm ±			1.72	3.21	2.08	1.91	3.56	2.31
CD (P = 0.05)			3.55	6.62	4.29	3.95	7.35	4.76
CV (%)			5.99	12.01	7.17	3.84	6.85	4.67

*** = average of three replication**

Means values in columns followed by same superscript letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 2: Effects of Bioagents on *P. oryzae* under *in vitro* condition

Trt	Treatment	Mycelial growth (mm)	% inhibition of mycelial growth
T1	Azotobacter SAG 19	36.33^{B}	50.58^{A}
T2	Bacillus cereus OG2L	33.67^{B}	52.65^{A}
T3	Bacillus subtilis OG2A	35.00^{B}	50.14^{A}
T4	Control	76.00^{A}	-
SE m ±		9.91	17.01
LSD (P = 0.05)		22.84	39.23
CV (%)		26.81	54.33

*** = average of three replication**

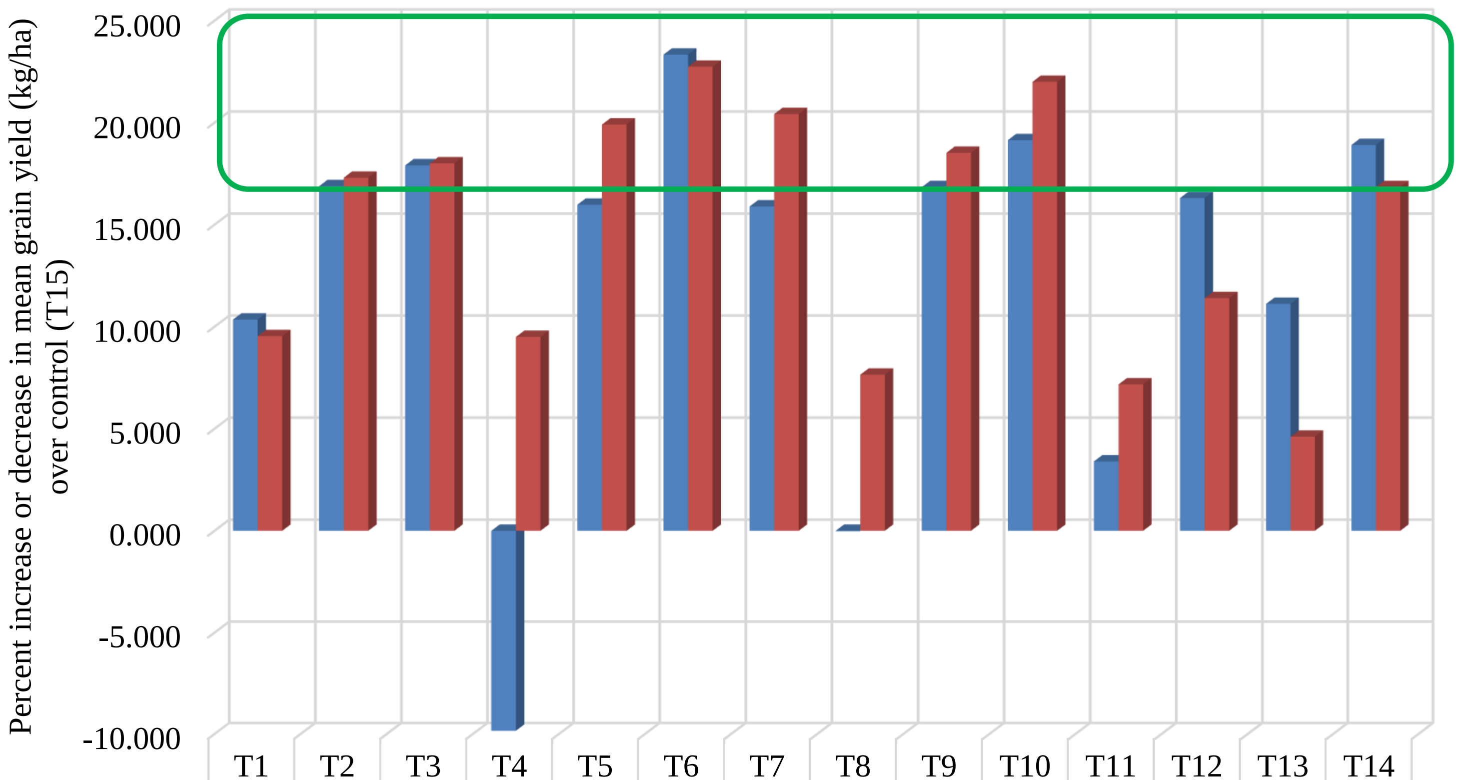
Means values in columns followed by same superscript letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 1: Effects of plant extract, bio-agents and new generation pesticides against blast

Treatments	Rate	Spring		Autumn	
		[1]Lesion Length (mm)	*Disease Severity (%)	[1]Lesion Length (mm)	*Disease Severity (%)
		21 DAI	21 DAI	21 DAI	21 DAI
Marigold	5%	42.800B	60.740(65.287)C	21.800AB	71.113(79.243)B
Black stage	10%	18.867EF	48.150(50.237)D	19.000B	56.293(60.127)D
Bael tree extract	15%	16.600F	46.670(48.550)D	18.067B	57.78(61.840)D
Welch onion/ chives	10%	46.000B	71.110(79.843)B	21.867AB	70.373(78.207)BC
Madar plant	5%	18.867EF	48.890(51.093)D	20.867B	58.520(62.740)D
BA- OG2L	2g/L	18.733EF	48.887(51.120)D	18.133B	54.813(58.273)D
BA- OG2A	2g/L	17.733F	51.850(54.527)D	18.600B	55.557(58.967)D
BA-SAG 19	2g/L	45.667B	71.853(80.397)B	21.933AB	71.853(80.370)B
Antracol 70WP	500g/ac.	18.533F	48.890(51.093)D	19.267B	59.260(63.737)CD
Nativo 75 WG	250g/ac.	19.000EF	48.150(50.237)D	17.733B	60.000(64.523)CD
Silvacur Combi 30 EC	200ml/ac.	44.933B	71.853(80.567)B	21.533AB	73.333(82.443)AB
Serenade 1.34 SC	400ml/ac.	25.400CD	51.850(54.517)D	17.333B	59.260(63.470)D
Cyclops	150ml/ac.	27.667C	53.333(56.267)CD	22.467AB	71.853(80.397)B
Fugione (Check)	300ml/ac.	22.400DE	46.667(48.563)D	20.600B	57.037(60.770)D
Control	Water	53.600A	80.000(93.640)A	26.800A	81.483(95.957)A
General Mean		**29.12**	**56.593(61.0621)**	**20.400**	**63.902(70.071)**
SEm ±		**1.813**	**4.611**	**2.610**	**7.161**
CD (P = 0.05)		**3.713**	**9.444**	**5.346**	**14.669**
CV (%)		**7.620**	**9.250**	**15.670**	**12.520**

[+]Figure in parenthesis show Arcsine transformation; * Average of three replications; [1]Average from five tag plants per each replications; [3]Data collected 7 days after second treatment applied(21 DAI)

Means values in columns followed by same superscript letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.



	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14
Spring,2016	10.35	16.88	17.90	-9.84	15.97	23.33	15.89	-0.01	16.84	19.14	3.401	16.30	11.11	18.90
Autumn,2016	9.536	17.29	18.00	9.501	19.91	22.74	20.42	7.649	18.52	21.99	7.174	11.40	4.608	16.83

Treatments

T1- Marigold; T2- Black stage; T3- Bael extract; T4- Chives; T5- Madar plant; T6- *B. cereus* OG2L; T7- *B. subtilis* OG2A; T8- *Azotobacter* SAG 19; T9 - Antracol 70WP; T10-Nativo 75 WG; T11-Silvacur Combi 30 EC; T12- Serenade 1.34 SC; T13- Cyclops; *T14- Fugione (Check)*; T15- untreated control

Figure1. Percentage increase or decrease in mean grain weight (kg/ha.) over the control (T15) treatment

Conclusion/ Recommendations:

- ✓ Application of plant extracts *viz.* black sage at *10%,* bael extract at 15% and madar plant at 5% recorded superior blast disease control compared to untreated control.

- ✓ Similarly, Two BA isolates, *B. cereus* OG2L and *B. subtilis* OG2A each at 2 g/L also

- ✓ And new generation fungicides *viz.* Antracol 70WP at 500 g/ac, Nativo 75 WG at 250 g/ac,

- ✓ These treatments NOT ONLY gave higher blast disease control BUT also showed positive influence in plant growth, yield parameters and increase in grain yield compared to untreated control.

Management of Sheath blight disease *(plant extracts, bio-agents & new generation fungicides)*

Table 1: Effect of plant extracts against *Rhizoctonia solani* under *in vitro* condition.

Trt.	Plants		Plant extracts (% w/v)					
	Common names	Scientific names	*Mycelial growth (mm)			% inhibition of mycelial growth		
			5%	10%	15%	5%	10%	15%
T1	Neem	Azadirachta indica	73.33^{BC}	36.67^{CD}	21.00^{D}	18.52^{CD}	59.26^{BC}	76.67^{C}
T2	Tulsi	Ocimum basalicum	65.00^{C}	46.67^{C}	35.00^{C}	27.78^{C}	48.15^{C}	61.11^{D}
T3	Lemon Grass	Cymbopogan flexousus	23.00^{E}	23.33^{DE}	5.00^{F}	74.44^{A}	74.08^{AB}	94.44^{A}
T4	Thick/broad leaf thyme	Thymus vulgaris	18.33^{E}	14.33^{E}	5.00^{F}	79.63^{A}	84.07^{A}	94.44^{A}
T5	Aloe	Aloe vera	79.00^{AB}	39.67^{C}	35.00^{C}	12.22^{DE}	55.93^{C}	61.11^{D}
T6	Marigold	Tagetes patula	17.33^{E}	14.00^{E}	6.667^{F}	80.74A	84.45^{A}	92.59^{A}
T7	Black stage	Cordia curassavica	41.67^{D}	34.67^{CD}	13.33^{E}	53.71^{B}	61.48^{BC}	85.18^{B}
T8	Bael tree extract	Aegle marmelos	39.33^{D}	43.33^{C}	31.67^{C}	56.30^{B}	51.85^{C}	64.82^{D}
T9	Welch onion/ chives	Allium fistulosum	90.00^{A}	90.00^{A}	90.00^{A}	0.00^{E}	0.00^{E}	0.00^{F}
T10	Clove	Syzygium aromaticum	21.67^{E}	18.33^{E}	5.00^{F}	75.93^{A}	79.63^{A}	94.44^{A}
T11	Madar plant	Calotropis gigantean (C. procera)	90.00^{A}	65.67^{B}	81.67^{B}	0.00^{E}	27.04^{D}	9.26^{E}
T12	Control	water	90.00A	90.00A	90.00^{A}	0.00^{E}	0.00^{E}	0.00^{F}
SEm ±			6.65	7.00	2.23	7.39	7.78	2.48
CD (P = 0.05)			13.73	14.45	4.60	15.26	16.05	5.11
CV (%)			15.08	19.91	7.81	22.67	18.26	4.96

* = average of three replication.

Means values in columns followed by same superscript letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 2: Effects of Bio-agents on *Rhizoctonia solani* under *in vitro* condition.

Trt	Treatment	*Mycelial growth (mm)	% inhibition of mycelial growth
T1	*Azotobacter* SAG19	74.67^{A}	17.04^{B}
T2	*Bacillus cereus* OG2L	51.00^{B}	43.33^{A}
T3	*B. subtilis* OG2A	75.33^{A}	16.30^{B}
T4	Control	90.00^{A}	0.00^{B}
SE m ±		8.36	9.29
LSD (P = 0.05)		19.29	21.43
CV (%)		14.08	59.38

*= average of three replication.

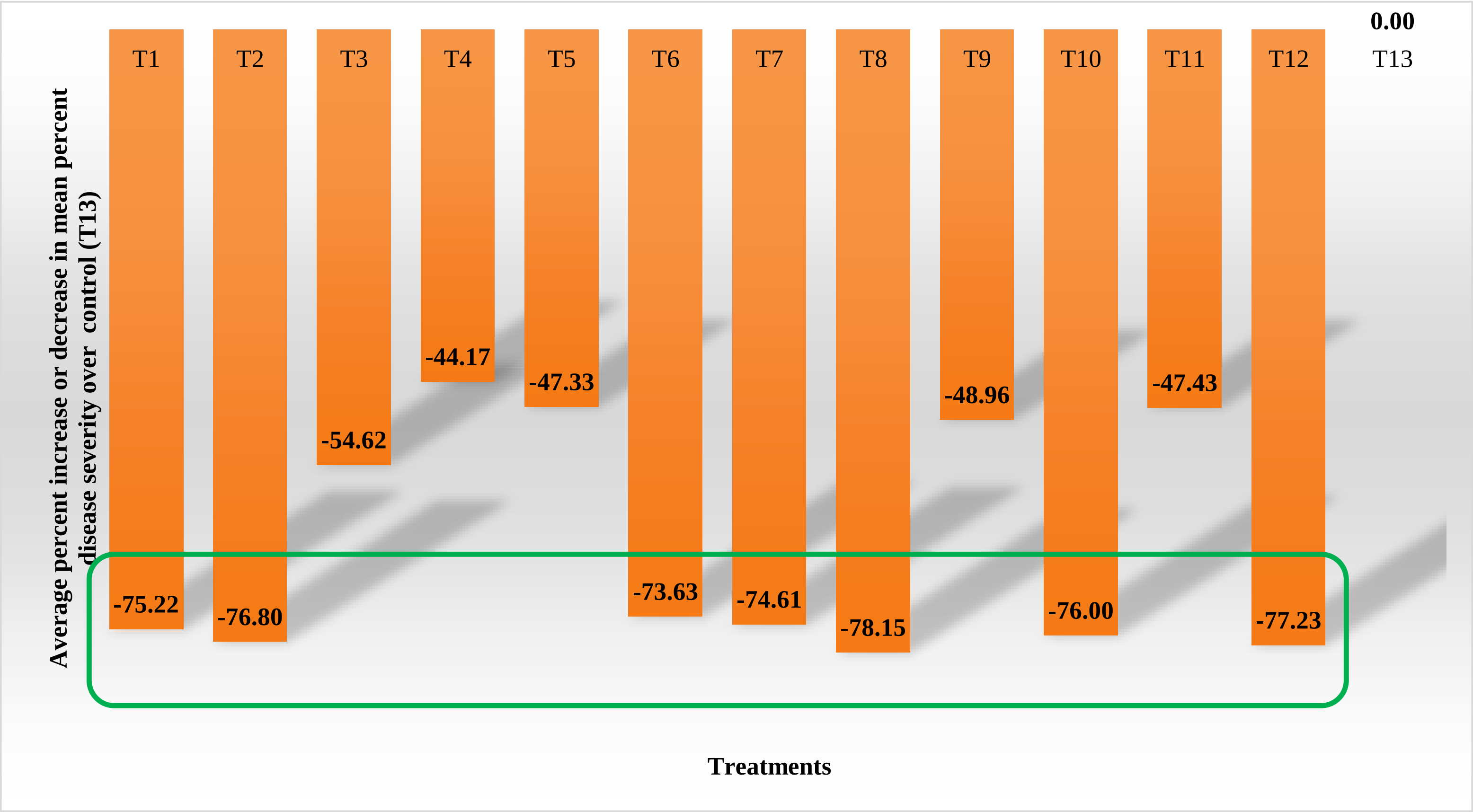
Means values in columns followed by same superscript letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 3: Effects of plant extract, bio-agents and new generation pesticides against sheath blight percentage disease severity

Trt.	Treatment	Rate	*Disease Severity (%)			
			Onverwagt Back, Spring		Burma Back, Spring	
			42 DAI	AUDPC	42 DAI	AUDPC
T1	Lemon Grass	15%	8.043(8.047)C+	173.200D	4.853(2.203)C++	139.040D
T2	Thick/ Broad leafThyme	15%	7.280(7.283)C	161.850D	4.707(2.170)C	133.710D
T3	Marigold	15%	14.867(14.920)B	302.560C	11.200(3.340)B	280.920C
T4	Clove	15%	16.943(17.027)B	353.010B	11.703(3.417)B	296.810BC
T5	Bacillus sp.(Strain:OG2L)	1g/L	16.007(16.080)B	329.880BC	11.027(3.317)B	284.690BC
T6	Bacillus sp.(Strain:OG2L)	2g/L	8.677(8.687)C	170.390D	5.087(2.253)C	138.230D
T7	Antracol 70WP	500g/ac.	7.787(7.793)C	179.340D	5.270(2.293)C	144.100D
T8	Nativo 75WG	250g/ac.	7.210(7.217)C	147.190D	4.203(2.040)C	132.320D
T9	Silvacur Combi 30EC	200ml/ac.	14.917(14.970)B	348.760B	11.077(3.317)B	296.210BC
T10	Serenade 1.34 SC	400ml/ac.	7.657(7.667)C	170.360D	4.787(2.180)C	141.080D
T11	CYCLOPS	150ml/ac.	15.710(15.780)B	360.120B	11.180(3.340)B	300.000B
T12	Fugione (Check)	300ml/ac.	8.050(8.060)C	175.450D	4.027(1.973)C	139.170D
T13	Control	Water	31.163(31.693)A	548.090A	20.43(4.513)A	419.190A
			12.639	263.090	8.427	218.88
General Mean			(12.709)		(2.797)	
SEm ±			1.0328	15.935	0.206	9.100
CD (P = 0.05)			2.1316	32.889	0.425	18.782
CV (%)			9.950	7.420	9.010	5.090

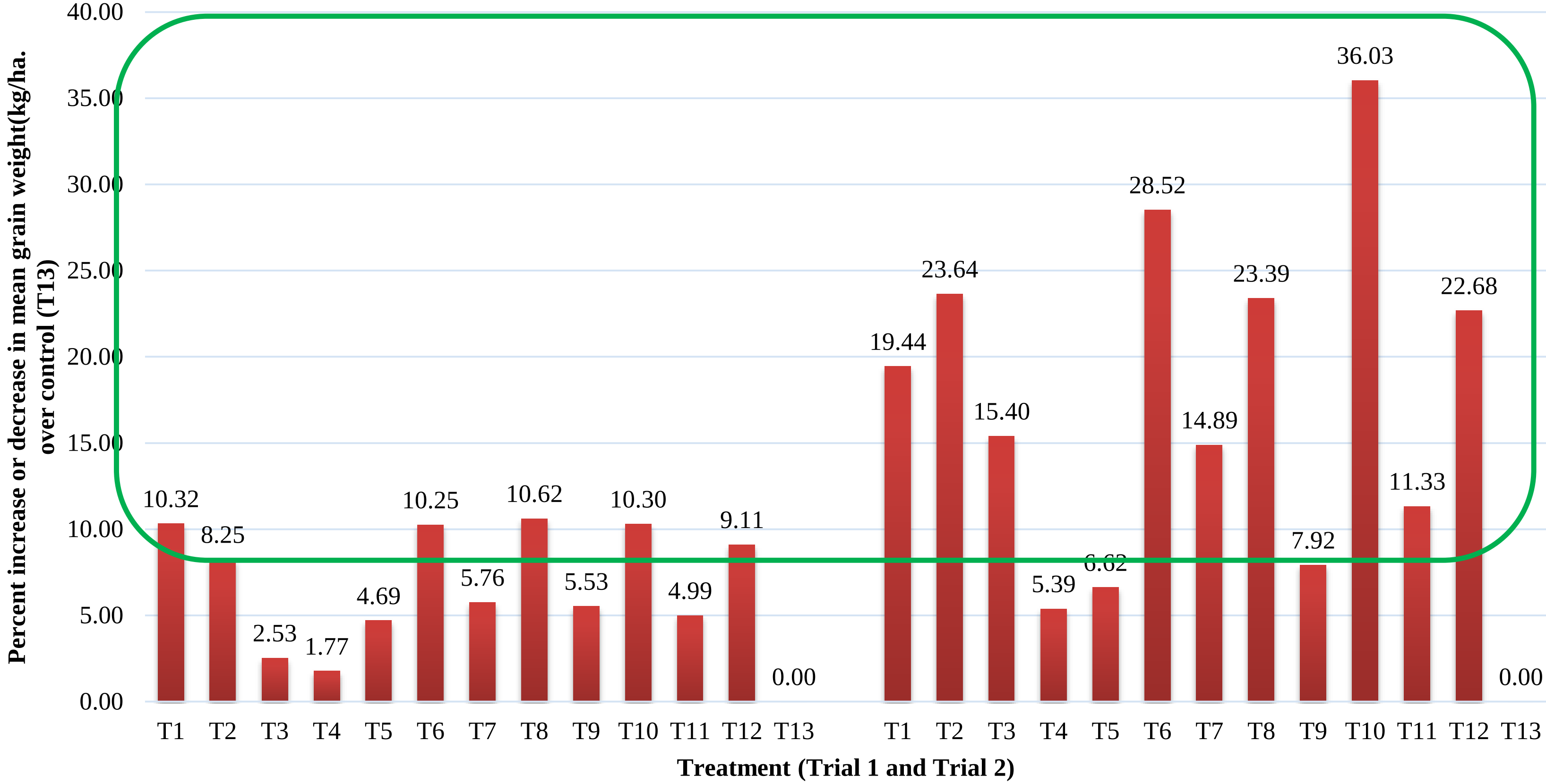
+Figure in parenthesis show Arcsine transformation;++= in parenthesis show Square root transformation * Average of three replications;

Means values in columns followed by same superscript letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.



*= average of three replication.

Fig 1: Overall average percentage decrease in mean percent disease severity over the negative / untreated control (T13) treatment at 42 days after inoculation



T1- Lemon Grass; T2- Thick leaf thyme; T3- Marigold; T4- Clove;T5- *B. cereus* OG2Lat 1 g/L; T6- *B. cereus* OG2L at 2 g/L; T7- Antracol 70WP; T8- Nativo 75 WG; T9- Silvacur Combi 30 EC; T10- Serenade 1.34 SC;T11- Cyclops; T12- Fugione; T13- Control

Figure 2. Actual percent increase or decrease in mean grain weight (kg/ha.) over untreated control (T13) for the two trials

Conclusion/ Recommendations:

- ✓ **Plant extracts** of: Lemon grass and Thick leaf thyme extract at 15% showed high efficacy against SB disease compared to untreated control .

- ✓ Like wise, **biocontrol agent** *B. cereus* OG2L at 2 g/L.

- ✓ Similarly, **new generation fungicides** *viz.* Antracol 70WP at 500 g/ac, Nativo 75 WG at 250 g/ac, Serenade 1.34 SC at 400 ml/ac. demonstrated effective control of sheath blight disease

- ✓ **NOT ONLY** these products demonstrated effective control of the SB disease, but also registered an increase in plant growth parameters and grain yield compared to untreated control…

RESEARCH AREA # 3:

To identify the causative agent and to develop strategies for managing rice grain discolouration.

Material and Methods

Isolation of pathogen associated with grain discolouration

- ✓ Seed health analysis was done using the blotter test, agar plate method & ISTA (1996)

Pathogenicity test…

***In vitro* screening of fungicides against grain discolouration**

- ✓ Evaluation of new generation fungicides was done utilizing the Poisoned food technique (Grower and Moore, 1962).

Field evaluation of fungicides against grain discolouration

- ✓ Design: Randomized Block Design (RBD), with three replicates

Material and Methods

Field evaluation of fungicides against grain discolouration

- ✓ Design: Randomized Block Design (RBD), with three replicates
- ✓ The experiment was inoculated with *C. lunata* conidial concentration of 10^5 (grown in laboratory) at panicle initiation (approx. 60-65 days) stage.
- ✓ These treatments were applied as foliar spray two times at an interval of 7-10 days.

Field evaluation and demonstrations in farmers' fields within the different rice growing regions

- ✓ The better preforming treatments from the small plots field trials were selected and carried forward…

Assessment of incidence of GD; growth and yield parameters

Results

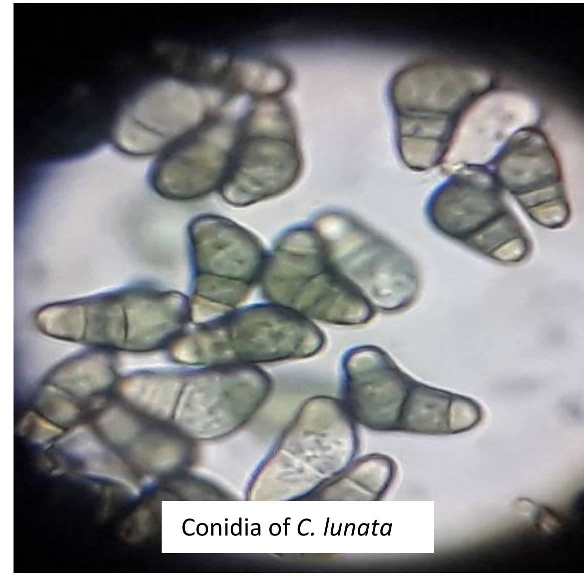
Pathogen associated with grain discolouration ('black tip')

- ✓ The seed health analysis showed that *Curvularia* spp. was the most predominant fungal pathogen associated with the discoloured rice grain.

- ✓ The presence of *Bipolaris oryzae*, *Scarladium oryzae*, *Alternaria* spp., *Aspergillus* spp. and *Fusariun* spp. were also observed at low levels (<3-5%).

- ✓ CABI confirmed *Curvularia lunata* as the most dominant fungal pathogen on the grains with the discolouration symptoms.

- ✓ The molecular analysis (sequencing) of the ITs region of the rDNA, revealed a 100% match for *C. lunata*…


Conidia of *C. lunata*


Conidiophore and conidia of *C. lunata*

Table 1. Screening of fungicides against *Curvularia lunata* isolated from grains with signs and symptoms of grain discolouration

Trt	Chemicals	Active ingredients	Rates	Mycelial growth (mm)	% inhibition of mycelial growth
T1	Amistar Xtra 28 SC	Triazol, Estrobilurtina., Cyproconazol, Azoxystrobin	1.0 ml/L	18.33 CDE	79.30 ABC
T2			1.5 ml/L	14.67 CDE	83.31 ABC
T3	Tantor 25 SC	Triazol + enizimdozole., Tubuconazole + Carbendazim	1.0 ml/L	21.667 CD	75.27 BC
T4			1.5 ml/L	16.67 CDE	81.09 ABC
T5	Glory 75 WG	Mancozeb + Azoxystrobin	3 g/L	13.33 DE	85.08 AB
T6			5.0 g/L	5.00 E	94.33 A
T7	Tridium 70 WG	Azoxystrobin 4.7% + Mancozeb 59.7% + Tebucuzonal 5.6% WG	1.25 g/L	5.00 E	94.33 A
T8			1.75 g/L	5.00 E	94.33 A
T9	Antracol 70WP	Propineb	2.5 g/L	29.00 BC	66.88 CD
T10			5.0 g/L	25.67 CD	70.94 BC
T11	Carbendazim 50SC	Carbendazim 50%	1.5 ml/L	5.00 E	94.33 A
T12	Manzate Pro Stick TM	Mancozeb 70%	1.5 g/L	15.33 CDE	82.86 ABC
T13	Fugione	Isoprothiolane	1.5 ml/L	43.67 B	50.61 D
T14	Control (Check)	Distilled water	-	88.33 A	0.00 E
Grand Mean				21.91	79.80
SE m ±				5.12	3.51
LSD (P = 0.05)				7.24	4.97
CV (%)				40.50	7.36

Means values in columns followed by same letter(s) are not differ significantly at 95% confidence interval according to Fisher’s Least Significant Difference (LSD) procedure.

Table 3. Effect of fungicides on the incidence of grain discolouration on GRDB 10 and GRDB 14 during spring 2017

Treatments	Rates/ L	*Percent incidence of grain discolouration				Percent reduction over control	
		GRDB 10		GRDB 14		GRDB 10	GRDB 14
Amistar Xtra 28 SC	1.5 ml	7.20	+(51.96) C	7.36	+(54.22) C	-60.01	-53.07
Tantor 25 SC	1.5 ml	11.93	(144.77) B	10.44	(119.08) B	-33.74	-33.44
Glory 75 WG	3.0 g	7.49	(56.82) C	6.38	(41.10) C	-58.40	-59.32
Glory 75 WG	5.0 g	6.45	(42.63) C	6.32	(40.48) C	-64.17	-59.70
Tridium 70 WG	1.75 g	8.71	(77.26) BC	8.53	(74.19) BC	-51.62	-45.62
Antracol 70WP	5.0 g	7.49	(57.12) C	6.72	(45.70) C	-58.43	-57.15
Carbendazim 50SC	1.5 ml	8.78	(80.10) BC	6.77	(45.96) C	-51.23	-56.85
Manzate Pro Stick TM	1.5 g	9.67	(94.67) BC	7.82	(73.94) BC	-46.29	-50.16
Fugi-One	1.5 ml	9.65	(93.67) BC	8.70	(77.53) BC	-46.42	-44.53
Control	Water	18.01	(334.05) A	15.69	(246.43) A		
Grand Mean			103.30		81.87		
SE m ±			28.62		20.92		
LSD (P = 0.05)			40.47		29.59		
CV (%)			47.98		44.27		

* = average of three replication; +Figure in parenthesis show square root transformation
Means values in columns followed by same letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 4. Effect of fungicides on yield parameter and grain yield of GRDB 10 and GRDB 14 during spring 2017

Chemicals	*GRDB 10					*GRDB 14				
	Panicle Length (cm)	Av. # Filled grains/ panicle	Av. # Unfilled grains/ panicle	1000 - Grain Weight (grams)	Grain yield (Kg/ ha.)	Panicle Length (cm)	Av. # Filled grains/ panicle	Av. # Unfilled grains/ panicle	1000 - Grain Weight (grams)	Grain yield (Kg/ ha.)
Amistar Xtra 28 SC	23.39A	74.97AB	12.70A	32.80A	6322.00AB	21.86A	65.10A	9.37A	32.42A	8153.50A
Tantor 25 SC	24.33A	94.40A	14.27A	30.99A	5605.50AB	19.37AB	68.00A	8.13A	32.57A	5185.80C
Glory 75 WG	21.83A	66.57AB	10.17A	32.58A	7639.30A	21.13A	72.43A	7.90A	30.65A	7697.90AB
Glory 75 WG	24.09A	81.63AB	9.17A	32.59A	5639.70AB	21.44AB	70.67A	10.27A	29.95A	6321.00ABC
Tridium 70 WG	23.31A	81.87AB	13.87A	32.06A	5936.80AB	20.11AB	49.87A	7.53A	32.06A	5747.10BC
Antracol 70WP	21.96A	65.57B	12.10A	29.75A	7191.40A	20.57AB	57.17A	8.83A	31.42A	6737.50ABC
Carbendazim 50SC	23.10A	73.40AB	7.50A	31.25A	6269.80AB	20.80AB	54.73A	11.60A	32.45A	6898.60ABC
Manzate Pro Stick TM	22.25A	70.43AB	10.23A	32.01A	6295.70AB	21.73A	64.50A	12.53A	35.24A	5558.40C
Fugi-One	23.15A	85.73AB	11.20A	31.56A	5966.20AB	21.56A	62.30A	9.00A	31.99A	6076.20BC
Control	22.64A	84.77AB	11.17A	32.41A	4868.00B	18.30B	56.93A	8.70A	29.30A	5204.30C
General Mean	23.01	77.93	11.24	31.80	6173.40	20.69	62.17	9.39	31.81	6358.00
SEm ±	1.31	13.25	3.74	1.76	1046.40	1.39	13.58	2.92	2.02	955.74
CD (P = 0.05)	NS	27.83	NS	NS	2198.40	2.92	NS	NS	NS	2007.90
CV (%)	6.99	20.82	40.81	6.78	20.76	8.24	26.74	38.06	10.98	18.41

* = average of three replication;

Means values in columns followed by same letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 5. Effect of fungicides on grain discolouration incidence of GRDB 10 and GRDB 14 during autumn 2017

Treatments	Rates/ L	*Percent incidence of grain discolouration				Percent reduction over control	
		GRDB 10		GRDB 14		GRDB 10	GRDB 14
Amistar Xtra 28 SC	1.5 ml	6.61	[+](46.38) D	6.60	[+](43.52) DE	-56.03	-57.66
Tantor 25 SC	1.5 ml	9.46	(90.27) B	9.39	(88.93) BC	-37.10	-39.75
Glory 75 WG	3.0 g	7.29	(53.62) CD	6.09	(37.46) E	-51.51	-60.93
Glory 75 WG	5.0 g	6.89	(47.73) D	6.22	(38.75) DE	-54.17	-60.08
Tridium 70 WG	1.75 g	9.16	(85.67) B	10.05	(101.51) B	-39.08	-35.51
Antracol 70WP	5.0 g	6.93	(48.08) CD	6.69	(44.81) DE	-53.94	-57.04
Carbendazim 50SC	1.5 ml	6.60	(43.57) D	6.53	(42.66) DE	-56.12	-58.09
Manzate Pro Stick TM	1.5 g	8.76	(76.75) BC	8.23	(67.79) CD	-41.78	-47.20
Fugi-One	1.5 ml	9.06	(82.74) B	8.21	(67.55) CDE	-39.74	-47.30
Control	Water	15.04	(226.72) A	15.58	(244.03) A		
Grand Mean			80.15		77.70		
SE m ±			9.68		10.21		
LSD (P = 0.05)			13.70		14.43		
CV (%)			20.93		22.75		

* = average of three replication; [+]Figure in parenthesis show square root transformation
Means values in columns followed by same letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

Table 6. Effect of fungicides on yield parameter and grain yield of GRDB 10 and GRDB 14 during autumn 2017

Chemicals	*GRDB 10					*GRDB 14				
	Panicle Length (cm)	Av. # Filled grains/ panicle	Av. # Unfilled grains/ panicle	1000 - Grain Weight (grams)	Grain yield (Kg/ ha.)	Panicle Length (cm)	Av. # Filled grains/ panicle	Av. # Unfilled grains/ panicle	1000 - Grain Weight (grams)	Grain yield (Kg/ ha.)
Amistar Xtra 28 SC	22.45 A	82.75 A	12.10 A	28.13 AB	6447.90 AB	22.19 A	68.06 A	9.08 CD	32.74 A	5763.00 AB
Tantor 25 SC	21.65 A	70.92 B	9.85 A	27.22 ABC	4268.10 DE	20.37 B	69.04 A	12.12 B	30.22 D	5175.20 BC
Glory 75 WG	23.36 A	86.42 A	10.88 A	29.88 A	7030.30 A	21.80 AB	75.27 A	8.22 D	31.60 ABCD	6664.80 A
Glory 75 WG	22.37 A	85.04 A	8.62 A	28.25 AB	5708.40 ABCD	21.44 AB	72.79 A	9.34 CD	32.21 AB	5919.80 AB
Tridium 70 WG	23.15 A	56.38 C	13.87 A	24.98 CD	5205.60 BCD	20.44 B	53.70 A	10.50 BCD	30.37 CD	4297.40 CD
Antracol 70WP	23.71 A	79.46 AB	12.62 A	28.03 AB	6483.20 AB	21.57 AB	68.22 A	8.19 D	31.72 ABC	6099.70 AB
Carbendazim 50SC	22.08 A	86.90 A	9.40 A	27.13 BC	5960.90 ABC	21.80 AB	66.38 A	10.06 BCD	32.43 A	5707.80 AB
Manzate Pro Stick TM	23.65 A	71.71 B	13.25 A	25.15 CD	5041.40 BCDE	20.73 AB	66.43 A	11.37 BC	31.61 ABCD	4439.70 CD
Fugi-One	22.35 A	60.56 C	11.10 A	25.91 BCD	4852.30 CDE	20.56 AB	60.84 A	12.03 B	30.96 BCD	4405.60 CD
Control	22.16 A	53.21 C	11.47 A	23.91 D	3729.70 E	20.64 AB	54.31 A	15.38 A	30.45 CD	3859.20 D
General Mean	22.70	73.34	11.32	26.86	5472.80	21.15	65.50	10.63	31.43	5233.20
SEm ±	0.80	3.00	2.09	0.91	487.57	0.56	7.62	0.81	0.47	379.06
CD (P = 0.05)	1.14	4.25	2.96	1.28	689.52	0.79	10.77	1.15	0.67	536.07
CV (%)	6.14	7.09	32.06	5.84	15.43	4.56	20.14	13.26	2.61	12.55

* = average of three replication;

Means values in columns followed by same letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure.

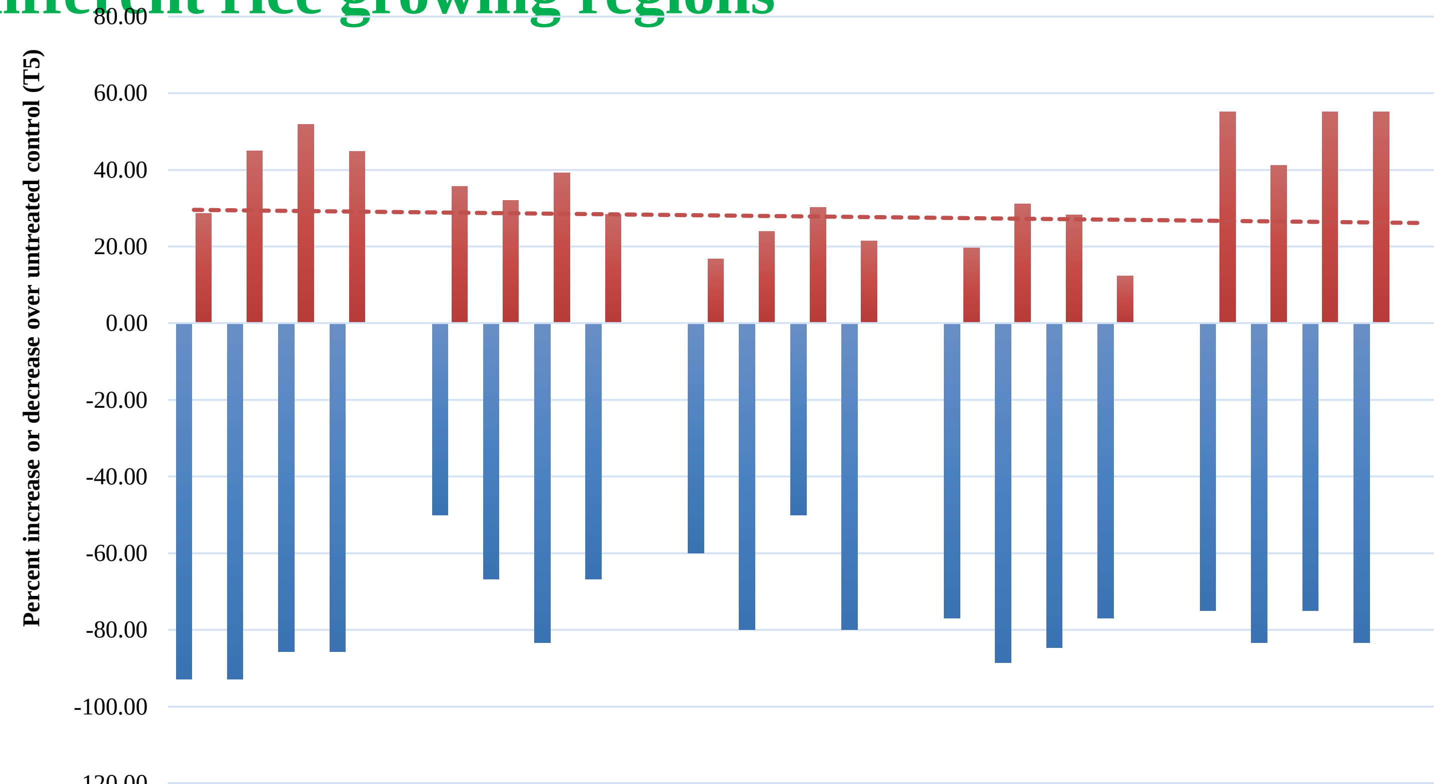
Field evaluation and demonstrations in farmers' fields within the different rice growing regions:

Table 7. Effect of fungicides on incidence of grain discolouration, growth, yield parameter and grain yield during autumn 2017 in region # 2

Chemicals	Rates / L	Plant height (cm)	*Panicle Length (cm)	*Av. # Filled grains/ panicle	*Av. # Unfilled grains/ panicle	*1000 - Grain Weight (grams)	Grain yields (Kg/ha)	*Percent incidence of grain discolouration	Percent reduction over control
Amistar Xtra 28 SC	1.5 ml	92.50 A	20.50 B	49.30 A	9.30 B	32.78 A	7204.50 A	5.52 +(30.87) B	-48.58
Glory 75 WG	3.0 g	96.17 A	20.59 AB	52.77 A	7.77 B	32.33 A	8069.80 A	4.96 (25.29) B	-53.82
Antracol 70WP	5.0 g	100.00 A	22.38 A	50.20 A	7.50 B	33.45 A	8307.20 A	5.48 (34.12) B	-49.00
Carbendazim 50SC	1.5 ml	91.17 A	21.48 AB	52.63 A	8.57 B	32.12 A	8708.30 A	5.52 (33.25) B	-48.58
Control	Water	96.50 A	22.27 AB	40.83 B	14.23 A	30.69 A	5535.70 A	10.74 (117.13) A	
Grand Mean		95.27	21.44	49.15	9.47	32.28	7565.10	48.13	
SE m ±		2.80	0.57	2.48	0.77	0.88	1123.90	9.00	
LSD (P = 0.05)		3.96	0.81	3.51	1.08	1.25	1589.40	12.73	
CV (%)		5.09	4.63	8.74	14.01	4.73	25.73	32.40	

* = average of three replication; +Figure in parenthesis show square root transformation
Means values in columns followed by same letter(s) are not differ significantly at 95% confidence interval according to Fisher's Least Significant Difference (LSD) procedure

SUMMARY: Field evaluation and demonstrations in farmers' fields within the different rice growing regions



	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5	T1	T2	T3	T4	T5
Percent reduction of GD incidence over control	-92.8	-92.8	-85.7	-85.7	0.00	-50.0	-66.6	-83.3	-66.6	0.00	-60.0	-80.0	-50.0	-80.0	0.00	-76.9	-88.4	-84.6	-76.9	0.00	-75.0	-83.3	-75.0	-83.3	0.00
Percent increase or decrease in grain yield (Kg/ha)	28.73	45.01	51.81	44.77	0.00	35.68	32.04	39.25	28.47	0.00	16.84	23.97	30.23	21.54	0.00	19.66	31.23	28.25	12.28	0.00	55.18	41.13	55.11	55.05	0.00

Treatments

T1- Amistar Xtra 28 SC at 1.5 ml/L; T2- Glory 75 WG at 3.0 g/L; T3- Antracol 70WP at 5.0 g/L; T4- Carbendazim 50SC at 1.5 ml/L; T5- Untreated control

Figure3. Percent reduction in the incidence of GD and percent increase or decrease in grain yield over untreated control (T5) during spring 2018 in region # 2, 3, 4, 5, 6

CONCLUSION / RECOMMENDATIONS

In vitro…

- ✓ Analysis of discoloured rice grains revealed the predominant association of *Curvularia* spp. with the grain discolouration condition.
- ✓ Centre for Agriculture and Biosciences International (CABI) in the United Kingdom confirmed *Curvularia lunata*, based on molecular analysis (sequencing) of the ITs region of the rDNA, as the most dominant fungal microorganism on the grains with the discolouration symptoms.

- ✓ The *in vitro* studies has found that new generation fungicides *viz.* Amistar Xtra 28 SC; Tantor 25 SC; Glory 75 WG; Tridium 70 WG; Antracol 70WP; Manzate Pro Stick TM; Carbendazim 50SC and Fugione were effective in inhibiting the mycelial growth of *C. lunata*.

CONCLUSION / RECOMMENDATIONS

Field trials:

- ✓ The application of fungicides have demonstrated a significant reduction in grain discolouration incidence compared to the untreated control in the current study.

- ✓ Application of fungicides *viz*, Amistar Xtra 28 SC at 1.5 ml/L; Glory 75 WG at 3.0 and 5.0 g/L, Antracol 70WP at 5.0 g/L and Carbendazim 50SC at 1.5 ml/L were effective in controlling grain discolouration (showed >50% reduction in incidence of GD) in both varieties- GRDB 10 and GRDB 14.

- ✓ Also these treatment showed high number of filled grains per panicle, 1000- grain weight and over all grain yields as compared to untreated control.

CONCLUSION / RECOMMENDATIONS

Field evaluation and demonstration: *similar findings…*

- ✓ The treatment with the fungicides *viz.* Amistar Xtra 28 SC; Glory 75 WG; Antracol 70WP and Carbendazim 50SC demonstrated a significant reduction in the incidence of GD ranging from 48.58 to 92.85 percent.

- ✓ Likewise, these treatments (Amistar Xtra 28 SC; Glory 75 WG; Antracol 70WP and Carbendazim 50SC) also demonstrated an positive influence interms of the growth and yield paramenters with an increase in the percent grain yield ranged from 12.28 to 55.18 over the untreated control.

- ✓ Thu, these treatments resulted in a significant reduction in GD incidence; better grain quality, as well as higher grain yields…greater profitability!!!

GENERAL CONTROL STRATIGIES:

1. The use of blast resistant & highly tolerant rice varieties…

RESISTANT Varieties ***will not** remain resistant indefinitely.*

Most varieties may break down after 3-5 years (6-8 cropping seasons)…

2. Recommended Cultural Practices for control of major rice diseases:

- Sow within recommended cropping period.
- Practice proper field sanitation.
- Do not have an excessively high planting density.
- Avoid application of excessive amounts of nitrogen… keep the soil nutrient status balance…
- Keep field flooded at a depth of 4” to 6”. Drier fields are more liable to blast attack.
- Keep alternative blast hosts under control e.g. birdseed grass, red rice and off-types of the rice varieties.

3. Alternative & 4. Chemical control:

Use recommended plant extracts and bio-agents once available:

Plant extracts	% Concentration	Effective against
Black sage	10%,	BL
Bael extract	15%	BL
Madar plant	5%	BL
Lemon grass	15%	SB
Thick leaf thyme	15%	SB
Bio-agents	Rates	Effective against
B. cereus-OG2L	2 g/L	BL & SB
B. subtilis-OG2A	2 g/L	BL

Use of recommended fungicides at the correct rate of application.

Fungicides	Rates	Effective against
Antracol 70WP	500 g/ac	BL, SB, BS, SR, GD
Nativo 75 WG	250 g/ac	BL & SB
Serenade 1.34 SC	400 ml/ac.	SB
Glory 75 WG	300 – 600 g/ac	BL, SB, BS, SR, GD
Amistar Xtra 28 SC	200- 300 ml/ac	BL, SB, BS, SR, GD
Carbendazim 50SC	200- 300 ml/ac	BL, SB, BS, SR, GD
Fugi-One	200- 300 ml/ac	BL, SB, BS, SR, GD
Super blast	200- 300 ml/ac	BL, SB, BS, SR, GD
Manzate	300g /ac	BL, SB, BS, SR, GD

Spray solution /acre recommended:2 motor blower!

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Screening for blast resistance in rice using AMMI models to understand G x E interaction in Guyana

Rajendra Persaud · Duraisamy Saravanakumar

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Identification of causal agent and management of grain discolouration in rice

Authors | Authors and affiliations

Rajendra Persaud, Mahendra Persaud, Duraisamy Saravanakumar, Oudho Homenauth

Original Article
First Online: 16 November 2019

Abstract

Grain discolouration has been noticed in rice over the years in Guyana. The disease has been a serious problem in affecting quality and yield of rice. A study was carried out to identify the causal agent of grain discolouration and to develop suitable disease management practices in rice. The initial identification revealed that *Curvularia* spp. was predominant in rice grains with expression of symptoms of grain discolouration from samples collected from various locations of Guyana. The Centre for Agriculture and Biosciences International (CABI) of the UK has confirmed the pathogen as *Curvularia lunata*, based on the amplification and sequence

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Plant extracts, bioagents and new generation fungicides in the control of rice sheath blight in Guyana

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ARTICLE INFO

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Rhizoctonia solani
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ABSTRACT

Sheath blight disease has become a major constraint in cultivation of rice in Guyana inflicting significant yield losses. Eleven plant extracts, three biocontrol agents and five new generation fungicides were screened for their efficacy against sheath blight pathogen, *Rhizoctonia solani* under *in vitro* conditions. The extracts of lemon grass, thick leaf thyme, marigold and clove at 15% showed high inhibition to mycelial growth of *R. solani*. Among biocontrol agents, *Bacillus cereus* OG2L exhibited high inhibition against mycelial growth of *R. solani*. New generation fungicides *viz.*, Antracol (Propineb), Nativo (Trifloxystrobin + Tebuconazole), Silvacur Combi (Tebuconazol + Triadimenol), Cyclops (*Cinnamon Oil* + *Clove Oil*) and a biofungicide (Serenade - *Bacillus subtilis* cepa QST 713) recorded complete inhibition of *R. solani* under *in vitro conditions*. The plant extracts, bioagent and new generation fungicides that showed high inhibition to *R. solani* under *in vitro* were evaluated for their efficacy against shealth blight disease under greenhouse and field experiments. The extracts of lemon grass (7.21; 8.04; 4.85%), thick leaf thyme (6.71; 7.28; 4.71%) at 15%; *B. cereus* OG2L at 2 g L^{-1} (7.86; 8.68; 5.09%) and new generation fungicides *viz.*, Antracol 70WP (8.51; 7.79; 5.27%), Nativo (7.62; 7.21; 4.20%) and Serenade (7.78; 7.66; 4.79%) have recorded low percent disease severity compared to untreated control (26.25; 31.16; 20.43%) in greenhouse, field trials I and II, respectively. The plant extracts, bioagent and new generation fungicides recorded a greater reduction (73.63%) in sheath blight disease incidence with an average yield increased from 10.25 to 36.03% compared to the control. The current study has provided chemical and non-chemical options for an integrated management of sheath blight disease in rice plants.

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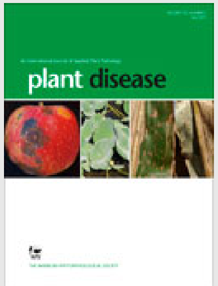

Rajendra Persaud , Duraisamy Saravanakumar, and Mahendra Persaud

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Abstract

One hundred and one rice genotypes were evaluated for response to sheath blight disease under greenhouse and low land irrigated field conditions in Guyana. The level of resistance varied from highly resistant to resistant in fourteen genotypes over five experimental trials. These genotypes were also observed with low area under the disease progress curve (AUDPC) values and slow blighting reactions against artificial

Metrics

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