

Breeding for Bruchid Resistance in Farmers' Preferred Common Bean (*P.vulgaris*) varieties in Tanzania

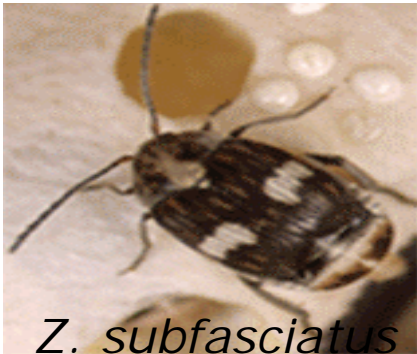


- Conference for Bean Diseases – Mpumalanga, South Africa
 - 20 - 24TH July 2015
 - Mpumalanga, South Africa

Bean bruchids (Weevils) – major pests in seed storage



A. obtectus



Z. subfasciatus



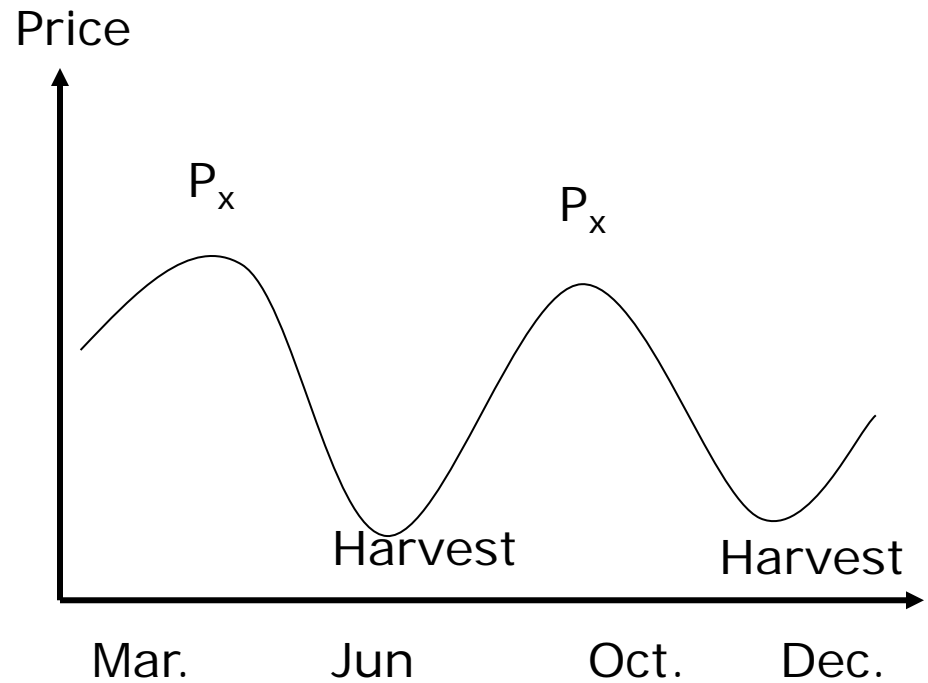
- Infestation starts from field and continues in storage
- 5-20% seed weight loss
- 7 – 40% loss of marketable beans
- Up to 100% seed damage
- Poor seed germination



Bean price and production under bimodal rainfall

Market price fluctuations

Low household income and food insecurity



Control strategies

- Cultural and mechanical
- Predators & Biological
 - Parasitoid-
Horismenus ashmead
- Botanical pesticides
- Chemical
- Genetic resistance from wild species



Resistance mechanism from seed storage proteins

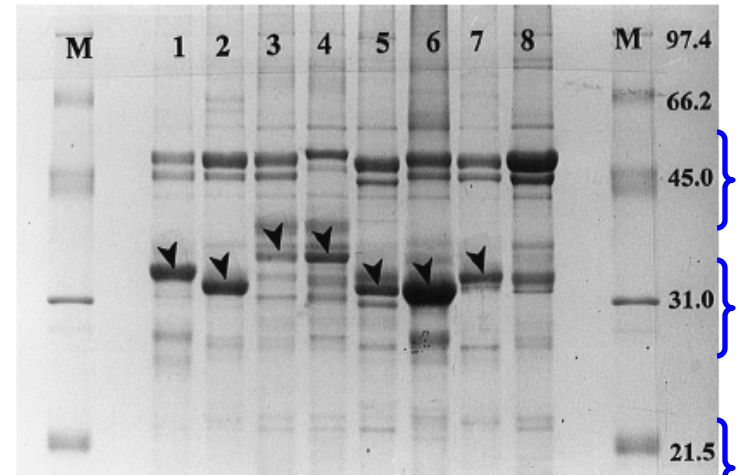
Major storage proteins with antibiosis to bruchids

- Different electrophoretic variants

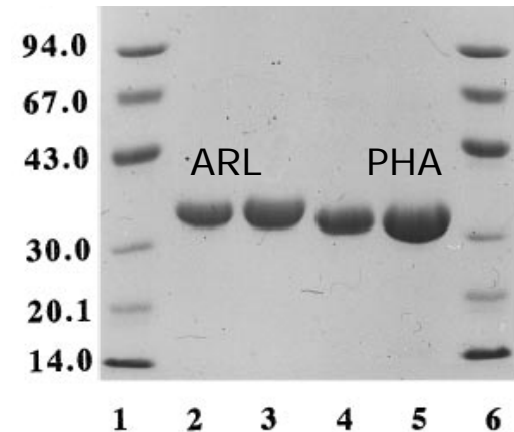
- Lectins -
Phytohemagglutinins E & L

- Lectin-like proteins (LLPs)
 - Arcelins – wild species

- Alpha amylase inhibitors



Acosta Gallegos et al. 1998



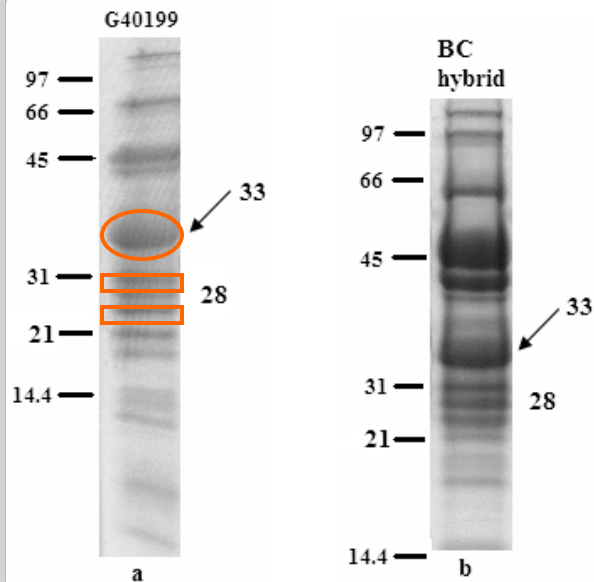
Fabre et al. 1998

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1  MASSNLLSRA  LFLLLPTHAI  SATDTYFNFD  FFKQNDADTN  RLILQRDATI
51  SSGGRLRLTG  VGSNEDPWVD  SMGRAFYSDP  IQIRDSTGNL  ASFHTNFTFI
101 IRANNAGHSA  YGLAFALFPV  GSQPKRKREN  LGLFPDAHTV  AVENTVSNVM
151 KSTSTPTRLA  QRGFAISTNH  NGETTDVQIT  YESPKKNLKI  VLPSTNSNVQ
201 YDFNAPLYLE  NEVDRNVSVG  FSATSGLTEE  TTETHDILSW  SFSSEFPDHT
251 TSEPSNILLN  NIL

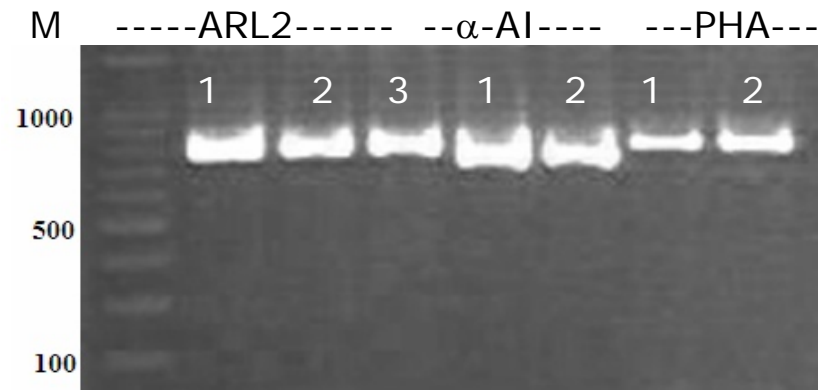
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ARL2^{pa} - Amino acid sequences from trypsin digested peptides of the ~33, 31 and 26 kDa protein bands from G40199 and interspecific BC hybrid

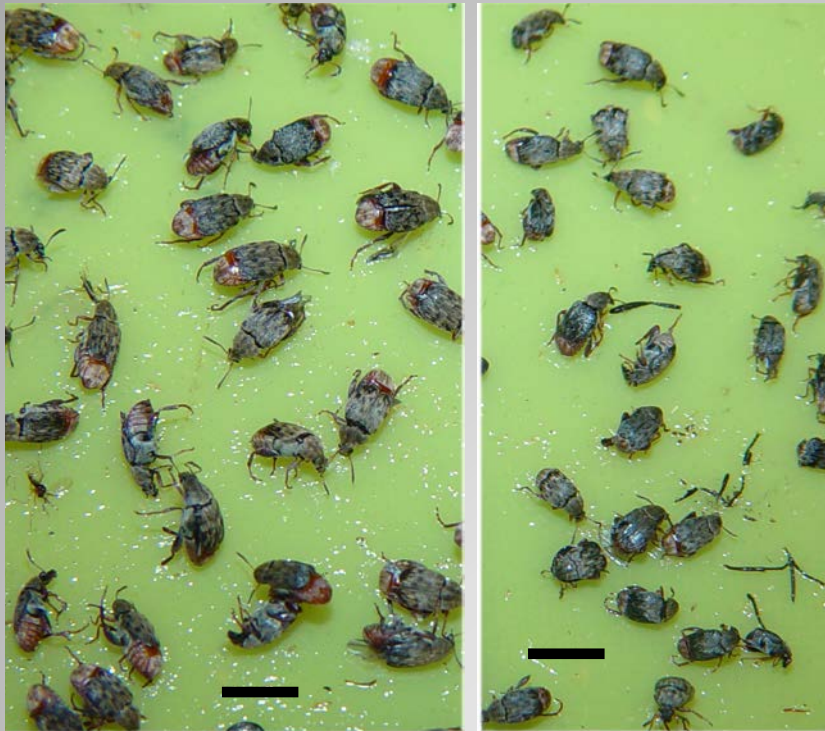


Genomic APA alleles

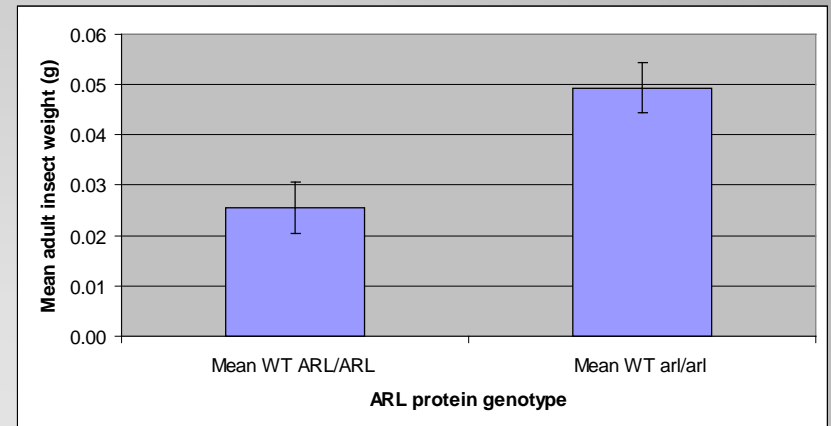
1. G40199
2. F₁ interspecific hybrids
3. BC₁F₁ into FPVs

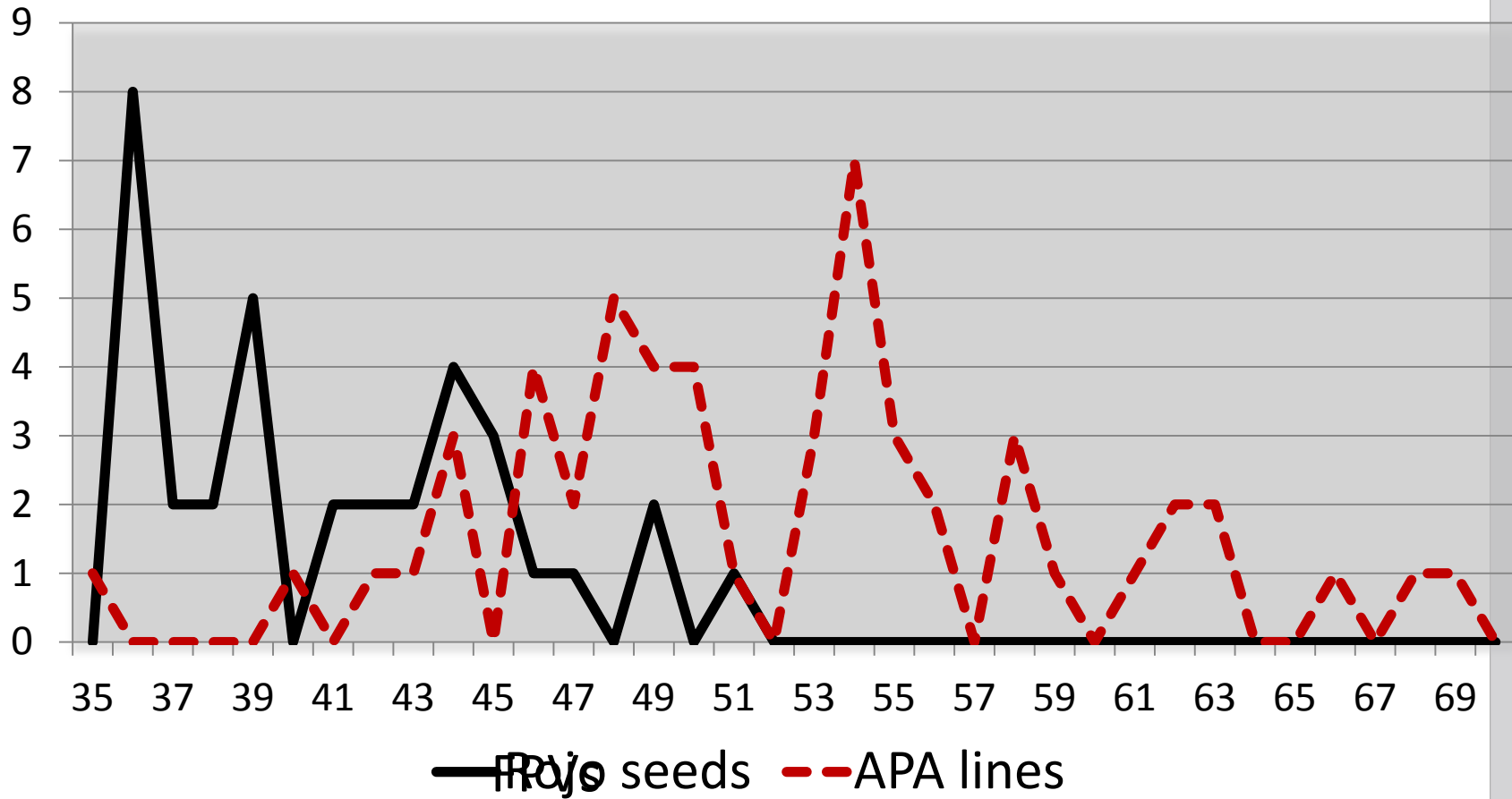


Size reduction

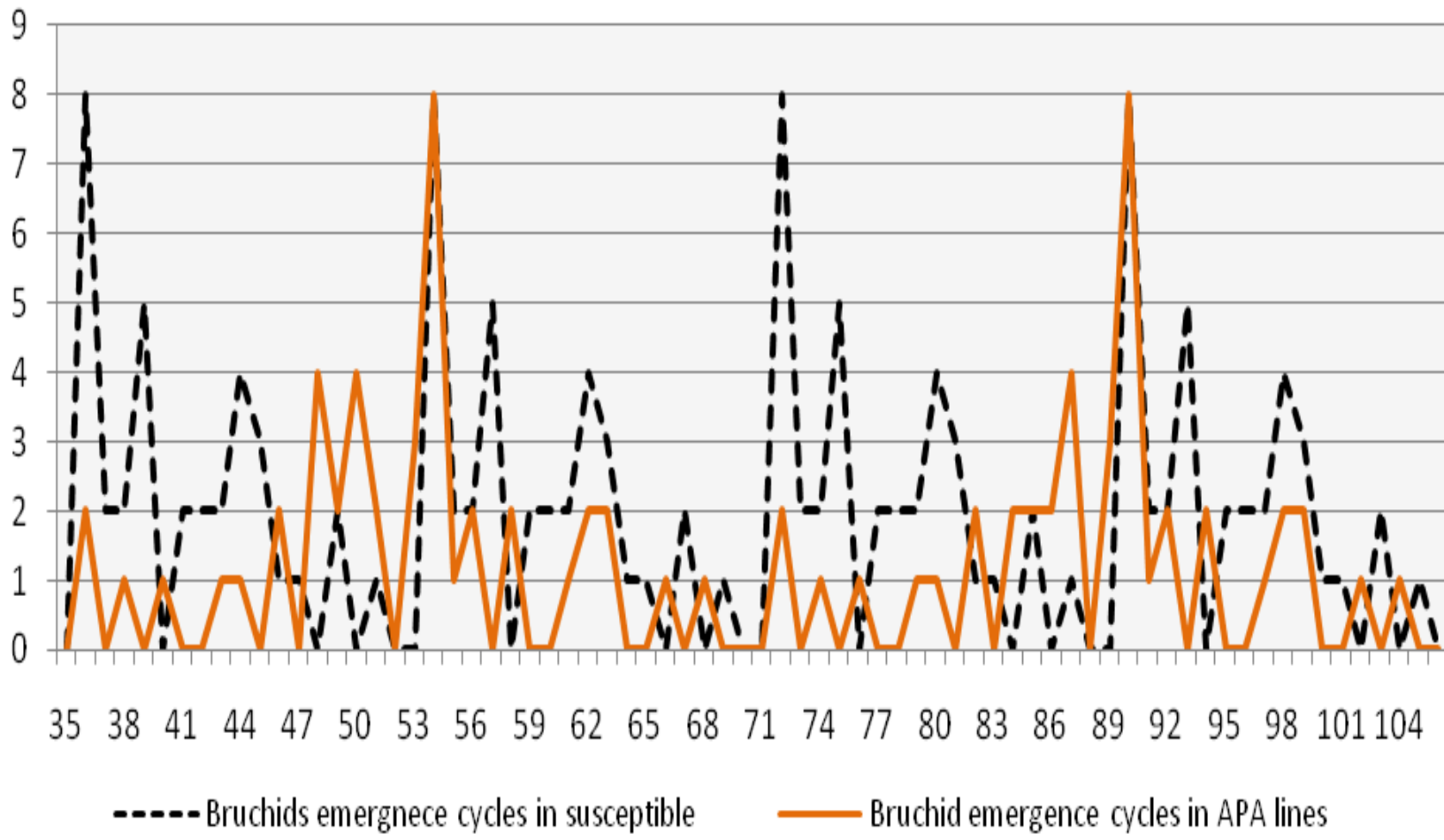


Weight loss/poor development





Delayed emergence of adults (#/day)

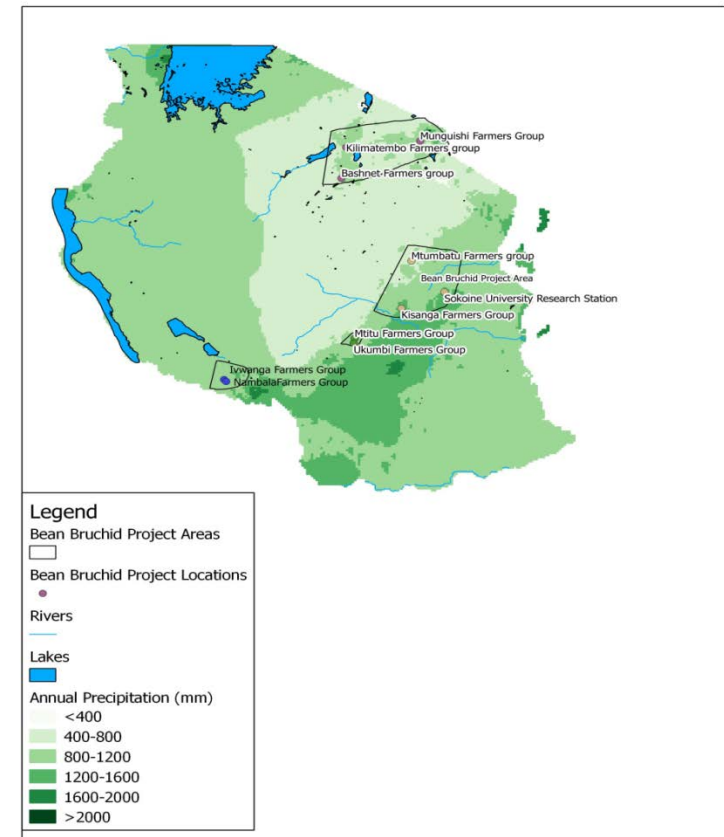


Projection of bruchid emergence cycles

Main Bruchid Research Project

- Major focus is to improve bean bruchid resistance among farmers' preferred bean varieties for increased seed storage period

Working areas in Tanzania



- We Identified the major FPVs and commercial market classes of bean varieties for Tanzania
 - Kablanketi
 - Soya njano
 - Soya ndefu
 - Rungemba (Punda

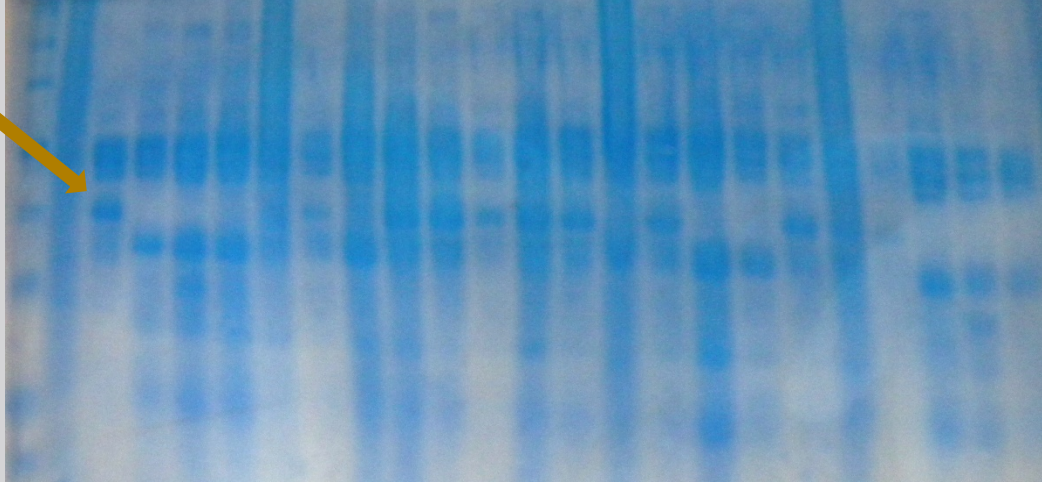
Selection based on the presence of DNA and SSP

Transfer of Arcelin 2 and ARL seed storage proteins for bruchid resistance by backcrossing

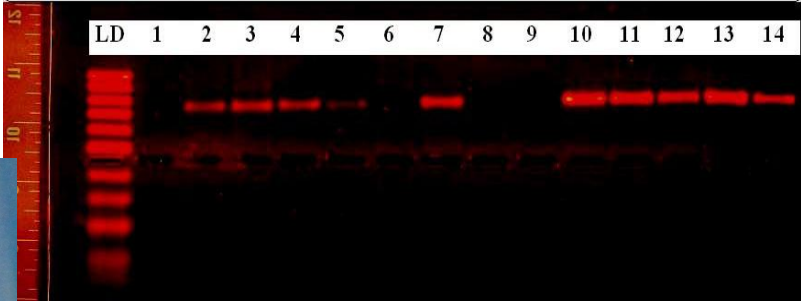
Bruchid Resistance screening & Selection of APA and Arcelin-2 breeding lines



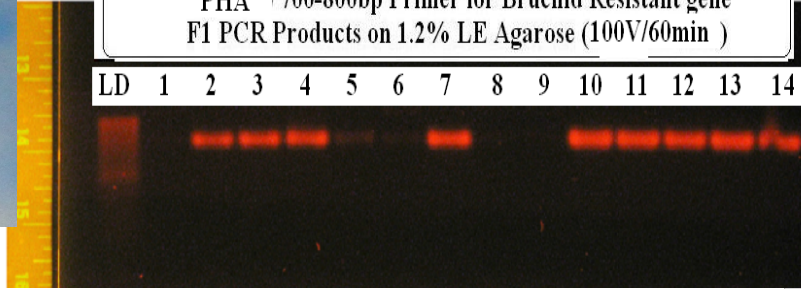




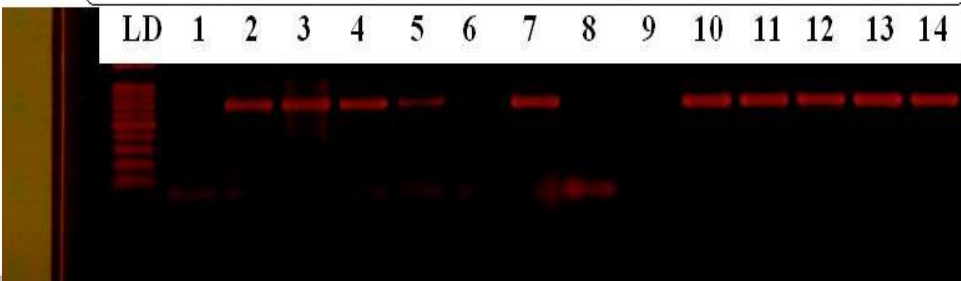
ARL3 700-800bp Primer for Bruchid Resistant gene
F1 PCR Products on 1.2% LE Agarose (100V / 90min).



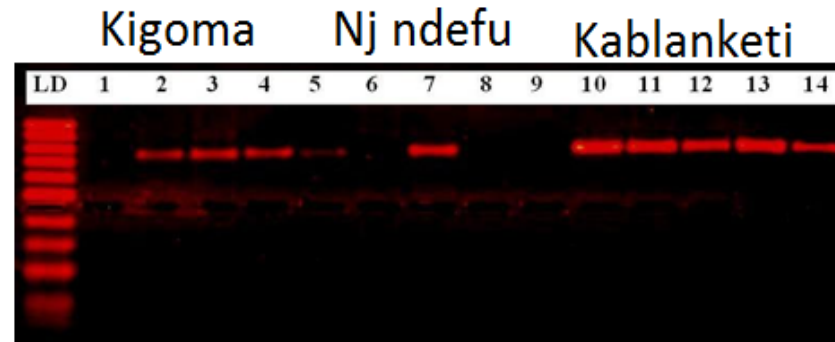
PHA 700-800bp Primer for Bruchid Resistant gene
F1 PCR Products on 1.2% LE Agarose (100V/60min)



alphaAL 700-800bp Primer for Bruchid Resistant gene
F1 PCR Products on 1.2% LE Agarose (120V / 30min)

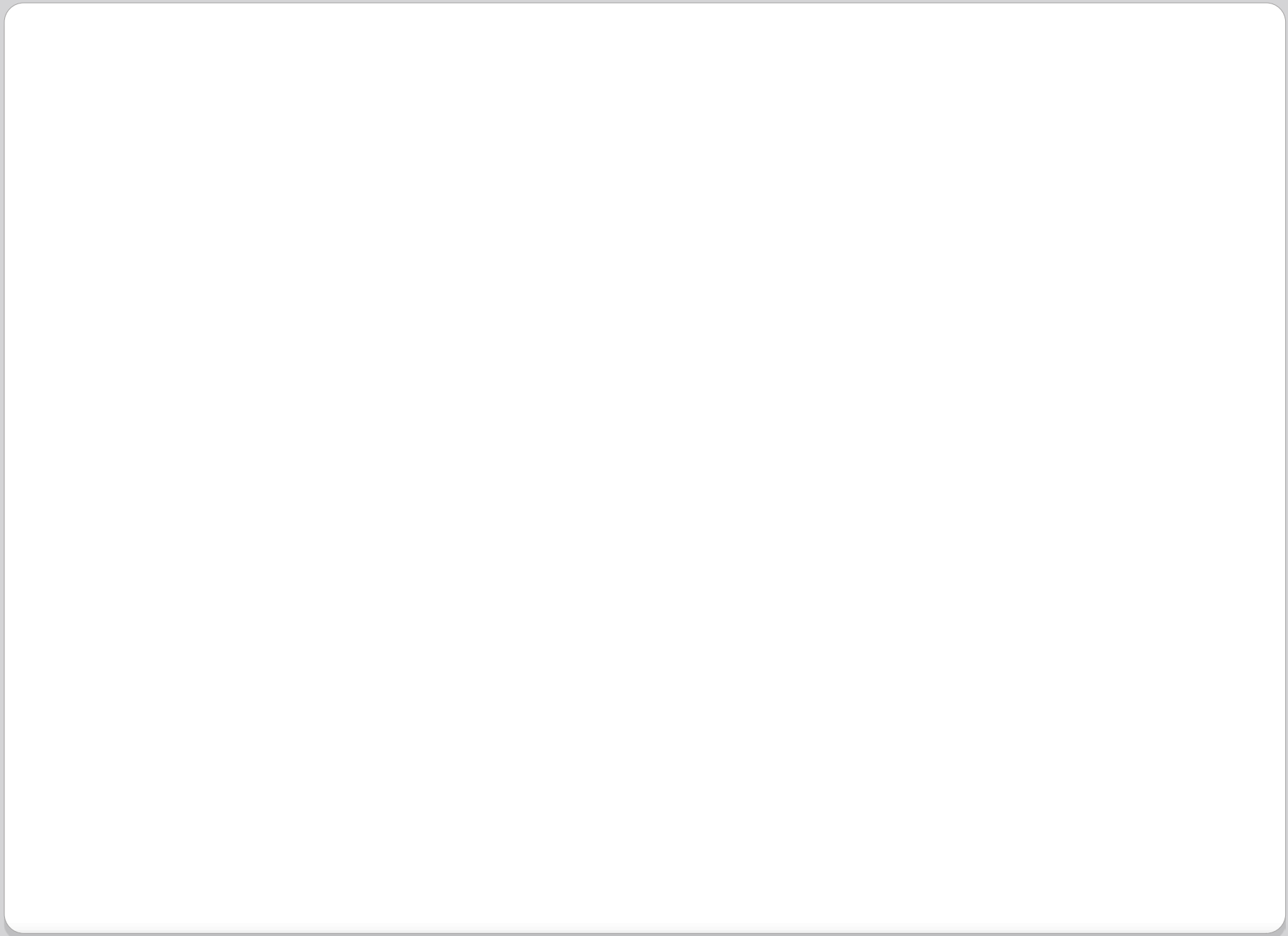


Selection for resistance to Acanthoscelides obtectus on APA lines

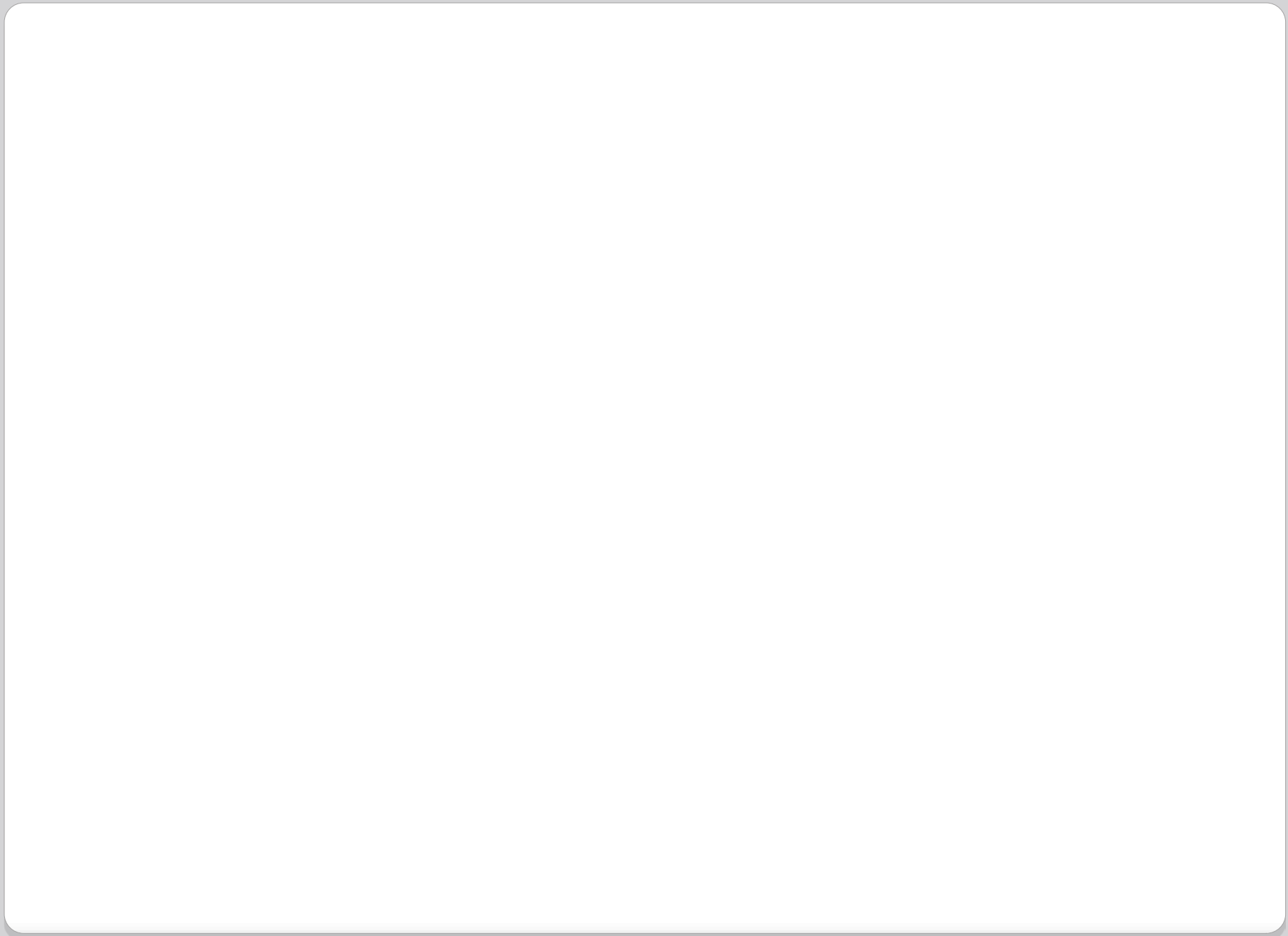


Screening and selection of resistant lines based on DNA markers and bioassay for bruchid feeding trials



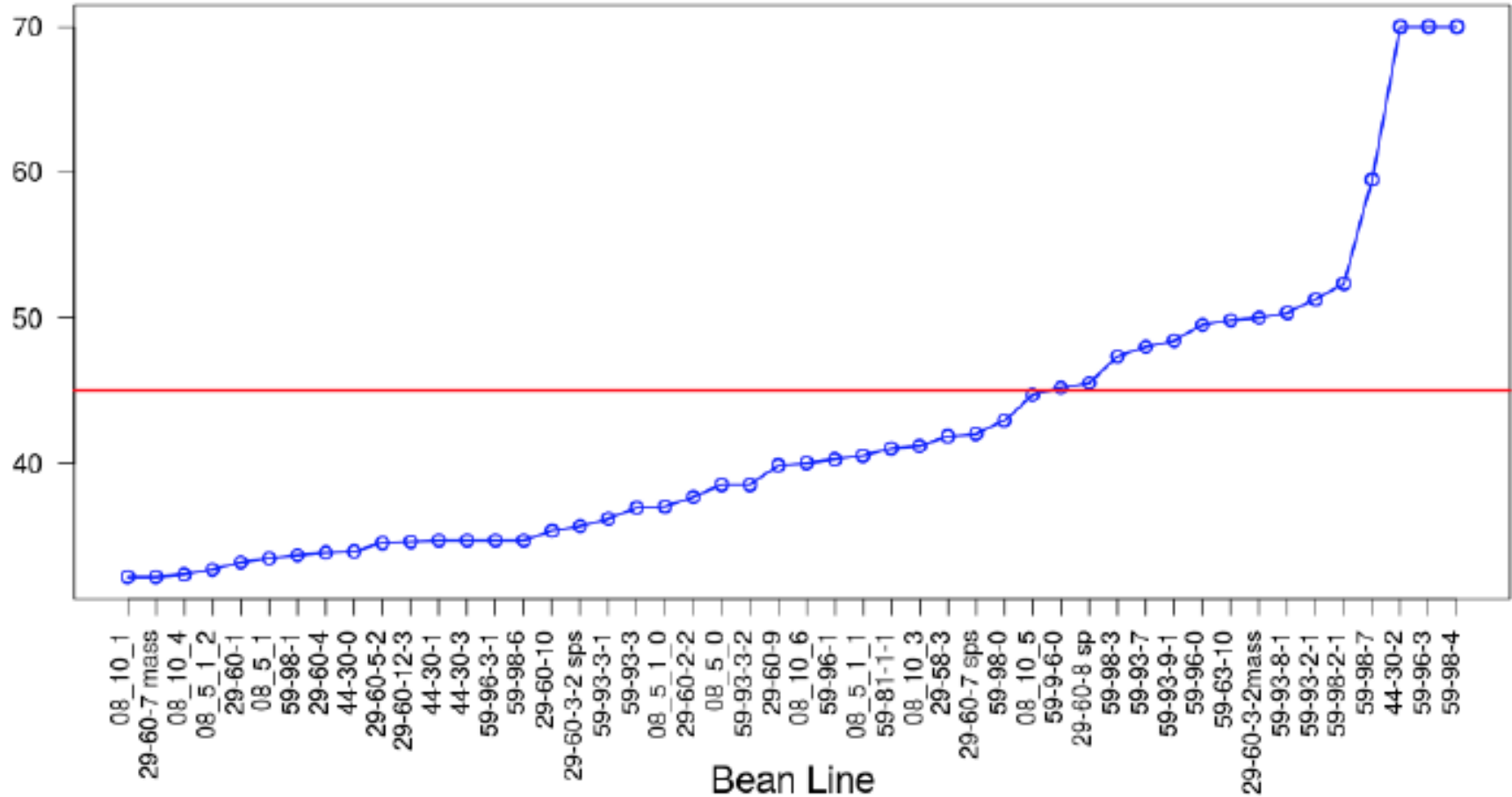




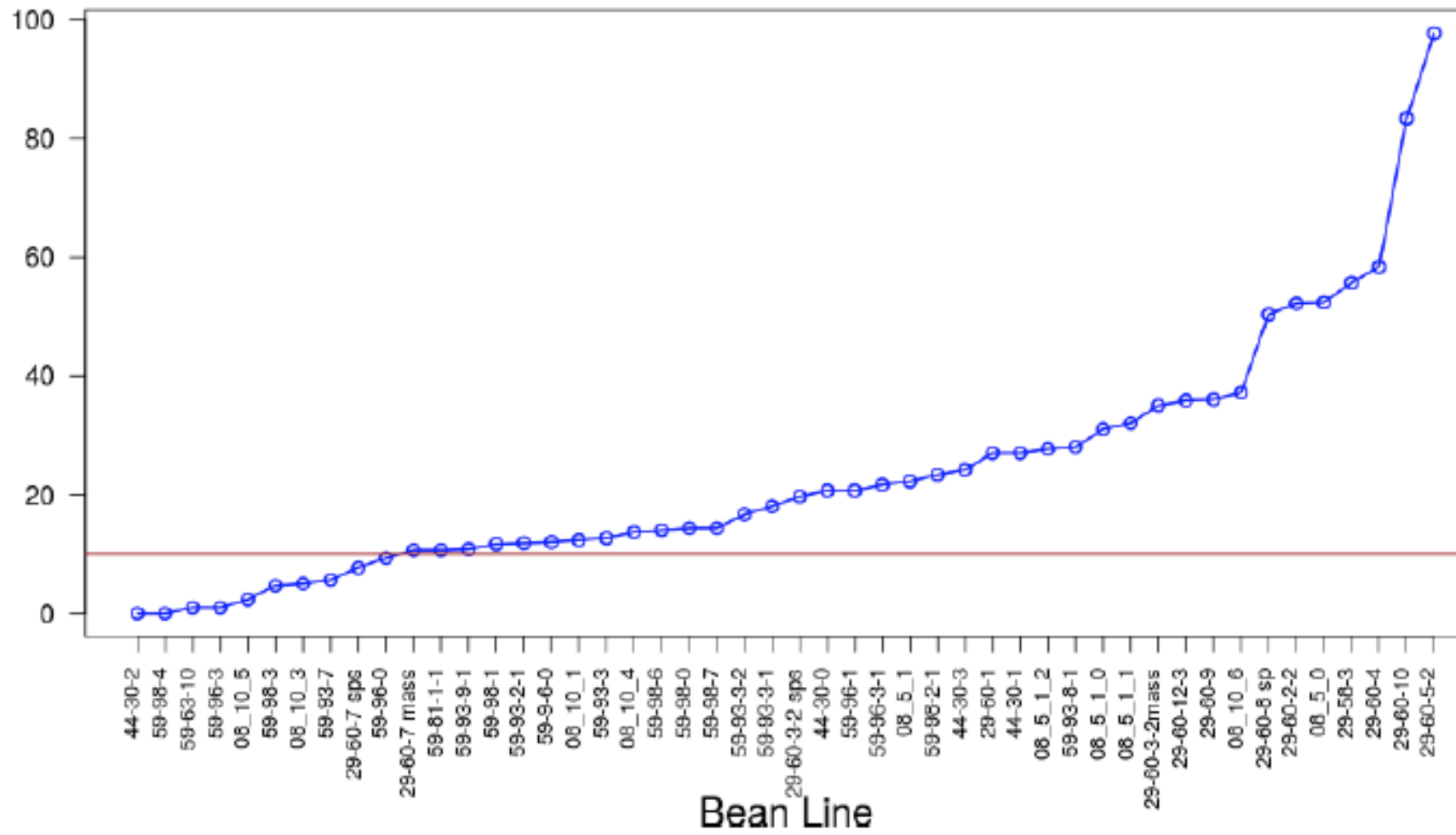




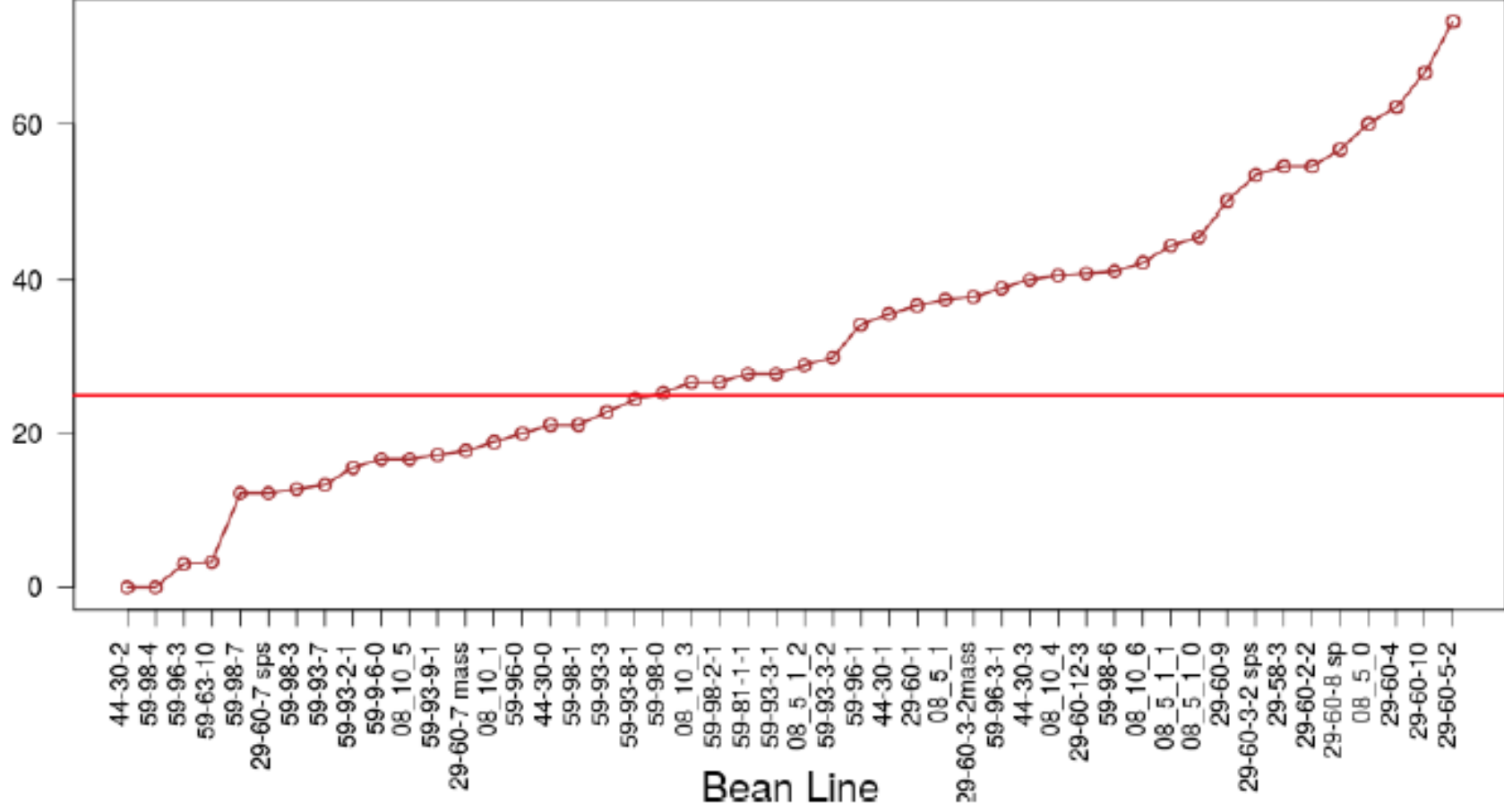
Mean days to adult emergence



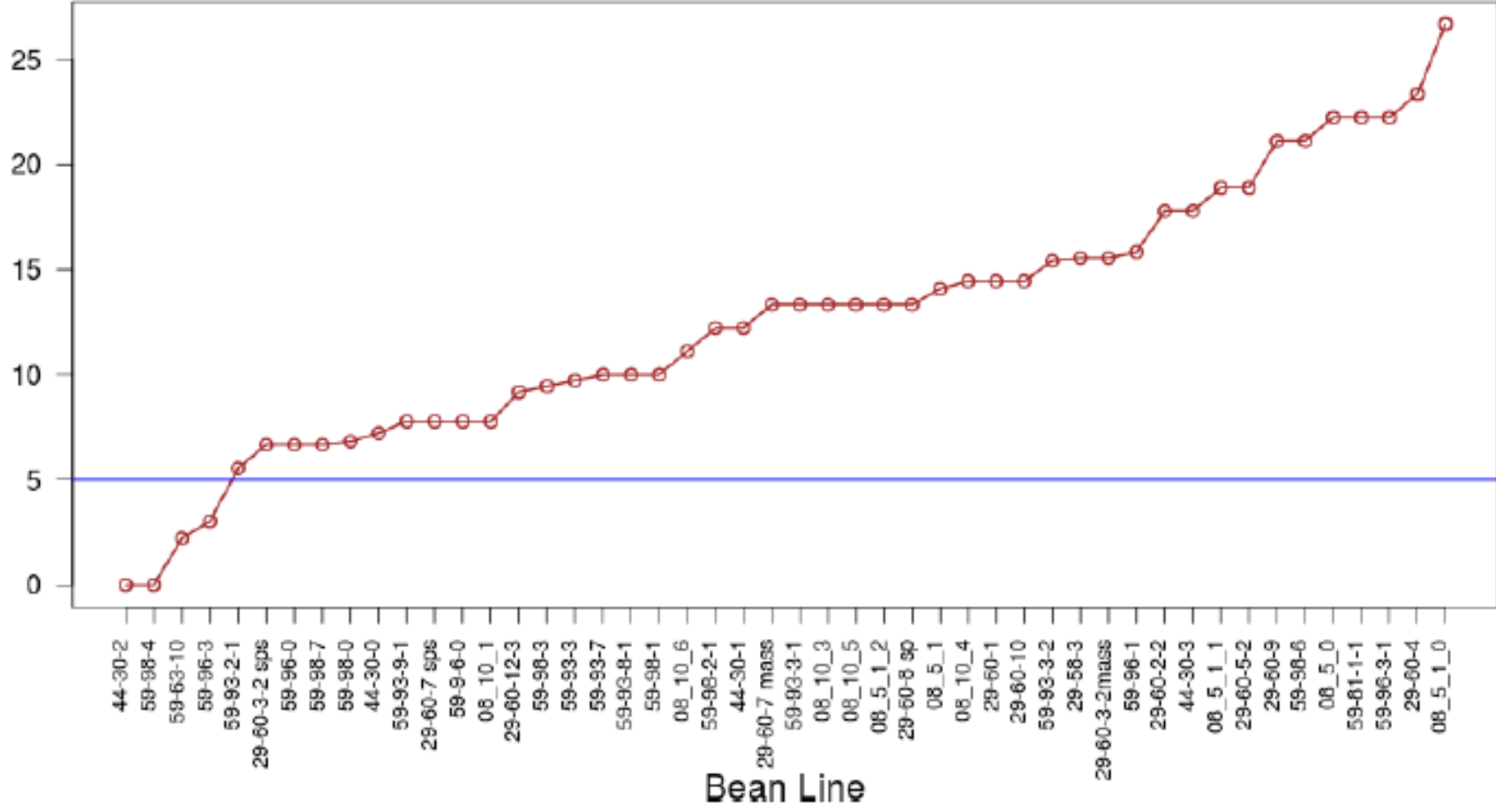
Mean number of insects



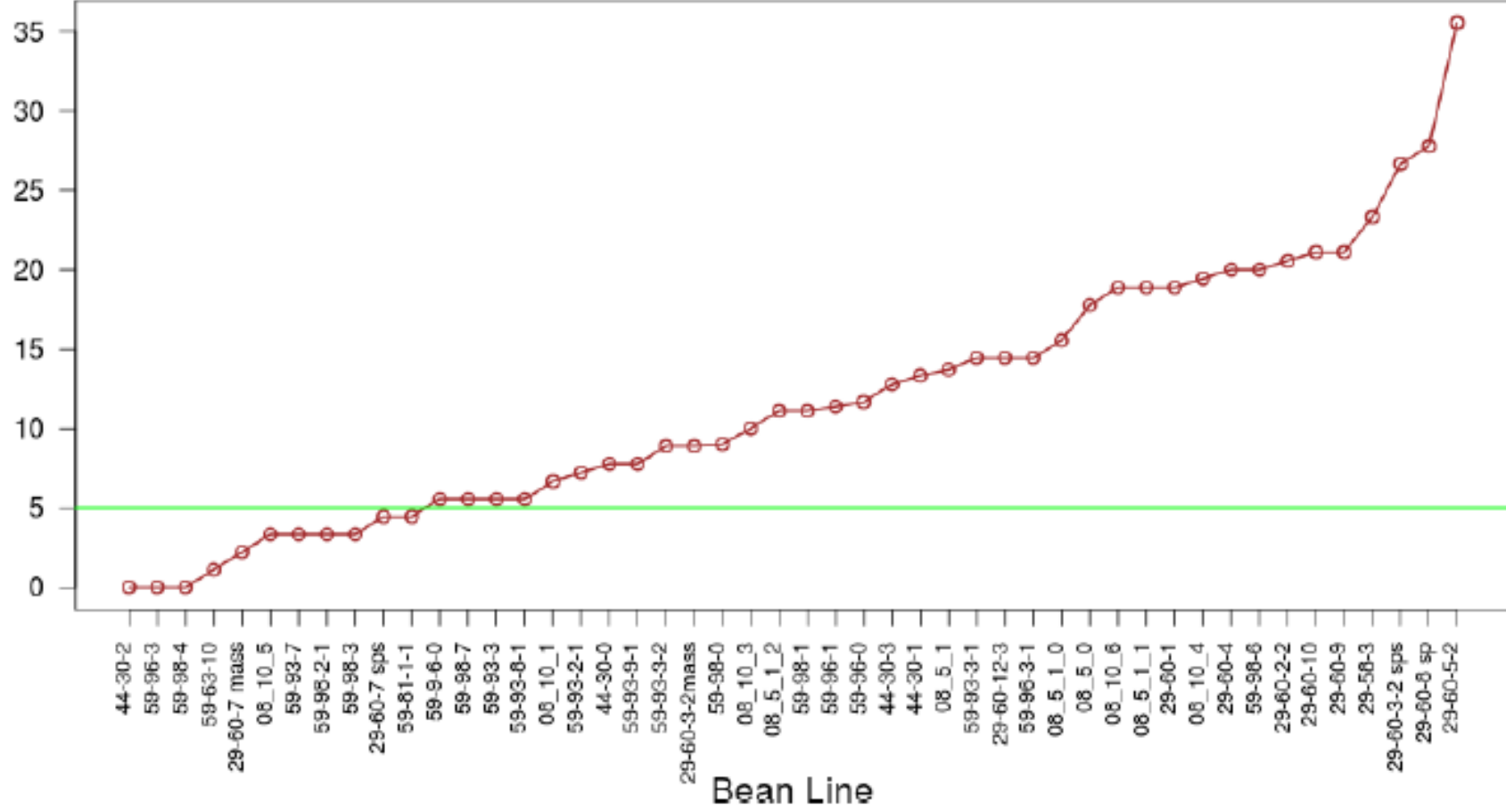
Mean of proportion of damaged seeds (%)



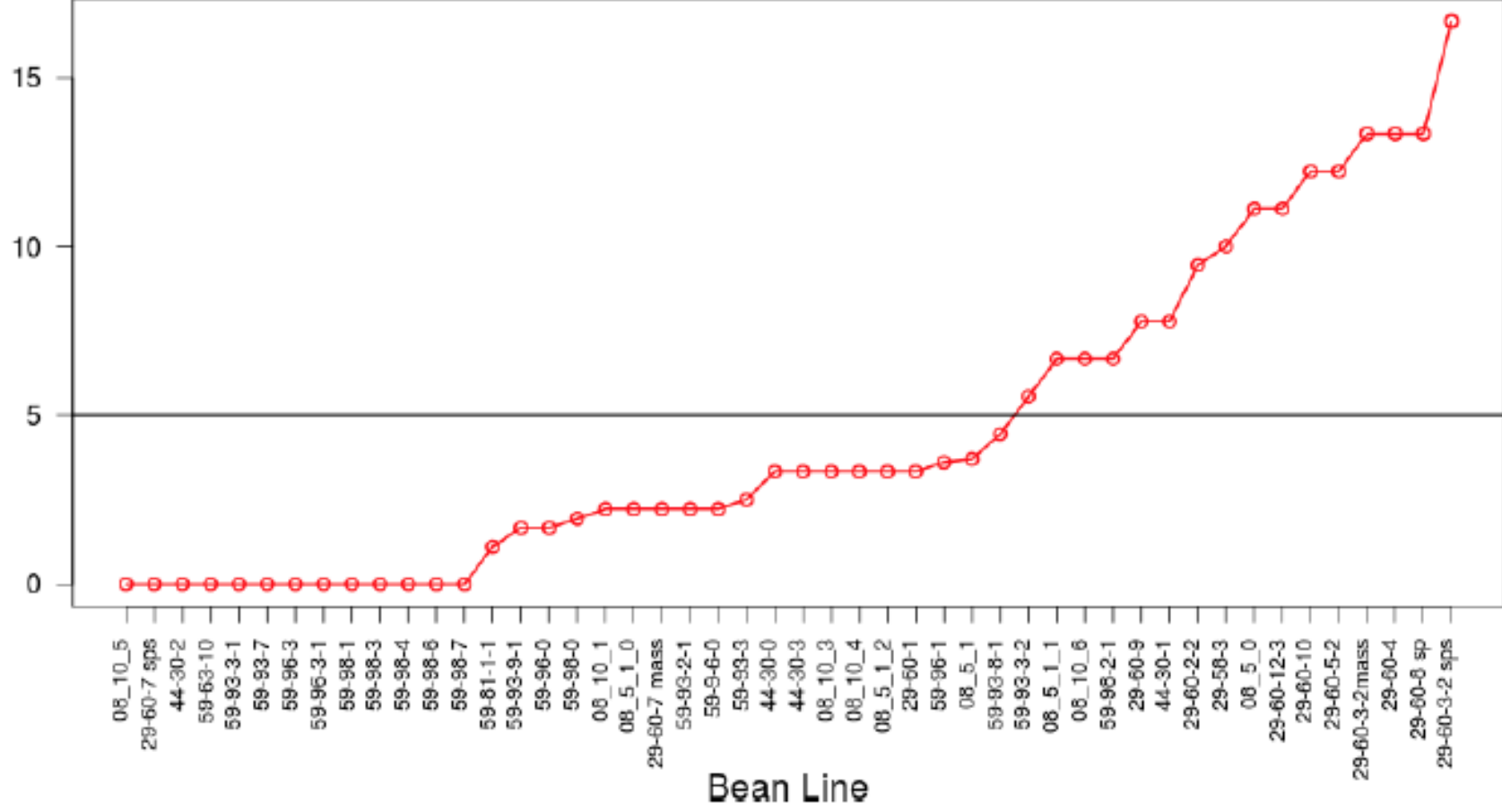
Mean of proportion of seeds with 1 hole (%)



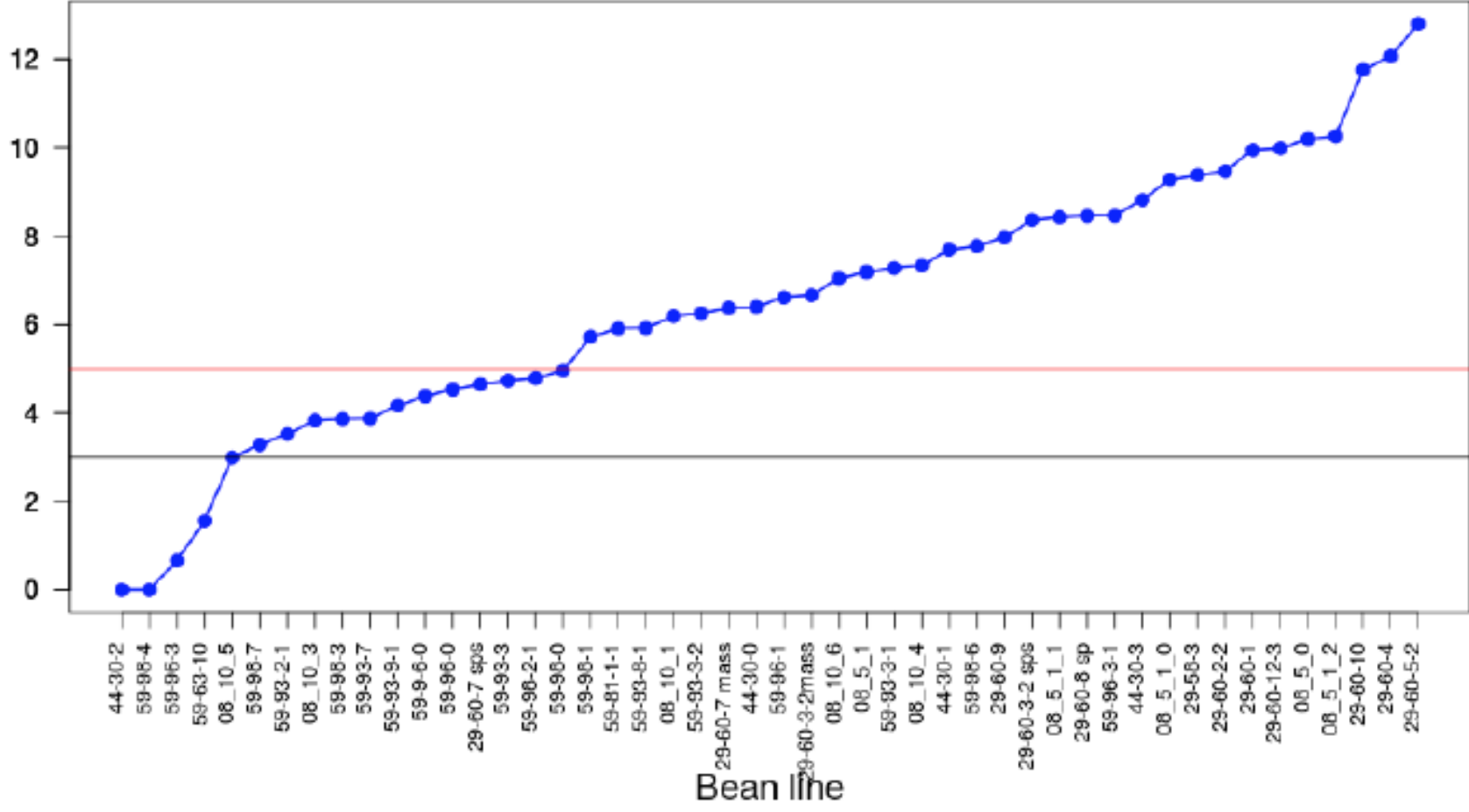
Mean of proportion of seeds 3 holes (%)



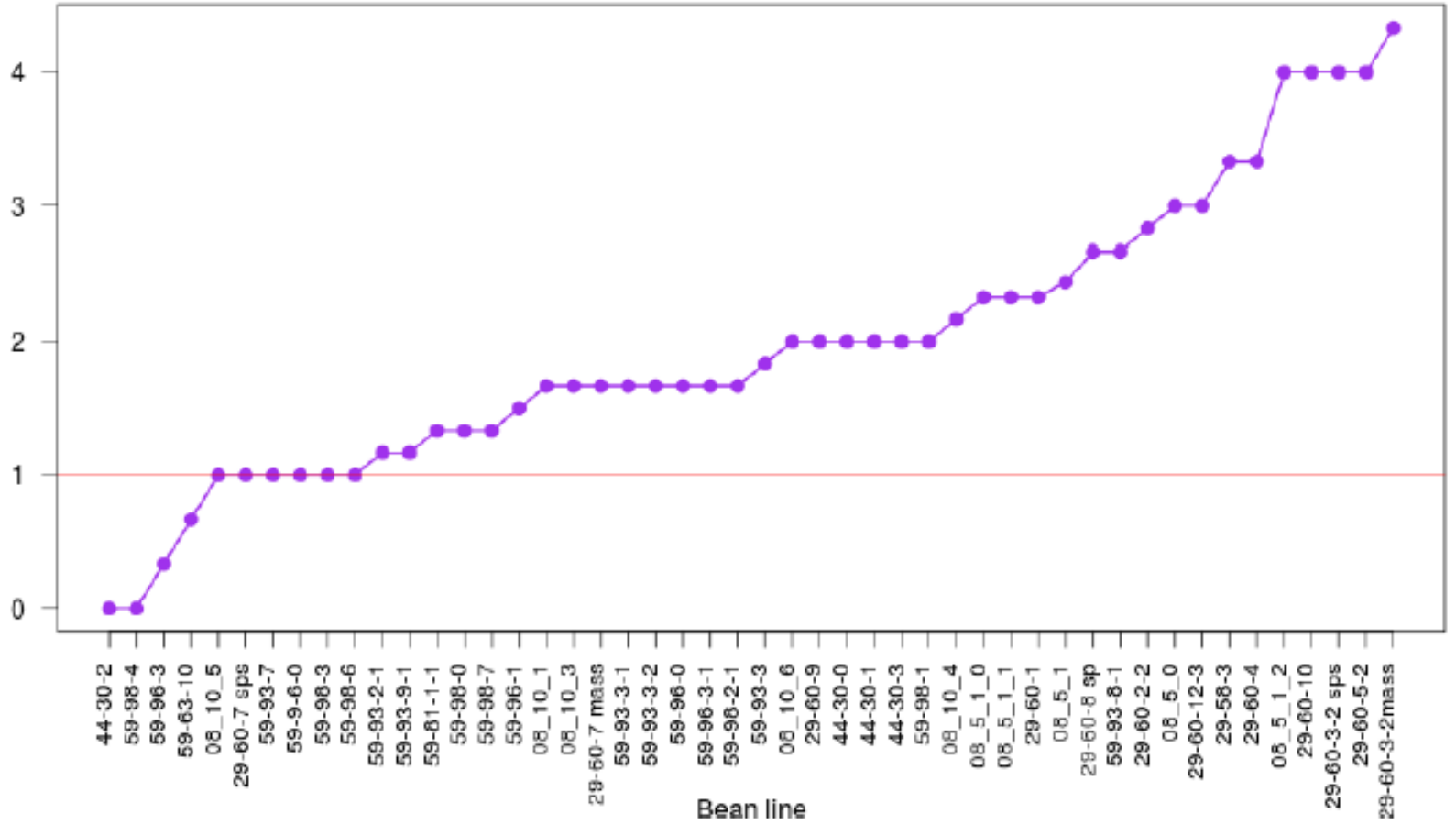
Mean of proportion of seeds with 5 holes(%)



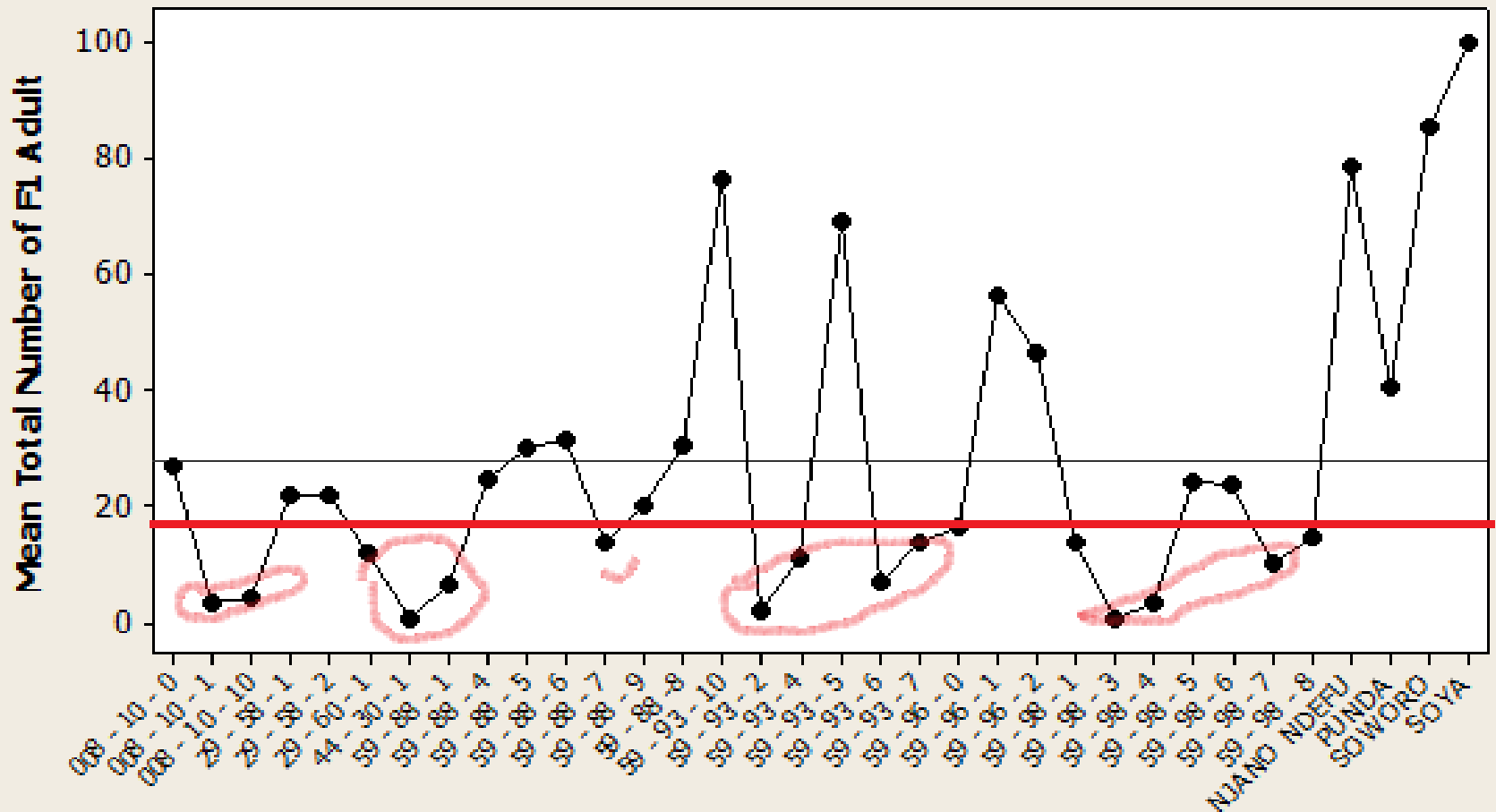
Mean Susceptibility Index



Mean Severity Ratio



Plot for Mean Total Number of F1 Adult *A. obtectus* Emerged

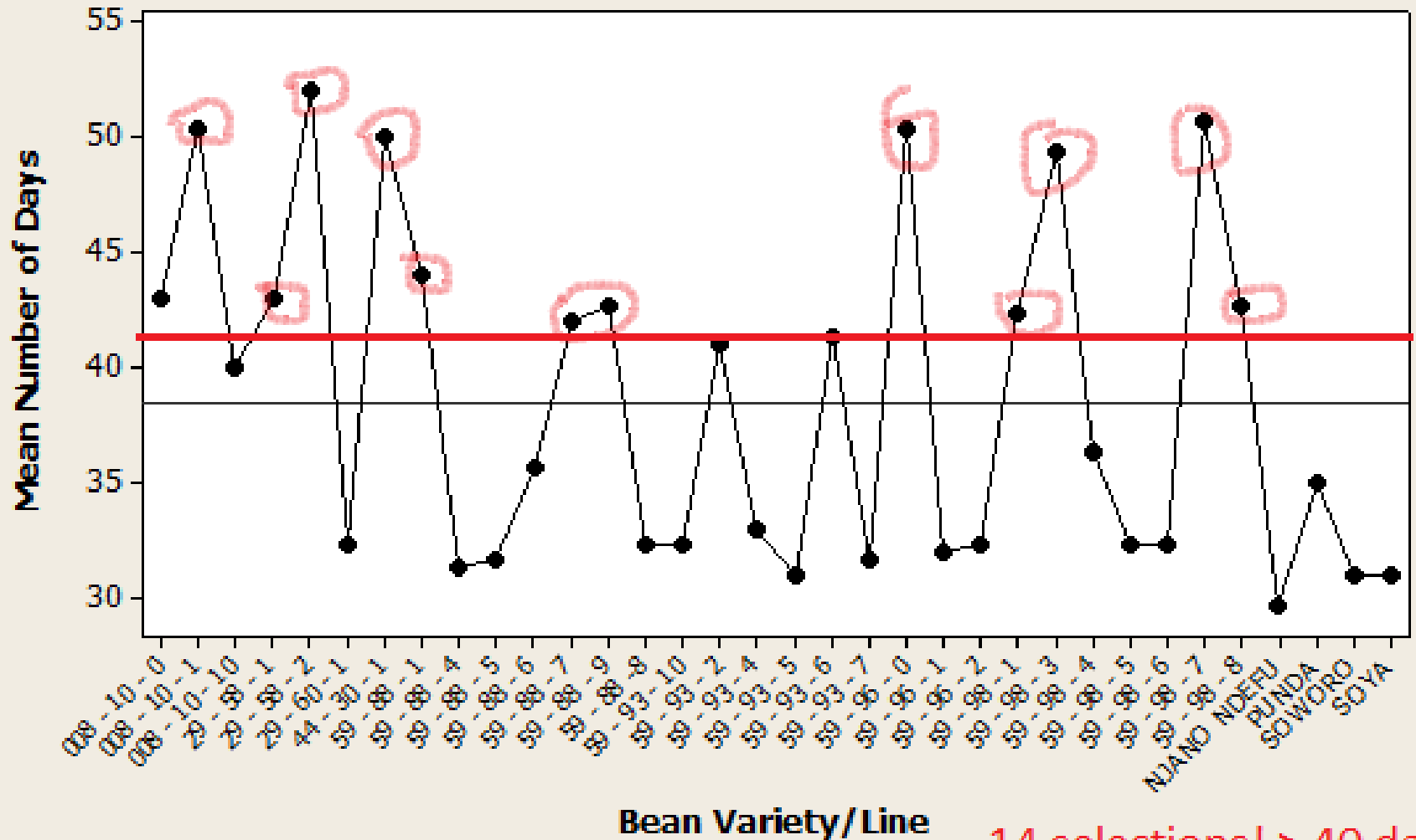


Bean Variety/Line 15 selections at TAE <20

Low Number of total emerged bruchids reflect less damage of stored beans for a given bruchid reproduction cycles

Susceptibility Index	Percentage of damaged seeds	Severity Ratio
44-30-2	44-30-2	44-30-2
59-98-4	59-98-4	59-98-4
59-96-3	59-96-3	59-96-3
59-63-10	59-63-10	59-63-10
08-10-5	08-10-5	08-10-5
59-98-3	59-98-3	59-98-3
59-93-7	59-93-7	59-93-7
59-9-6-0	59-9-6-0	59-9-6-0
29-60-7 sps	29-60-7 sps	29-60-7 sps
59-98-7	59-98-7	59-98-6
59-93-2-1	59-93-2-1	
59-93-9-1	59-93-9-1	-
59-96-0	59-96-0	-
59-93-3	59-93-3	-
59-98-0	59-98-0	-
08-10-3	29-60-7 mass	
59-98-2-1	08-10-1	-
	44-30-0	
	59-98-1	
	59-93-8-1	

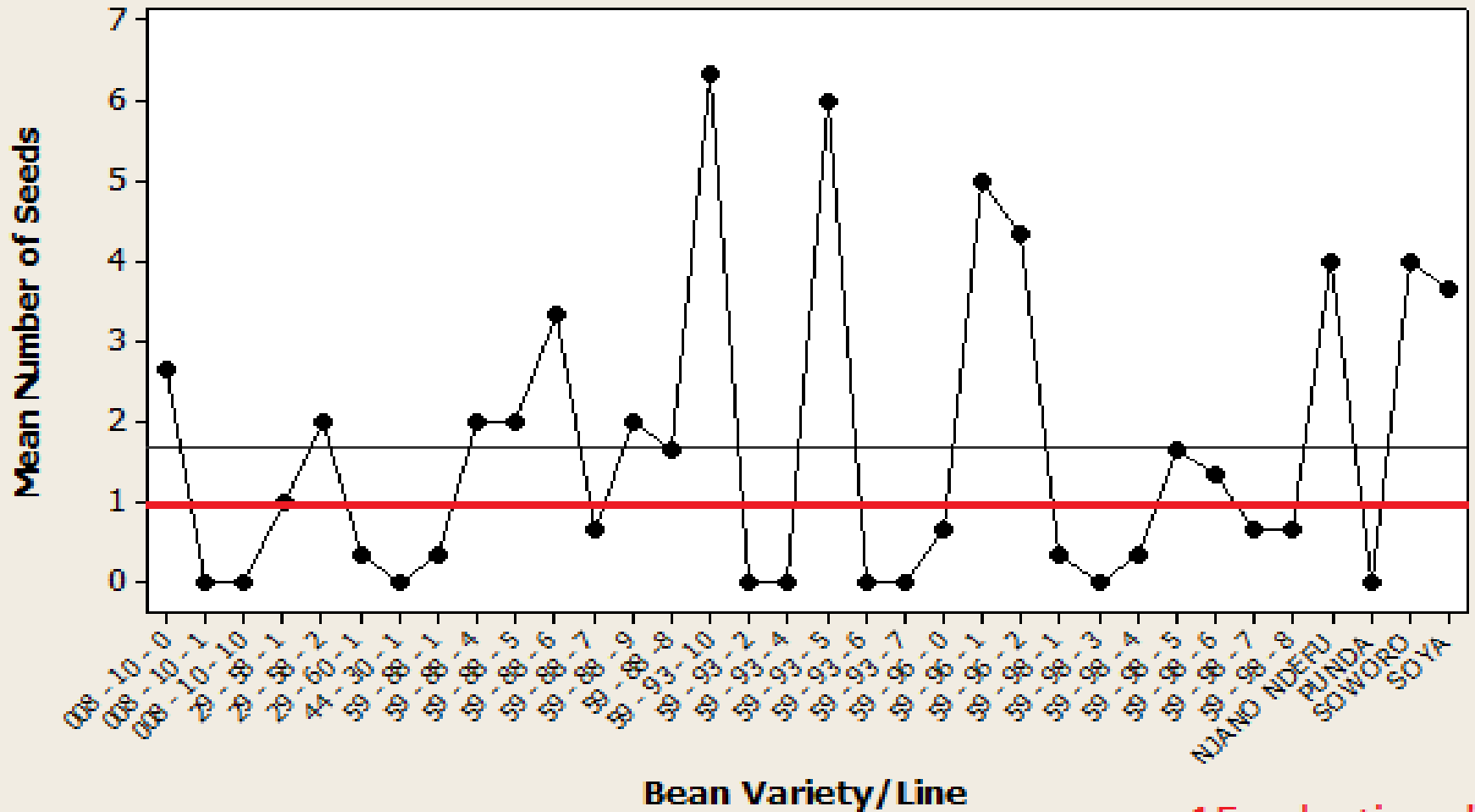
Plot for Mean Number of Days to 50% Emergence of *A. obtectus*



14 selections! > 40 days

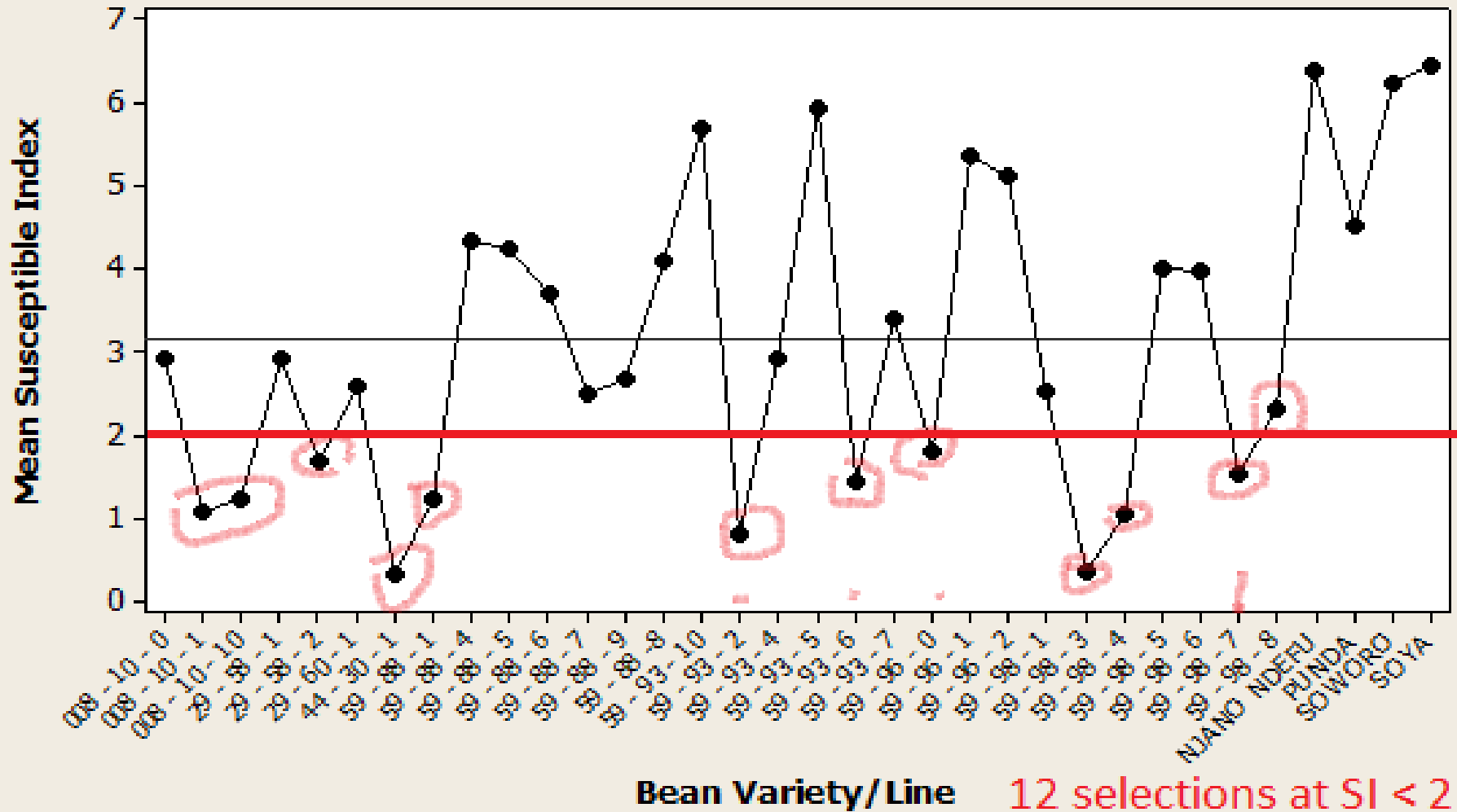
Long reproduction cycle due to delayed emergence of adult bruchids corresponds to DNA markers presence of APA proteins

Plot for Number of Seeds with >5 Holes



15 selections!

Plot for Mean Susceptible Index



Bean Variety/Line 12 selections at $SI < 2$

The Least susceptible lines to bruchid damage are selected based on number of emerging adults and days to emergence. The lower the SI the better resistance



PUNDA
08-05-1
'APA'



SOWORO - KIGOMA
(NSANO GOLOLI)
44-30-1
'APA'



NIJANO NDEFU
29-60-1
APA



SOYA - KABLANKETI
59-93-10
'APA'



SOYA - KABLANKETI
59-88-6
'APA'

***Selection for resistance
to *Zabrotes subfasciatus*
on Arcelin 2 lines***



APA BC
lines

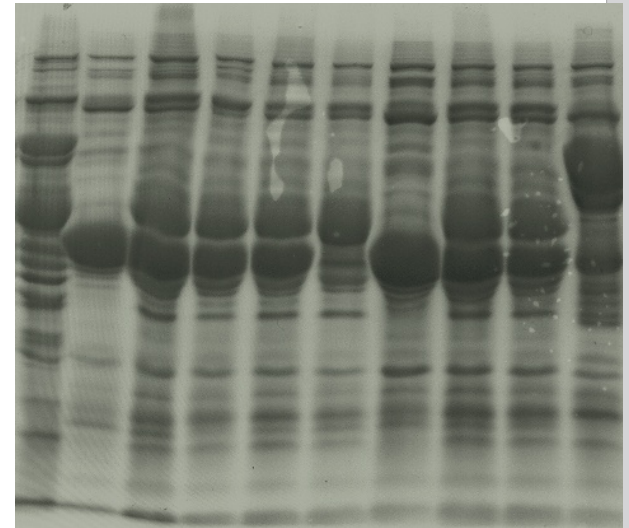


Rojo



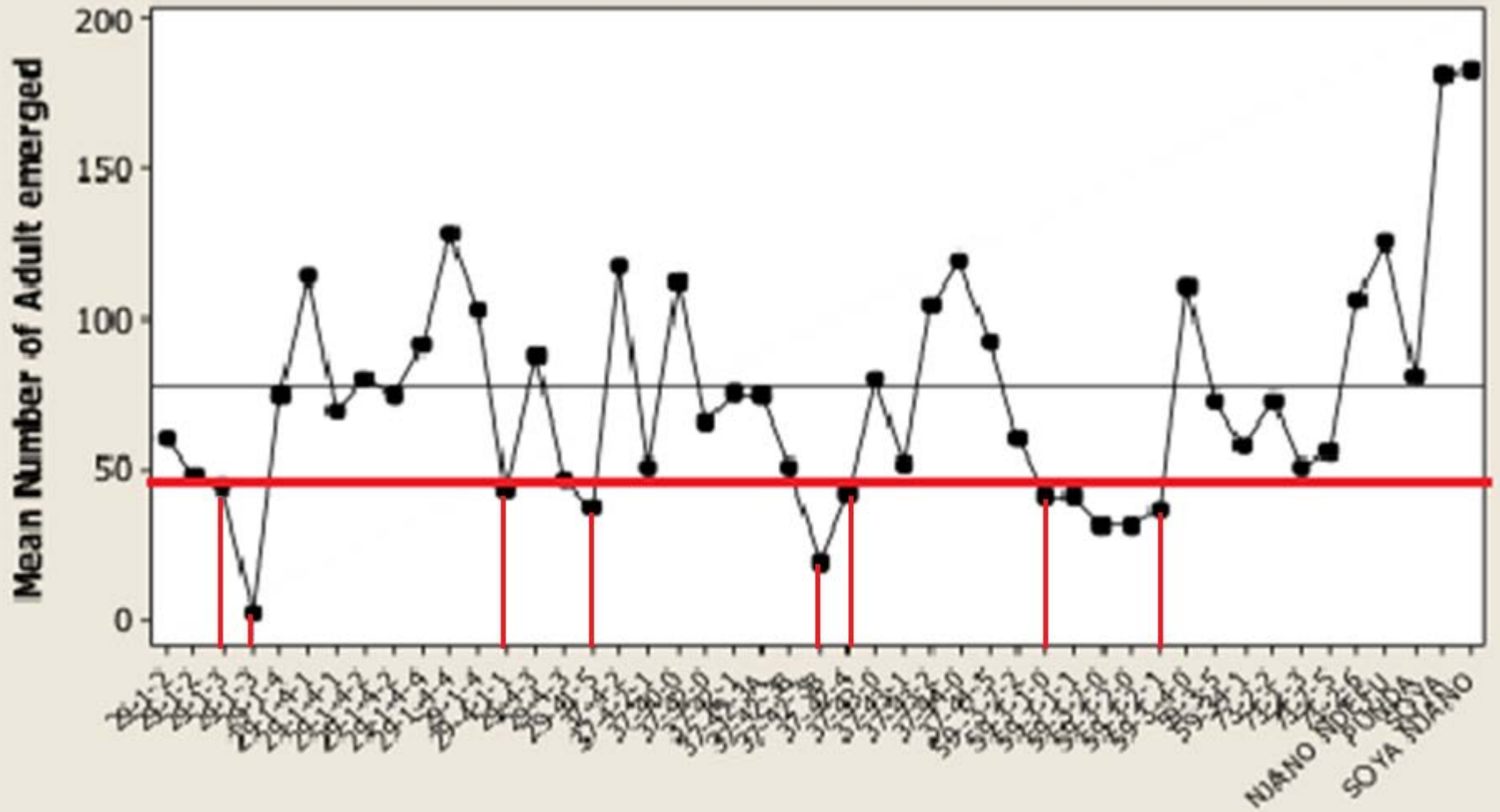
ArI-
PN

3-4 backcrosses



ArI-PN

Plot for Mean Number of F1 Adult Z. subfasciatus Emerged

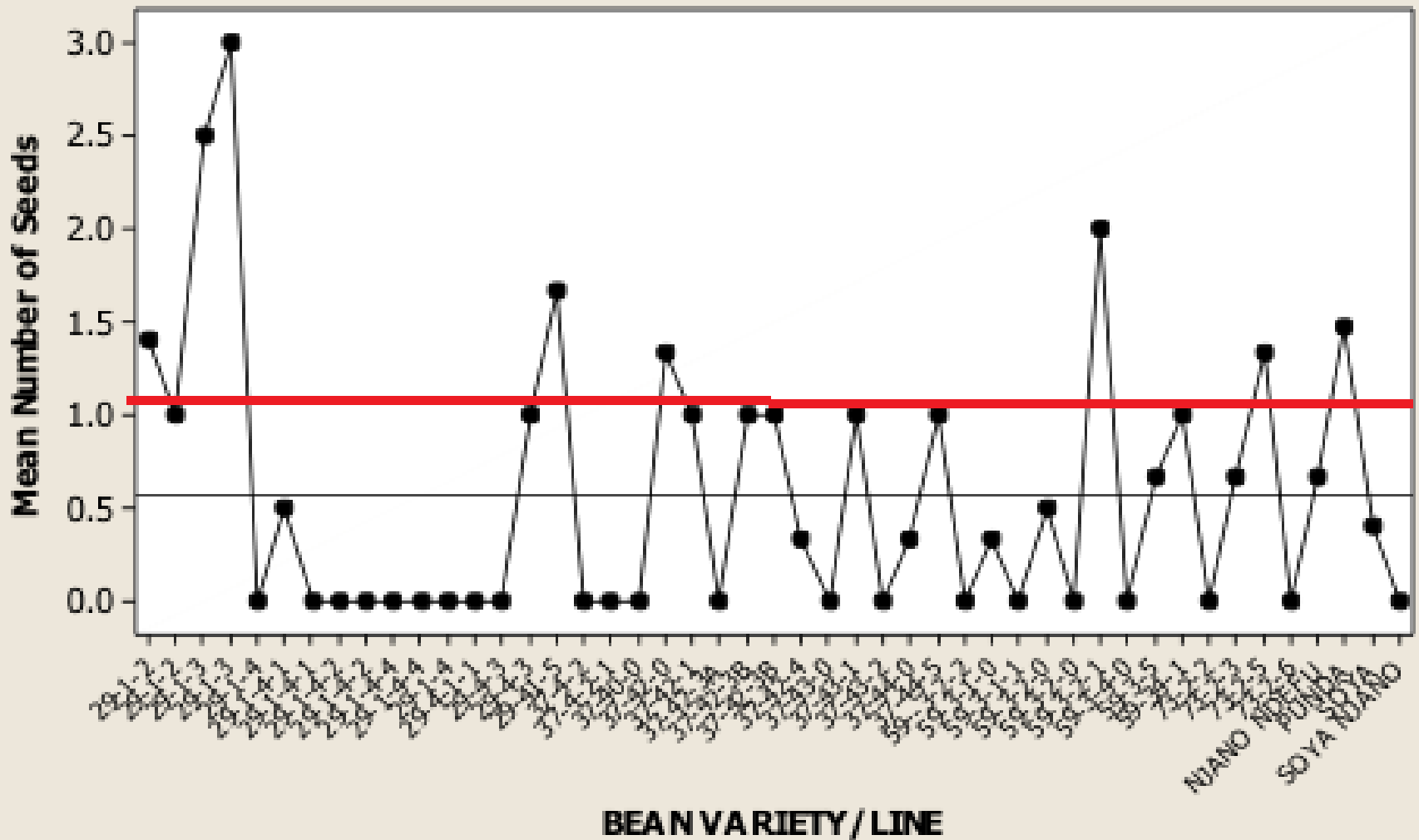


BEAN VARIETY / LINE

12 selections < 50 TAE

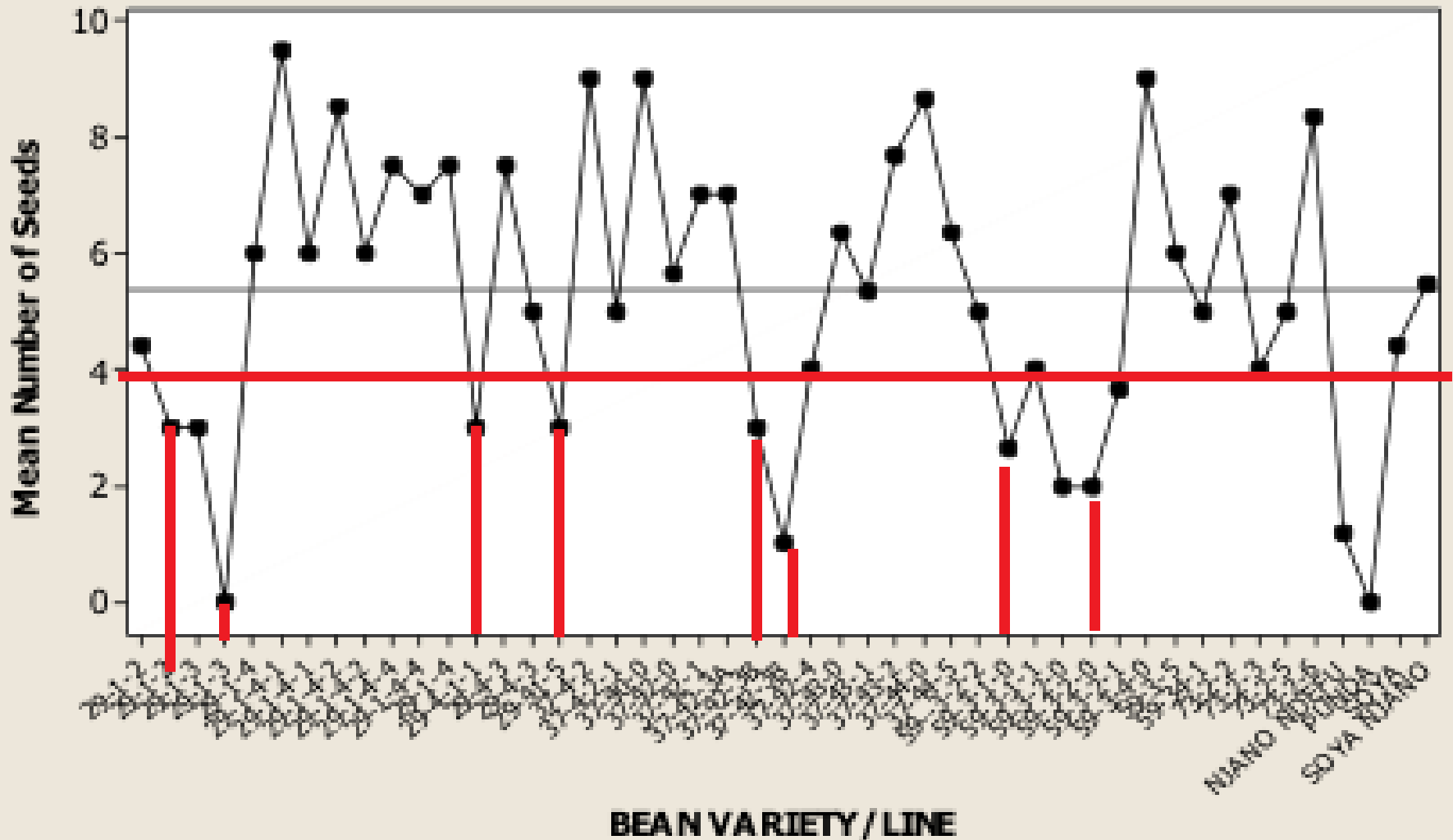
Selections for low number of bruchid emergence, high infestations was observed on this species.

Plot for Mean Number of Seeds With 1 Holes for *Z. subfasciatus*



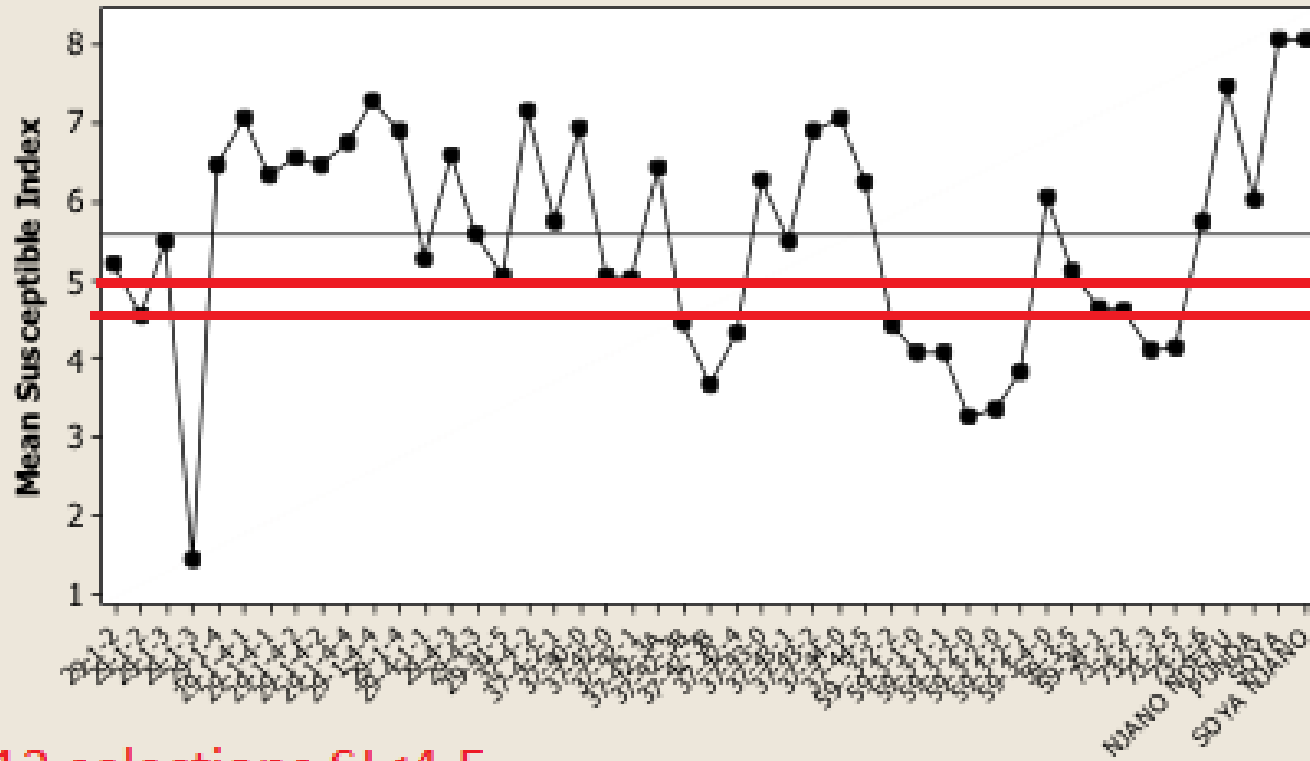
Indication of minimal damage more seeds with only one hole

Plot for Meand Number of Seeds With >5 Holes for *Z. subfasciatus*



It is important to check these lines for levels of resistance to both species

Main Effects Plot for mean Susceptible Index for *Z. subfasciatus*



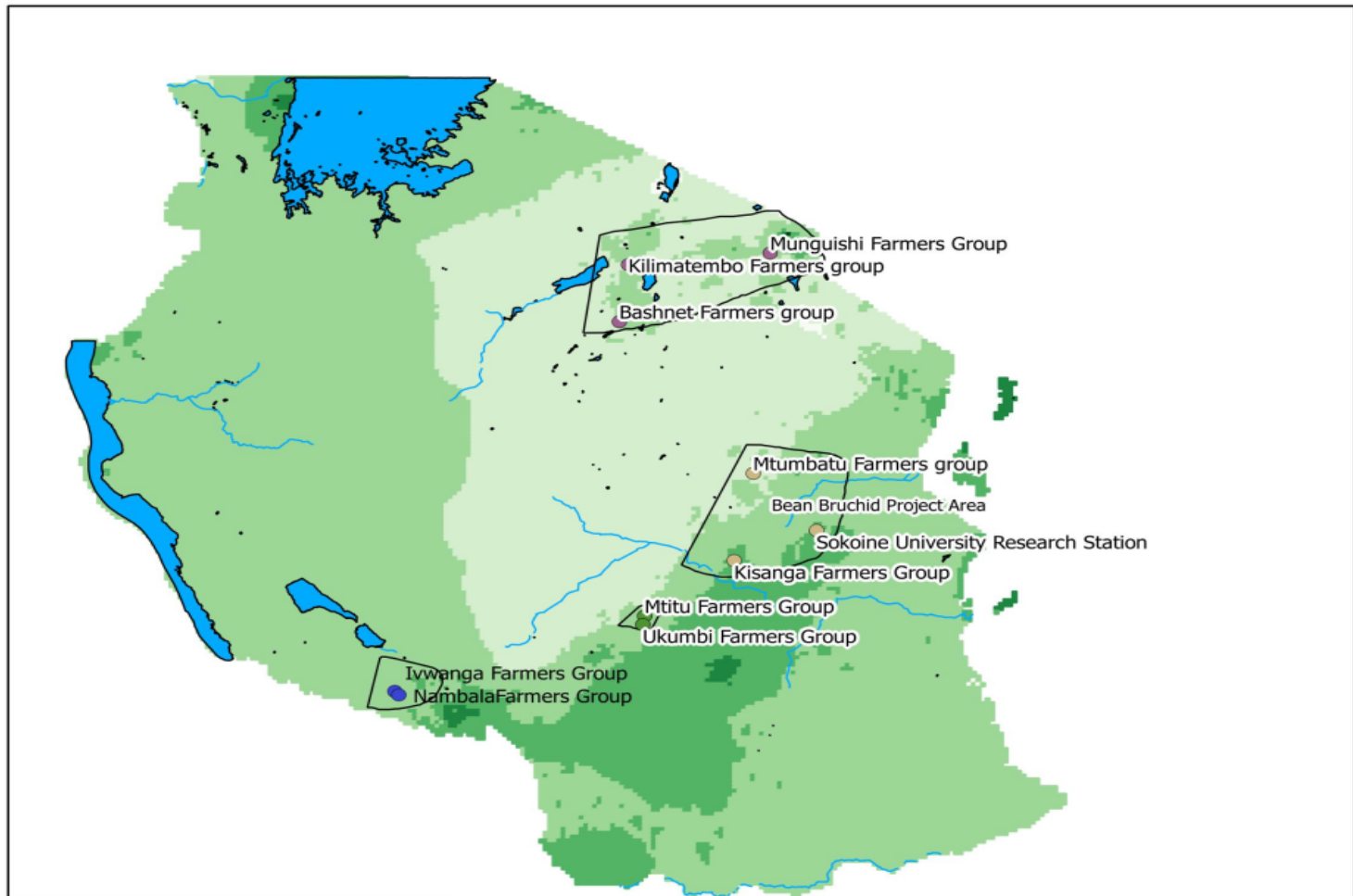
12 selections SI < 4.5

BEAN VARIETY/LINE

15 selections SI < 5

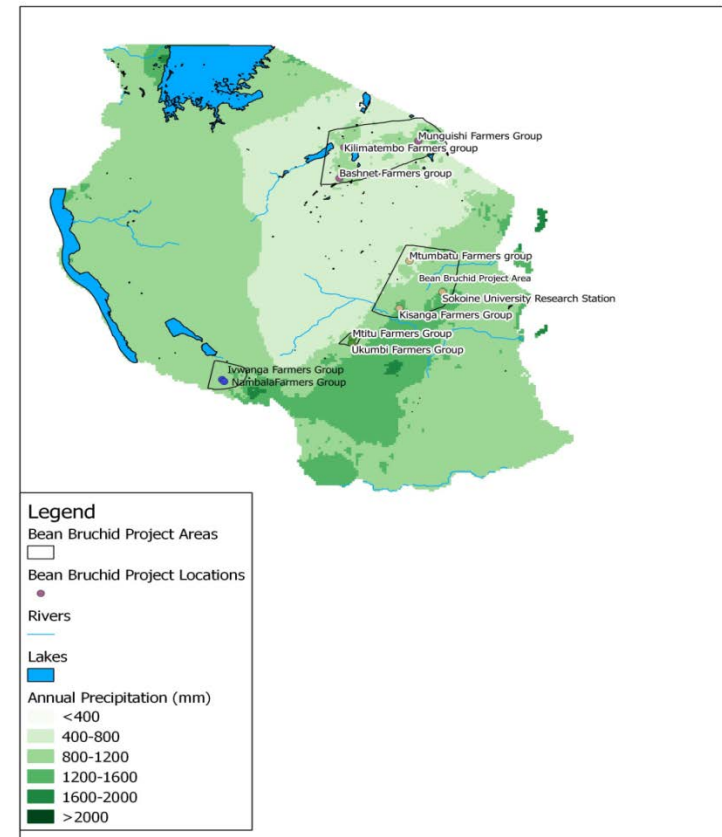
	Arcelin 2 lines	DAE 50	Rec Parent
• 1	29-1-2	45.8	Njano Ndefu
• 2	29-1-2	47.0	
• 3	37-42-0	48.3	Canadian W
• 4	37-42-1	45.6	
• 5	37-42-4	48.0	
• 6	37-44-5	50.0	
• 7	59--3-2-2	52.7	Kablanketi
• 8	59-3-1-0	48.3	
• 9	59-3-1-1	45.3	
• 10	59-3-2-0	51.5	
• 11	59-3-2-0	54.0	
• 12	59-3-2-1	49.0	
• 13	59-34-1	47.3	
• 14	73-2-2	47.3	Punnda
• 15	73-2-3	50.7	
• 16	73-2-5	50.3	

Participatory Variety evaluation and selection



Legend

Working areas in Tanzania

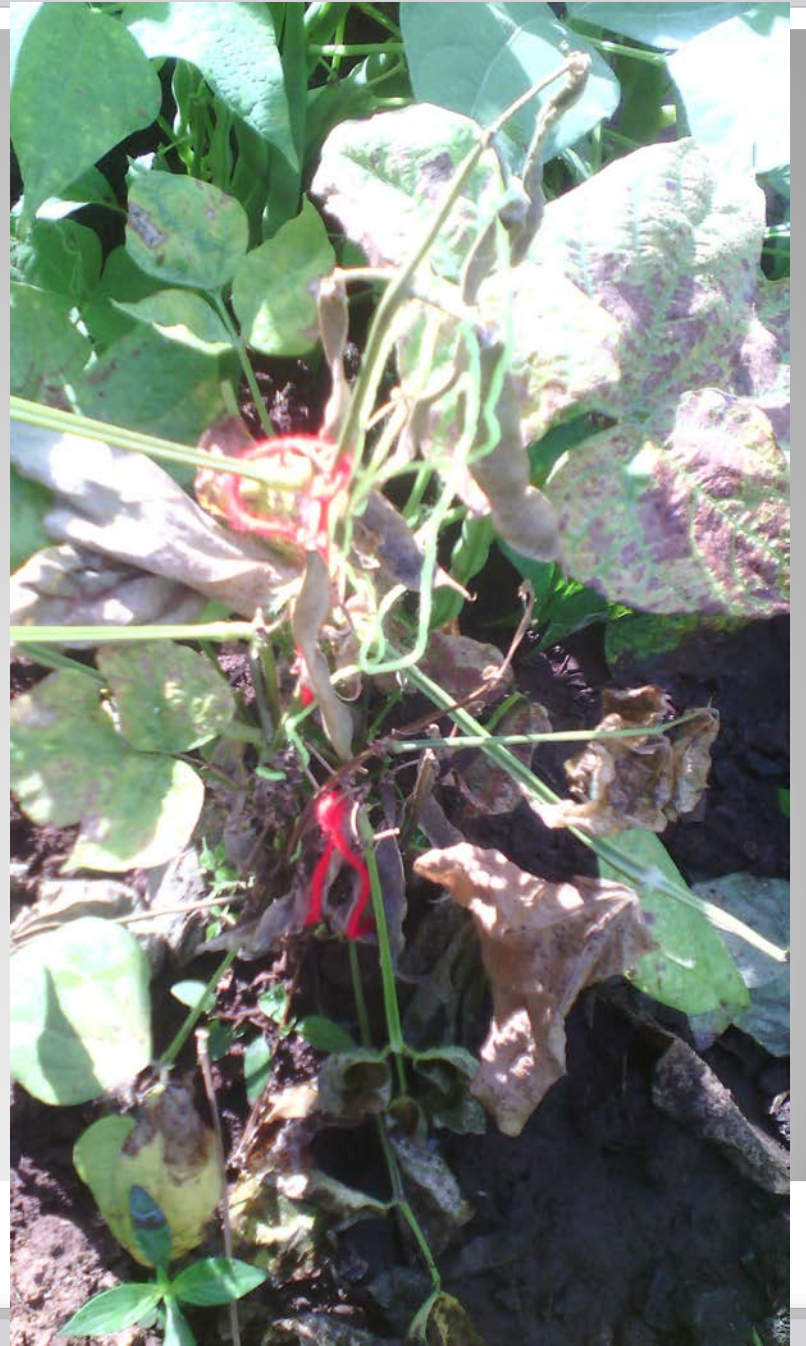
















CBB and ALS



Making a depressive combination of diseases in FPVs



Karatu trials – 600 -1200mm rains



**Munguishi Hai site
800 – 1200 mm rainfalls**



**Munguishi Hai site
800 – 1200mm rainfalls**



Munguishi Hai site



Mbozi trials 1200 – 1600 mm rainfalls



Mbozi trials



Variation of experimental plot management and local weather conditions might influence the mean performance of varieties in different ecological sites

Chart of Mean average podsper plant in different sites

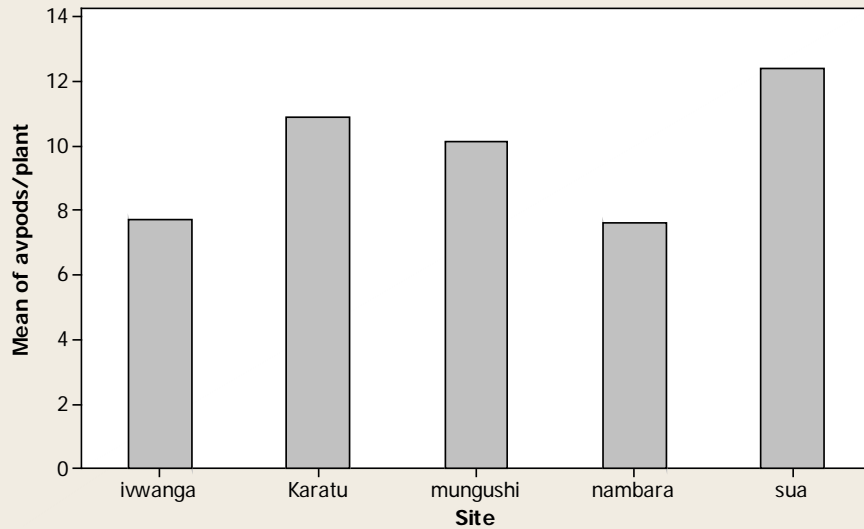
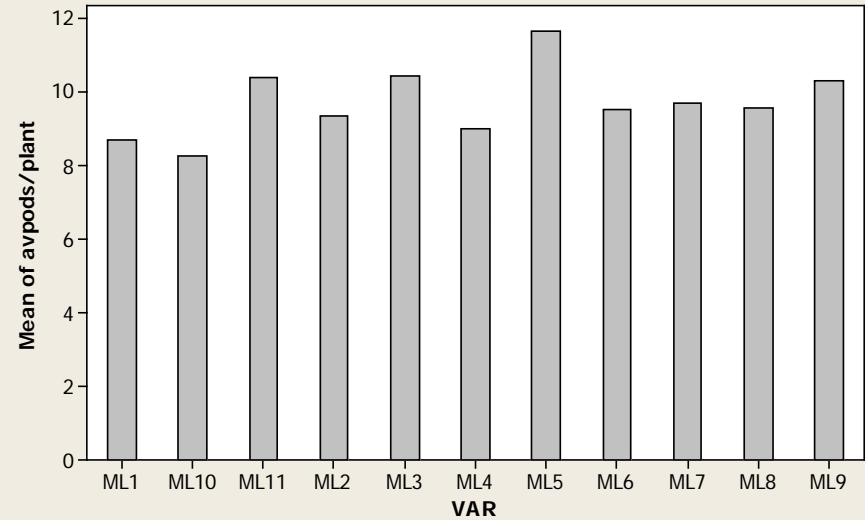


Chart of Mean average pods per plant for different varieties



All varieties perform relatively well in in term of yield but there is a significant variations in yield across locations of the trials

Use of Botanicals in Integrated management of bruchids

1: *Zanha. Africana* (Mjui, Livanga) barks from the roots and from the trunk

Need to see difference in active compounds from the two sources

2: *Neorautanenia mitis* (Tupa daka or Lidupala)

3: *Chenopodium ambrosioides* (*Ikanganyishe*)



Acknowledgements

- The McKnight Foundation for the funding of the project activities

The BIC organizing committee for funding my participation to the meeting

- Collaborators Chitedze, OSU and SUA Research Team
- All the VEO and farmers from our focus group Farmers

