Alliance

Bioversity International

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Strategies to mitigate the impact of cassava mosaic disease in Southeast Asia

Imran Malik

Cassava Production Systems Specialist

a.malik@cigar.org

10 August 2021, ICAR-CTCRI

CGIAR

Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
CGIAR is a global research partnership for a food-secure future.

Outline…..

- Background
- On going research
- Dissemination of disease free planting material

CMD

CWBD

Cassava in Asia

- More than 8 million farmers grow cassava in Asia covering approximately 4.2 million ha, and it is increasing……
- A direct food crop to an industrial crop ……. export oriented

	Cambodia	China	India	Indonesia	Laos PDR	Philippines	Thailand	Vietnam
Production ('000 t)	10,207	4,794	4,554	20,775	3,096	2,815	31,161	11,045
Harvest area ('000 ha)	388	291	204	867	94	225	1,462	580
Yield (t ha^{-1})	25.9	16.2	21.9	23.5	32.2	12.3	21.0	18.7

Malik *et al*. 2020

Pest and disease in the region- a new challenge

Cassava mealybug
Phenacoccus manihoti

Cassava witches broom
phytoplasma

Cassava Mosaic Disease
Geminiviruses

Large volumes of planting material moves around the region

FANTASTIC IN THE ABSENCE OF PEST AND DISEASE

Cassava Mosaic disease has spread throughout the main cassava producing regions in mainland

2015: Cambodia (Wang et al. 2016)

2016: inter province spread in Cambodia (Minato et al. 2018)

2017: Vietnam (Uke et al. 2018)

2017: China (Wang et al. 2018)

2019: Thailand (Leiva et al. 2020)

2020: Lao PDR (Chittarath et al., 2021)

Courtesy Mr. Erik Delaquis

What are the options to combat CMD Approaches……

- Sustainable solution to the CMD is a long-term endeavor
  - Short time – screen for resistance in the current varieties
  - Medium term- use of exotic sources of resistance (i.e. IITA and/or CTCRI) (evaluate agronomic and economic suitability)
  - Long term – introgression the resistance in the local varieties
  - CMD2 gene has resistance for SLMD valeted

CMD Monitoring within demonstration trial: A terrible opportunity (2017-18)

Variety: 7

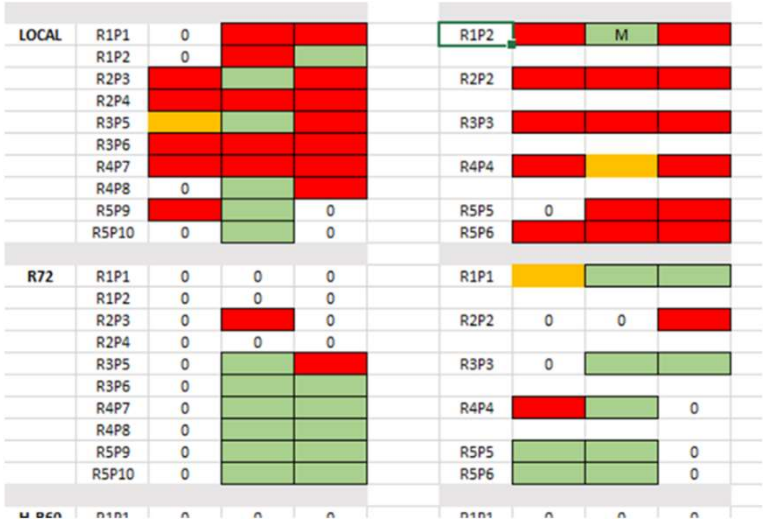
- HuayBong 60
- KU50
- Rayong72
- KM98-1
- **SC8**
- **SC9**
- Local(farmer's variety reserved from 2016)

DNA fingerprinting shows that SC8 & SC9 are the same variety

Asymptomatic plants also carry virus

	V	rayong_72						R	1			V	km98-1						R	2			V	huay_bong_60						R	3	
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0
R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	1	0	0	0	0	R4	0	0	0	0	0	0	0	0	0	0
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	0
	V	ku50						R	1			V	sc9						R	2			V	km98-1						R	3	
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0	R1	0	0	0	0	0	0	0	0	0	0
R2	0	0	0	0	0	0	0	0	0	0	R2	0	0	0	0	0	0	0	0	0	0	R2	0	M	0	0	0	0	0	0	0	0
R3	0	0	0	0	0	0	0	0	1	0	R3	0	0	0	0	0	0	0	0	0	0	R3	0	0	0	0	0	0	0	0	0	0
R4	0	0	0	0	0	0	0	0	0	0	R4	0	0	0	0	0	0	0	0	1	0	R4	0	0	0	0	M	0	0	0	1	0
R5	0	0	0	0	0	0	0	0	0	0	R5	0	0	0	0	0	0	0	0	0	1	R5	0	0	0	0	0	0	0	0	0	1
	V	km98-1						R	1			V	rayong_72						R	2			V	sc8						R	3	

Sampling across the plots – 10 samples



PCR assessment shows many plants that did not display typical symptoms had the virus

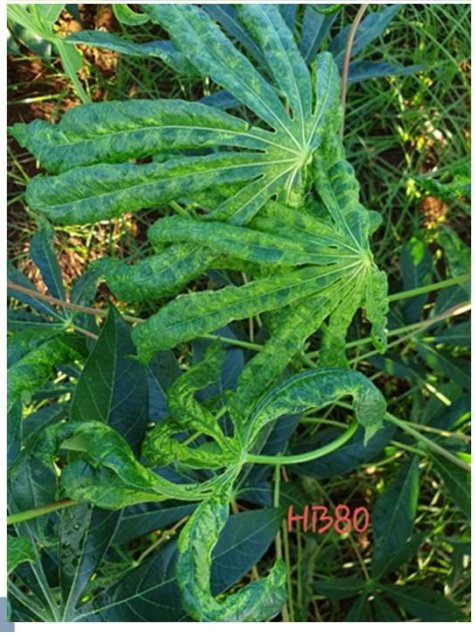
e.g. Rayong 72 during the first visual assessment didn't show high incidence but did with PCR analysis

Approach CAVAC for funding for screening for CMD resistance (2018-19 and 2020)

- Systematic evaluation of resistance to CMD in current varieties
- Effect of fertilizer application (building on results with CWBD in Laos)
- Evaluate yield impacts on different varieties

Variety	Origin	Genetic background
KU50	Thailand	R 1 x R 90
Rayong 11	Thailand	R 5 x OMR 29-20-118
SC8	China	CMR38-120-10
HuayBong60	Thailand	R 5 x KU 50
KM98-1	Vietnam	R 1 x R 5
Rayong 5	Thailand	27-77-10x R3


TMR 3

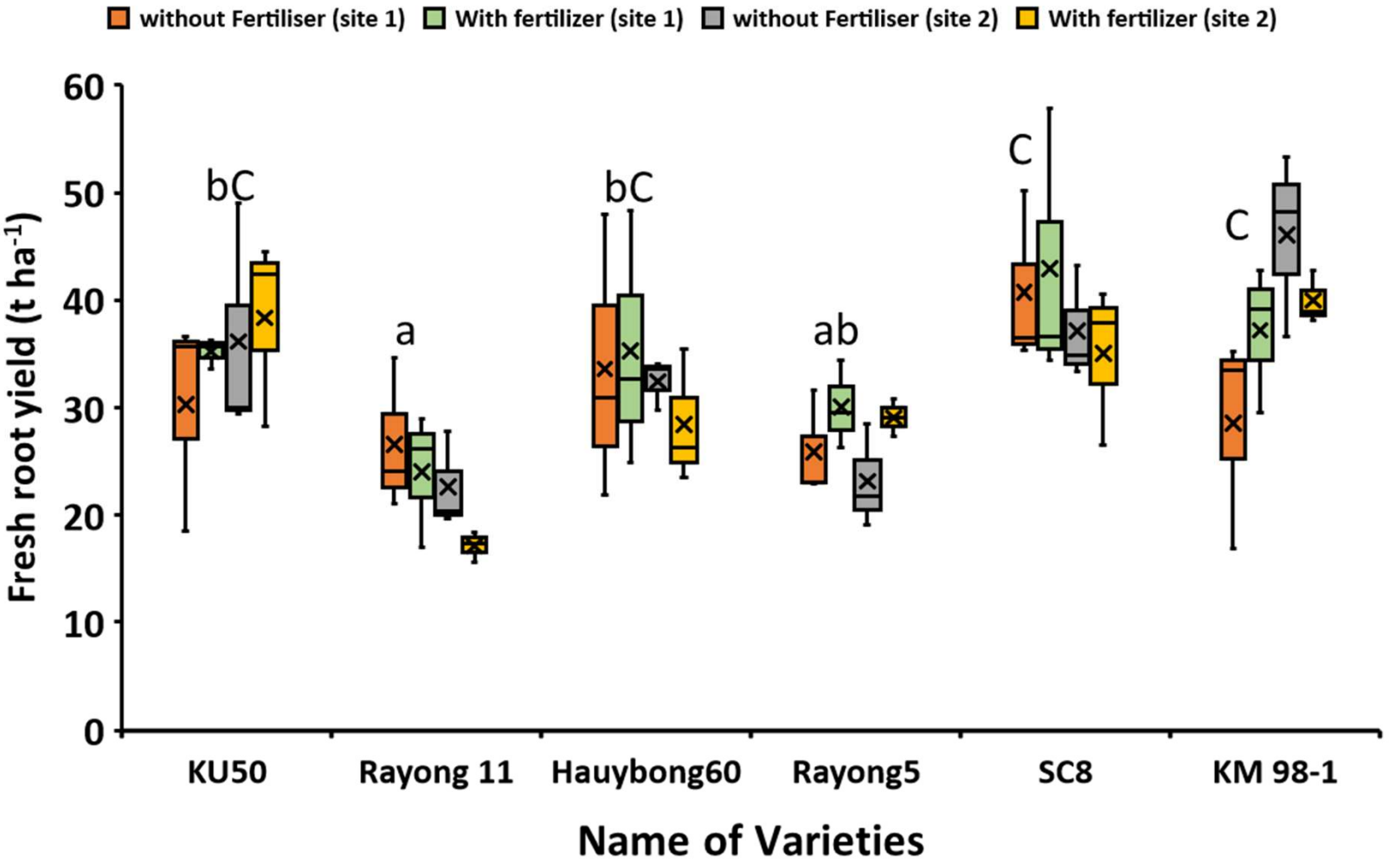

HB80

Healthy cassava crop 4 months growth

Healthy cassava crop 7 months growth

Alliance Bioversity International CIAT

No effect of fertilizer on disease severity

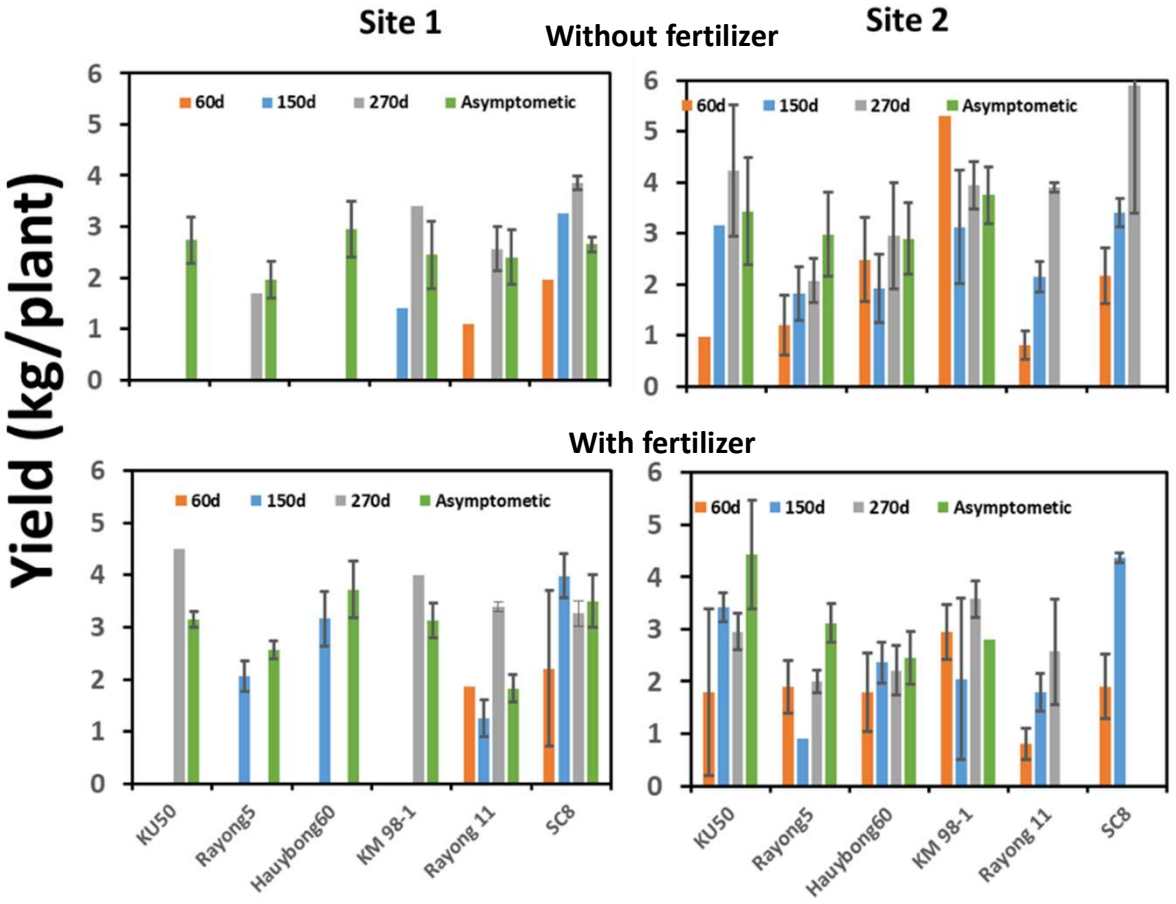


No effect of fertilizer on disease severity

Variety SC8 yielded highest in both treatment at site 1, however, in site 2 KM 98-1 produced highest.

Rayong11 yielded lowest in both treatment and both site.

Early infection can lead to crop failure



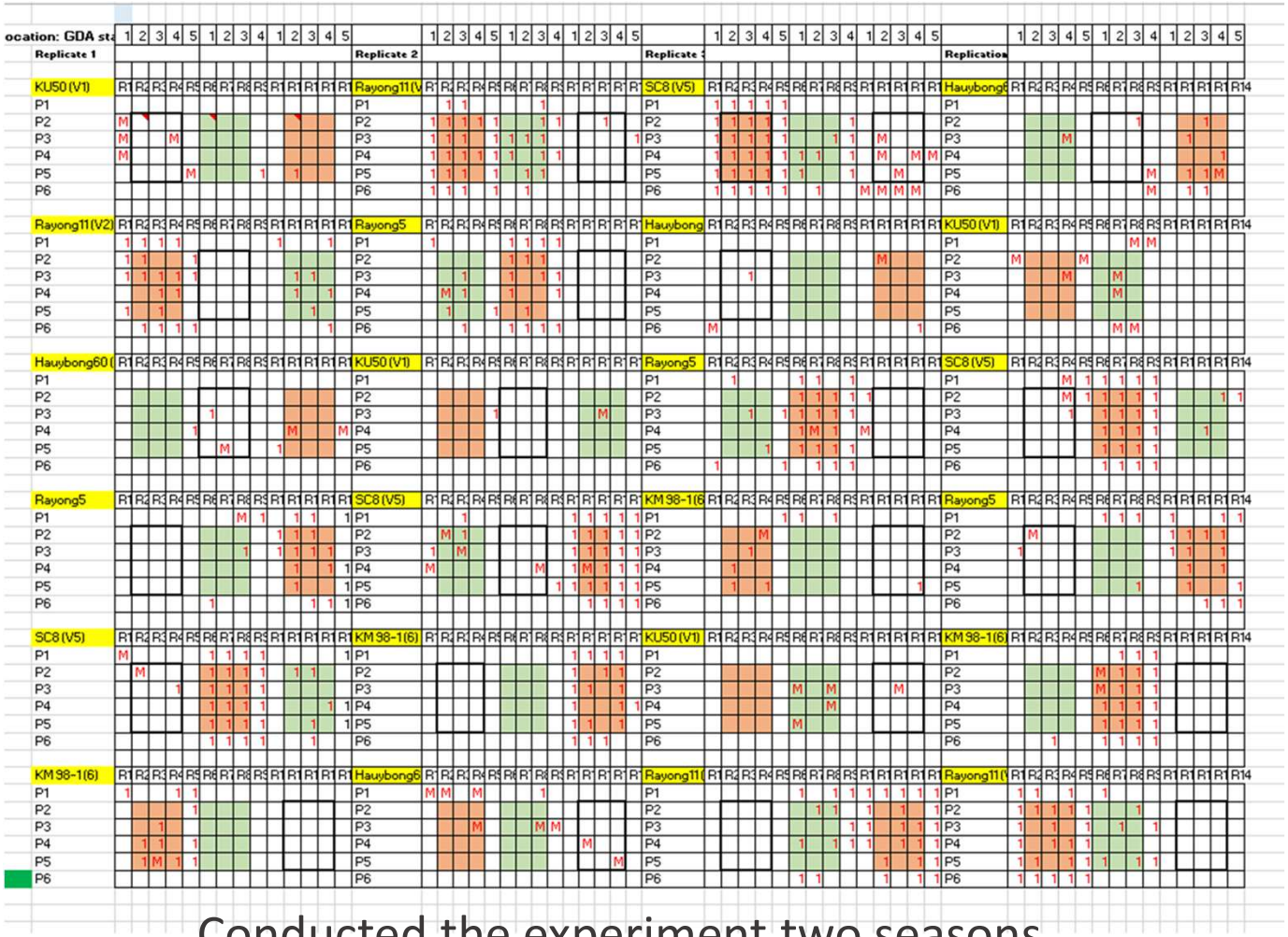
Infected at 60 DAP produced on an average 1.5 to 2.2 kg/plant

Infected at 270 DAP and/or asymptomatic plants produced 2.5 to 3.8 kg/plant

Some variation in disease susceptibility was observed
Early infection can lead to crop failure
Clean plating material can produce profitable yield during first year of infection

Alliance Bioversity International CIAT

Is there yield penalty for planting diseased stakes?

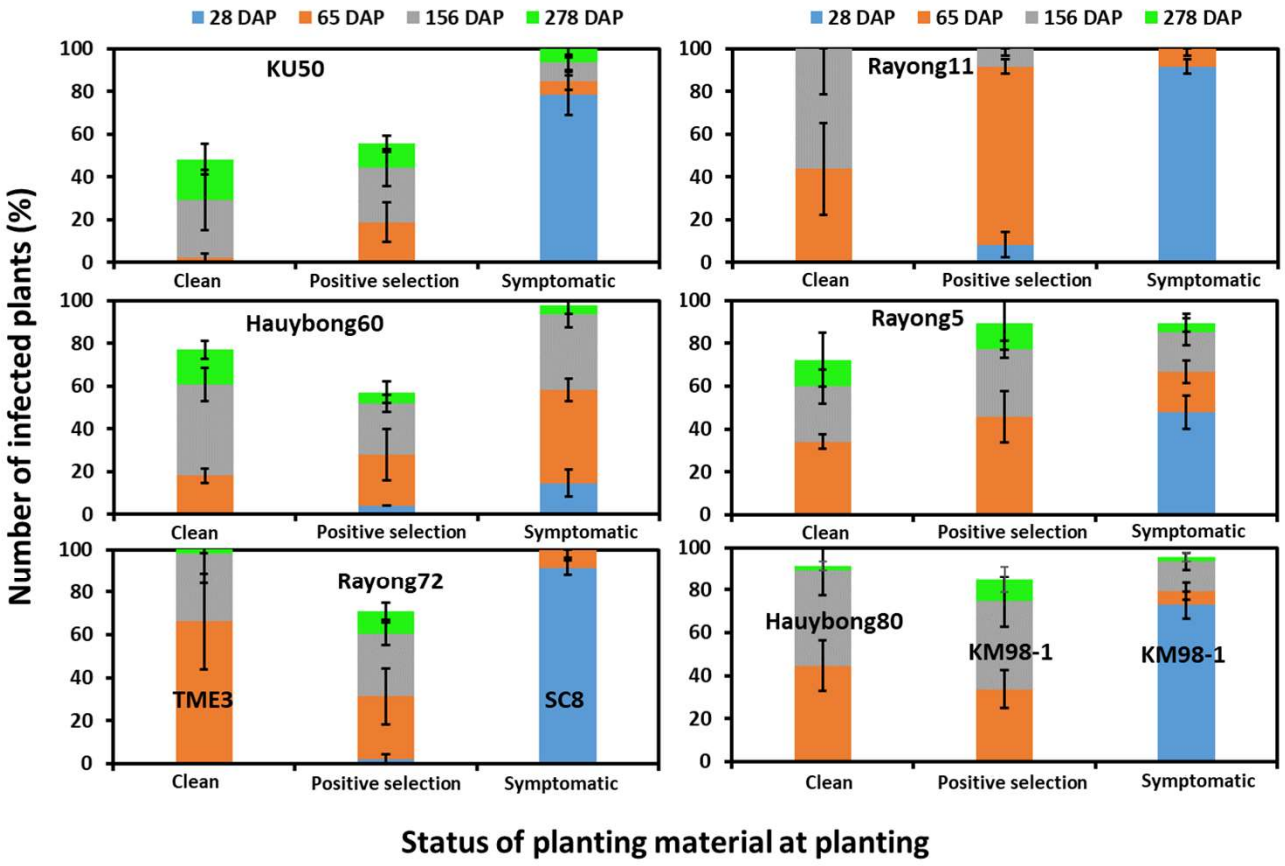


Conducted the experiment two seasons

(1)positive selected (i.e. visually healthy looking plants) planting material from 2018–19 multiplication block,

(2)symptomatic planting material from 2018–19 experiment; and

(3)clean planting material from the Thai Tapioca Development Institute (TTDI).

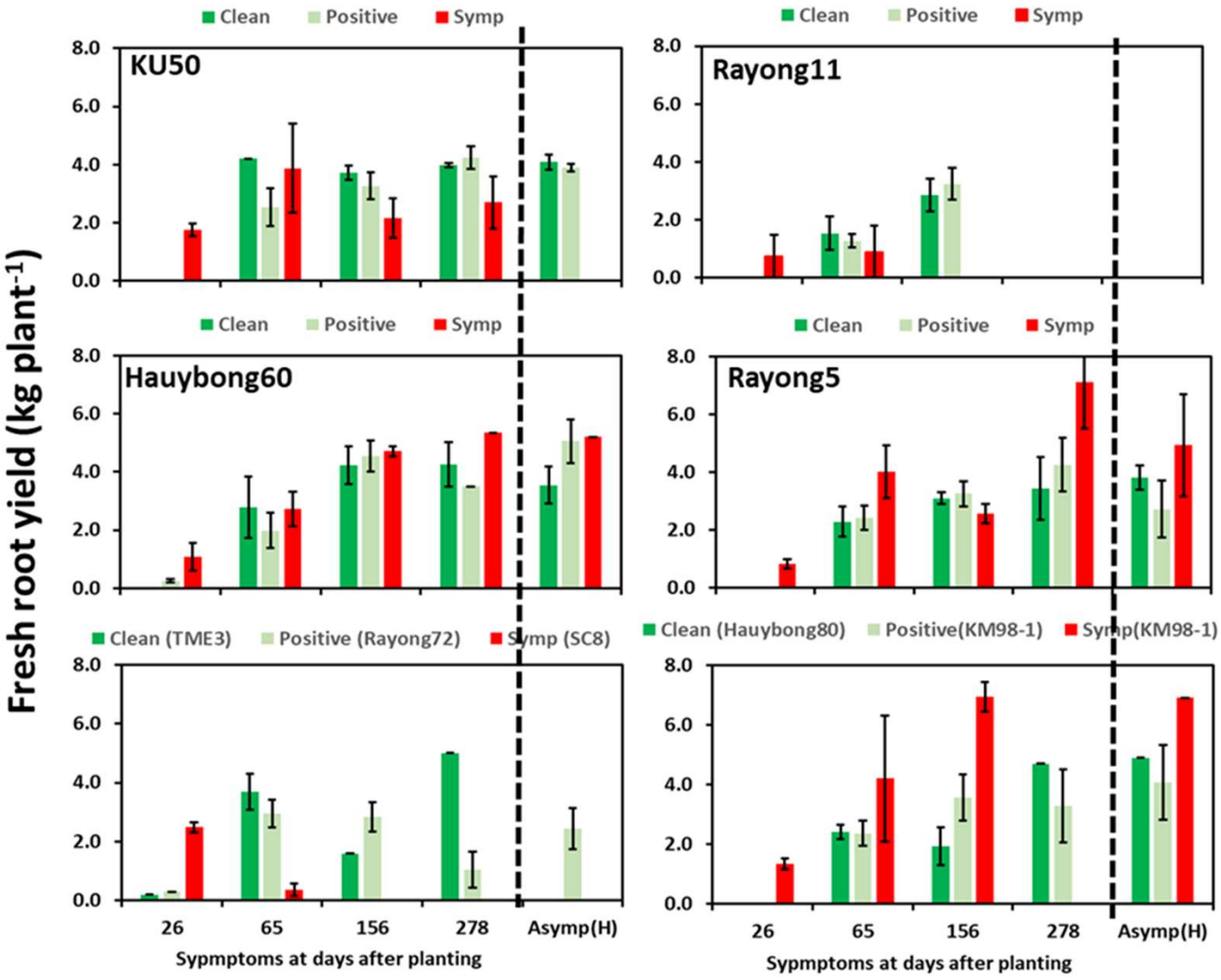


2020-21

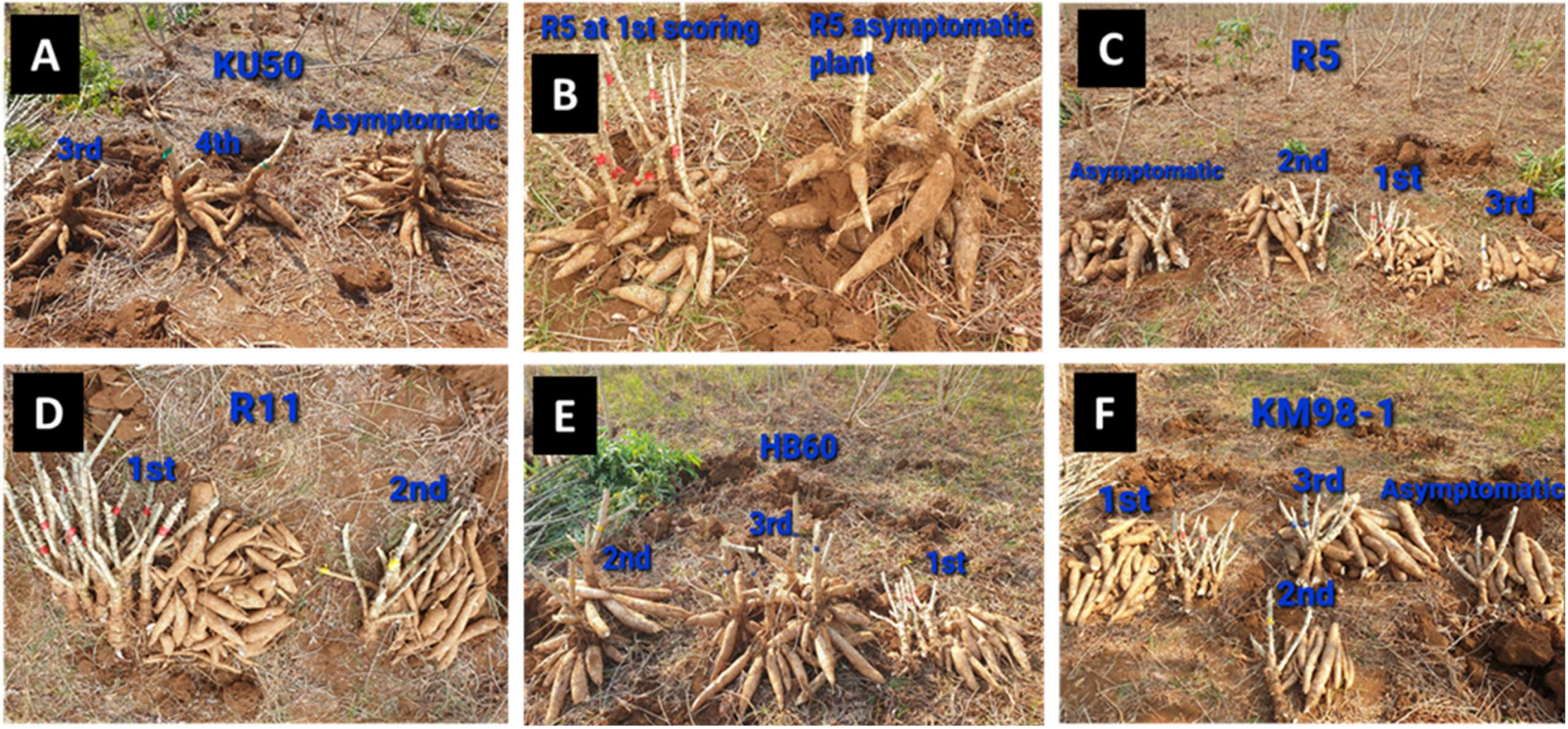
Areal view of the experiment site

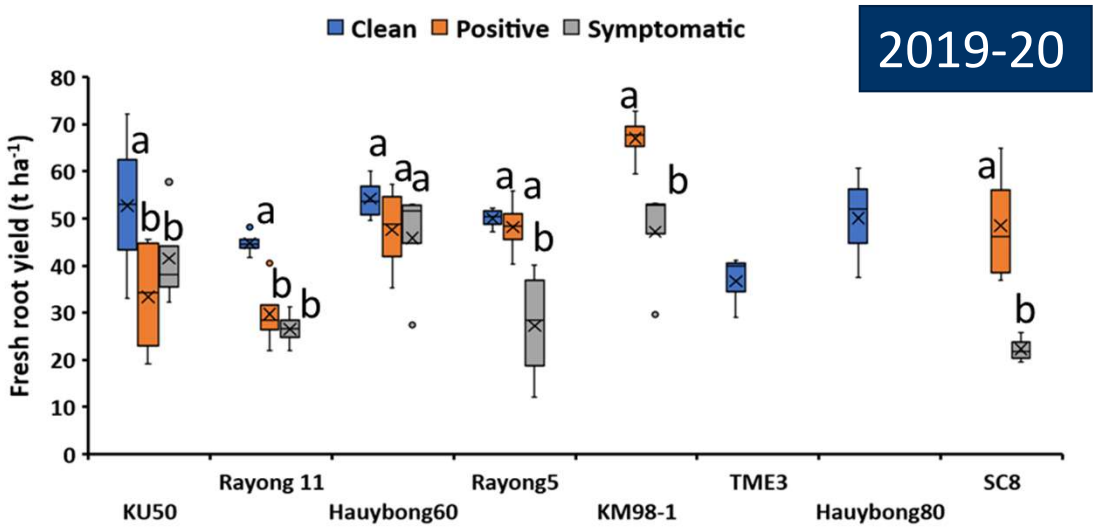
The number of infected plants increased with time.
Many plants from symptomatic planting material did not develop symptoms

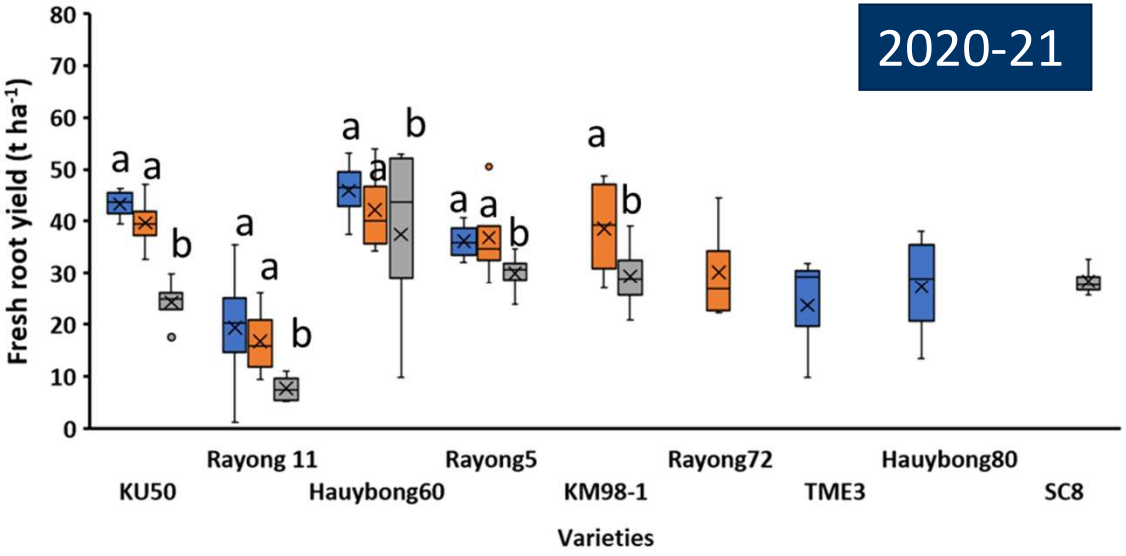
2020-21



Plants from clean and positive selection planting material produced 2- to 3-fold higher yields than diseased planting material


A
KU50
Asymptomatic
3rd
4th
B
R5 at 1st scoring
R5 asymptomatic plant
C
R5
Asymptomatic
2nd
1st
3rd
D
R11
1st
2nd
E
HB60
3rd
2nd
1st
F
KM98-1
1st
3rd
Asymptomatic
2nd

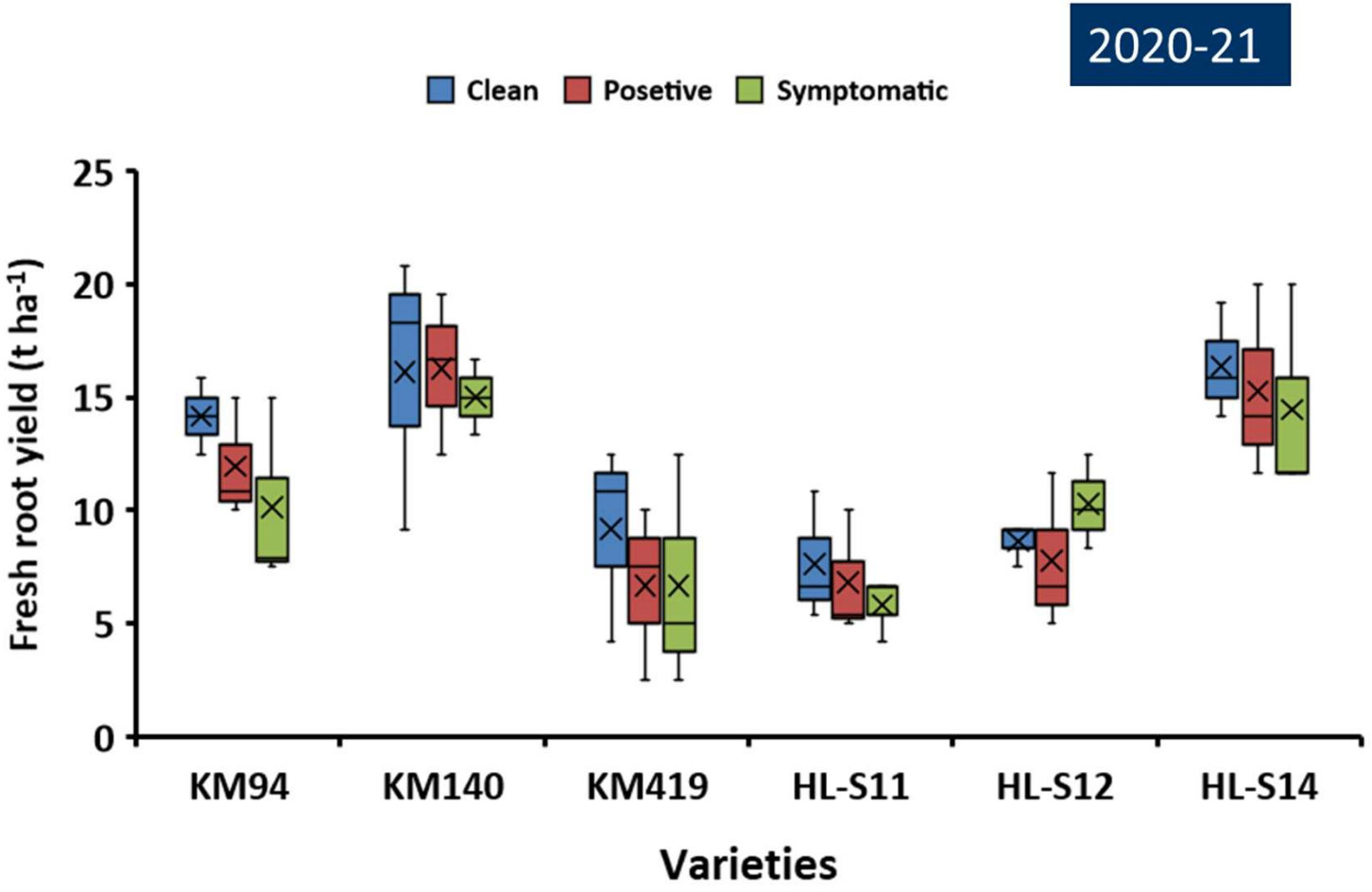




Plot yield was 1.2- to 2.2-fold higher in plants from clean and/or positive selection planting material than those from symptomatic planting material

No significant effect of disease on starch content on

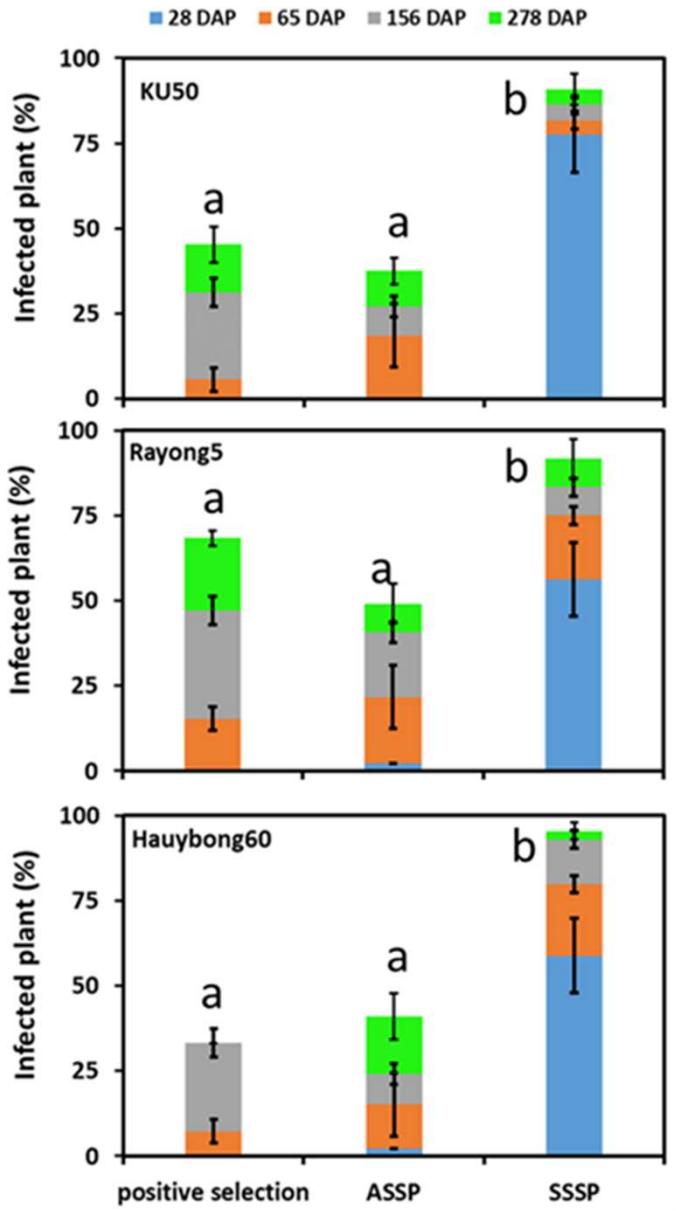
All plants demonstrated symptoms within 30 days of planting in an experiment in high disease pressure area (Tay Ninh, Vietnam)

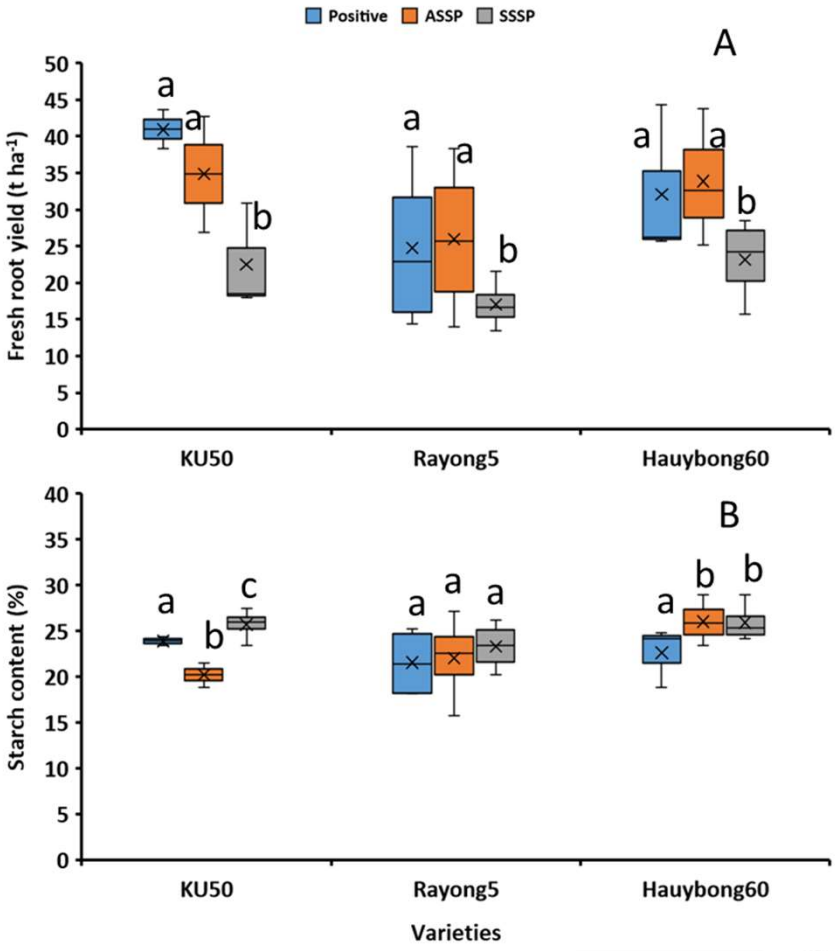


Plot yield was up to 1.4- fold higher in plants from clean and/or positive selection planting material than those from symptomatic planting material

What to do with asymptomatic stem of a symptomatic plant

ASSP= Asymptomatic stem of a symptomatic plant
SSSP=Symptomatic stem of a symptomatic plant




Positive
ASSP
SSSP
A
Fresh root yield (t ha-1)
50
45
40
35
30
25
20
15
10
5
0
a
a
b
a
a
b
a
a
b
KU50
Rayong5
Hauybong60
B
Starch content (%)
40
35
30
25
20
15
10
5
0
a
b
c
a
a
a
a
b
b
KU50
Rayong5
Hauybong60
Varieties

Conclusions

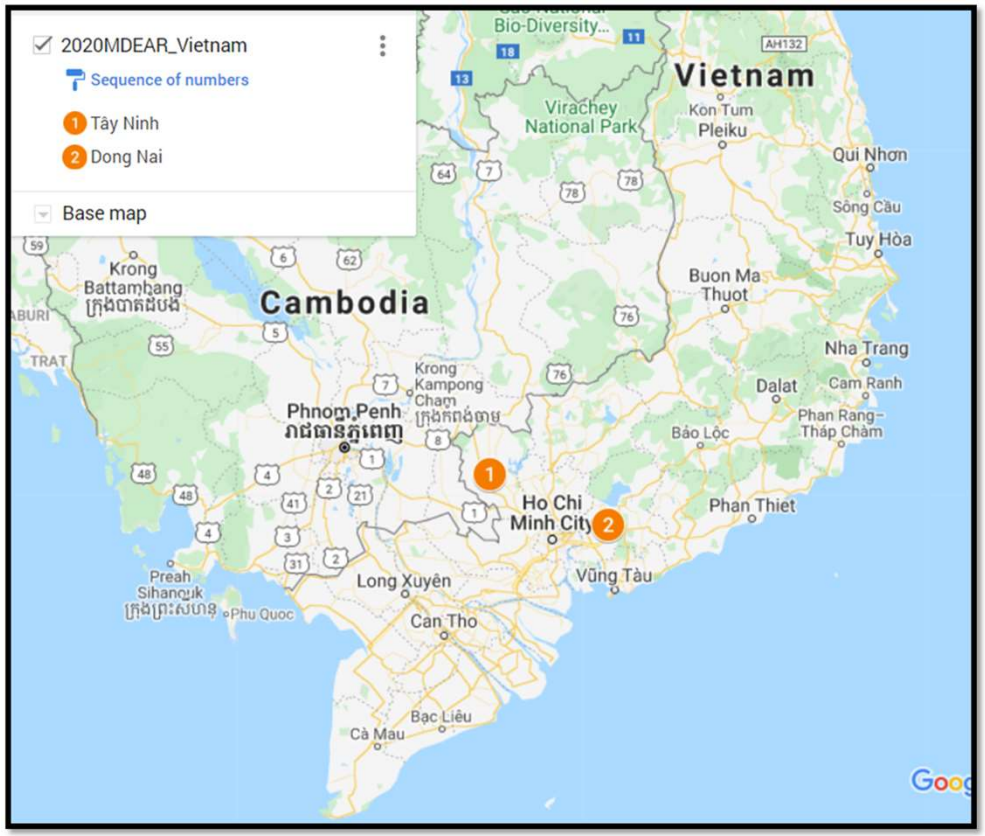
- Higher yield can be achieved from clean stakes compared to symptomatic stakes. Planting clean KU50 or Huaybong60 remains our advice to farmers in Cambodia at this stage.
- The results also show that positive selection of healthy stems from an infected field could be a viable method for farmers to limit the impact on yield.
- PCR analysis showed a high rate of asymptomatic infection. Even plants from clean and positive selection planting material carried virus very soon after planting. This could misguide farmers to consider these planting materials as virus-free and/or resistant to the virus. This could contribute to the rapid propagation of the disease in the country.

Coffee cup field diagnostics

Dr. Jonathan Newby

Screening for CMD resistance

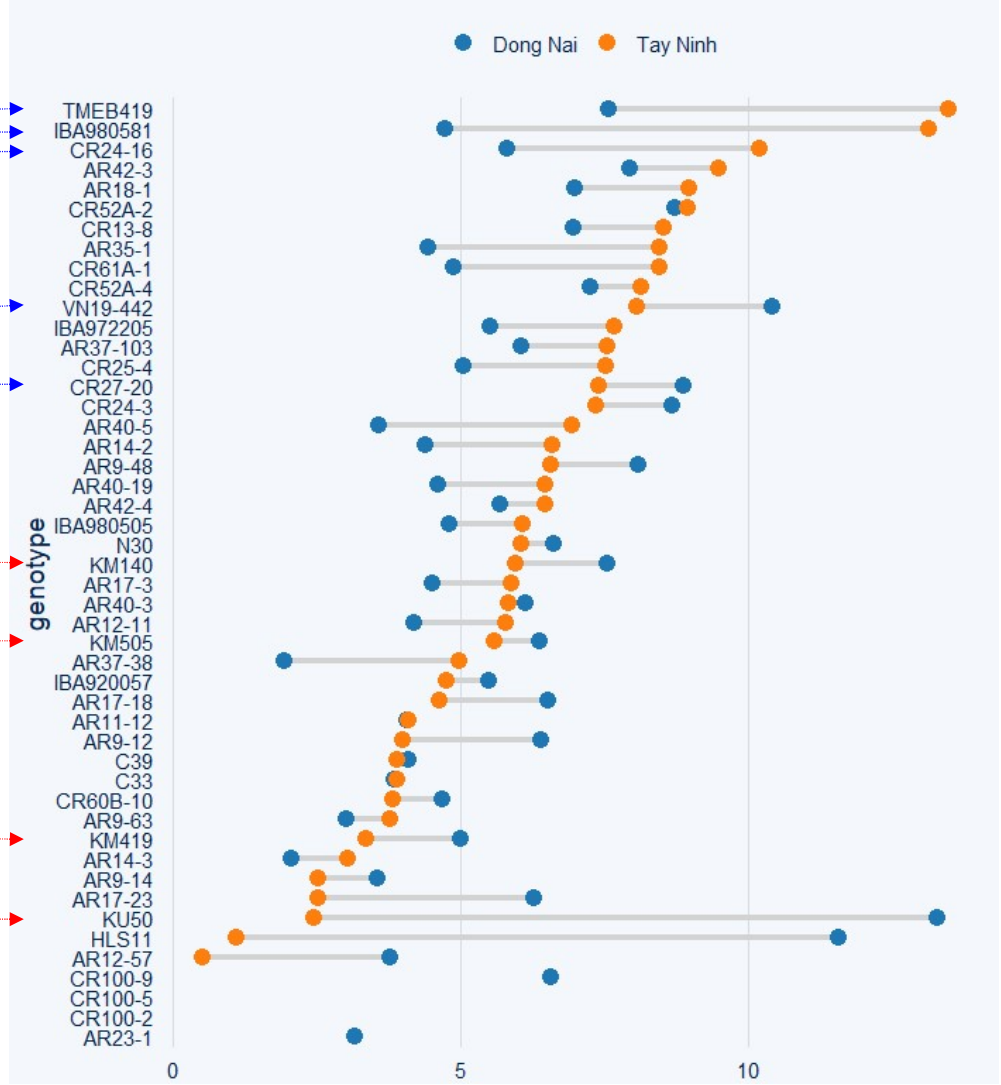
- CIAT102, 34 + 2 = 36 clones
- 5 IITA clones
- 7 varieties or landraces in SEA



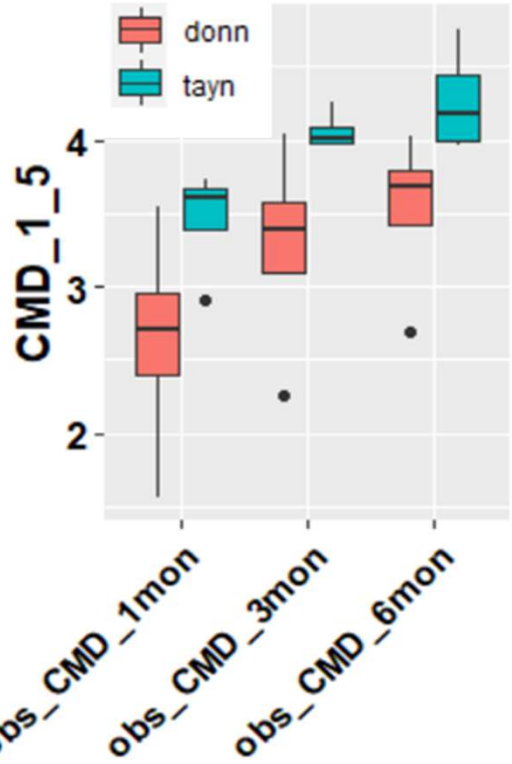
Courtesy Dr Xiaofei Zhang

	CIAT	CIAT	IITA	SEA
1	C33	CR100-2	IBA920057	HLS11
2	C39	CR100-5	IBA972205	KM140
3	AR11-12	CR100-9	IBA980505	KM419
4	AR12-11	CR13-8	IBA980581	KM505
5	AR12-57	CR24-16	TMEB419	KU50
6	AR14-2	CR24-3		N30
7	AR14-3	CR25-4		VN19-442
8	AR17-18	CR27-20		
9	AR17-23	CR52A-2		
10	AR17-3	CR52A-4		
11	AR18-1	CR60B-10		
12	AR23-1	CR61A-1		
13	AR35-1			
14	AR37-103			
15	AR37-38			
16	AR40-19			
17	AR40-3			
18	AR40-5			
19	AR42-3			
20	AR42-4			
21	AR9-12			
22	AR9-14			
23	AR9-48			
24	AR9-63			

Stability of Starch Yield



Performance at Two Locations



Starch yield of KU50 in Cambodia experiment Clean planting material was 12 t ha^{-1}and was for symptomatic plants it was 7 t ha^{-1}.

Courtesy Dr Xiaofei Zhang

MGTCL Molecular Genetics and Tissue Culture Laboratory

CIAT'S CASSAVA SEED SYSTEM APPROACH

1 **Implementation of relevant technologies for different scales**
· Industrial level
· Small farmer associations

2 **Simplified protocol to achieve low-cost design with adaptable equipment.**

3 **High throughput platform to integrate with multiple crops.**


In vitro methodologies


1 Conventional in vitro culture 2 Biorreactores 3 Synthetic seeds 4 Rural TC laboratory 5 Rural schools initiatives

TRAINING AND


Scaling up: Hardening & macro propagation


1 Hardening phase of in vitro culture 2 Tunnels system & sprouting rooting 3 Mature and immature cuttings 4 Pellets

CAPACITY BUILDING


To end-users


1 Farmers associations 2 Industrial company 3 NGO´s 4 NAR´s 5 School projects

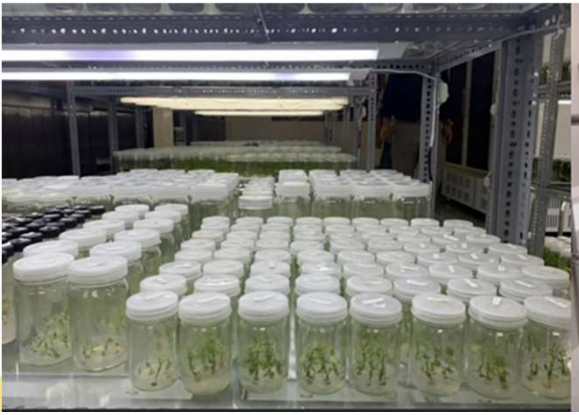
Alliance

Bioversity International

CIAT

Steps of rapid multiplication

Mother plant for tunnel



Bioversity International

CIAT

Two node stem-cutting horizontally placed in the sand bed

Approximately 35 plant (two long stem each plant) give about 700 two node cuttings

Viable sprout are with 5 to 6 nodes, average height of KU50 sprouts are couple cm taller compared to Rayoung11

Interest in tunnel systems from private stake holders

- Khousap Company Bachiang district from Champasak provience

Laos – NAFRI, Napok Vientiane

Laos – Khonsup Import-Export, Champasak

Transplanting in the field

Alliance Bioversity International CIAT

Productivity of tunnels

Variety	Number of seedlings per season per tunnel	No of viable sprout in each cutting	No of days to get new plantlets	No of days to transplant to field (from Tunnel)	Number of plants in the field	Transplantation field Success rate (%)
KU50	3840	768 ± 74	[a]50 ± 4.6	[b]96 ± 15	*2690	100
Rayong11	5040	840 ± 123	[a]49 ± 3.0	[b]95 ± 4	4210	100

* Lost one batch to mealybugs, a= delayed by 7 day due to unavailability of substrate, b= delayed by 10 to 15 days due to delayed in irrigation system set up.

Multiplication rate from mother plants is 6-10x under traditional field multiplication
In tunnel multiplication it is 100-125x over the course of a season

Conclusions

- Start with clean planting material
- Rapid identification and multiplication of promising varieties is the key for interim period
- Promising long solutions -CMD resistant varieties on the way

- https://cassavadiseasesolutionsasia.net/
- http://cassavavaluechains.net/

Australian Government
Australian Centre for International Agricultural Research

CGIAR
RESEARCH PROGRAM ON Roots, Tubers and Bananas

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

TTDI

https://cassavadiseasesolutionsasia.net/

http://cassavavaluechains.net/

Alliance
Bioversity International
CIAT

Alliance

Bioversity International

CIAT
International Center for Tropical Agriculture
Since 1967 Science to cultivate change

Thank you!

Imran Malik

Cassava Production Systems Specialist

a.malik@cigar.org

CGIAR

Bioversity International and the International Center for Tropical Agriculture (CIAT) are CGIAR Research Centers.
CGIAR is a global research partnership for a food-secure future.