

# PAMP responses in the Triangle of U

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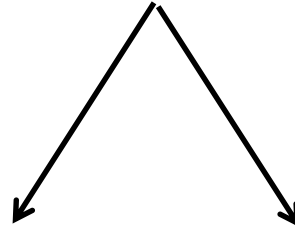


# Disease resistance on Brassica crops

1. Major fungal diseases on Brassicas 10-20% yield loss
2. Loss of usable fungicides and R-genes
3. Mechanisms of Quantitative Disease Resistance.
4. PAMP-triggered immunity
  1. Toolbox in Brassica crops
  2. QTL mapping in *B. oleracea*
  3. GWAS in *B. napus*
5. Identify genetic markers associated with QDR mechanisms for breeding



# Plant Immunity



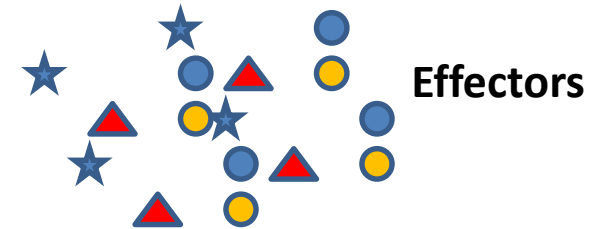
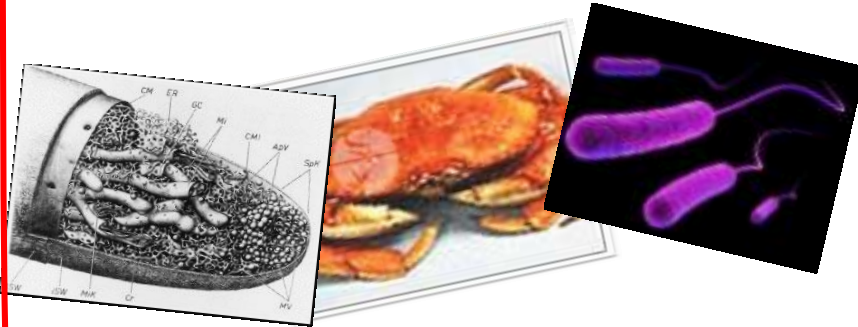
First level:

Second level:

**PAMP-triggered immunity (PTI)**

**Effector-triggered immunity (ETI)**

**Pathogen Associated Molecular Patterns**



Effectors

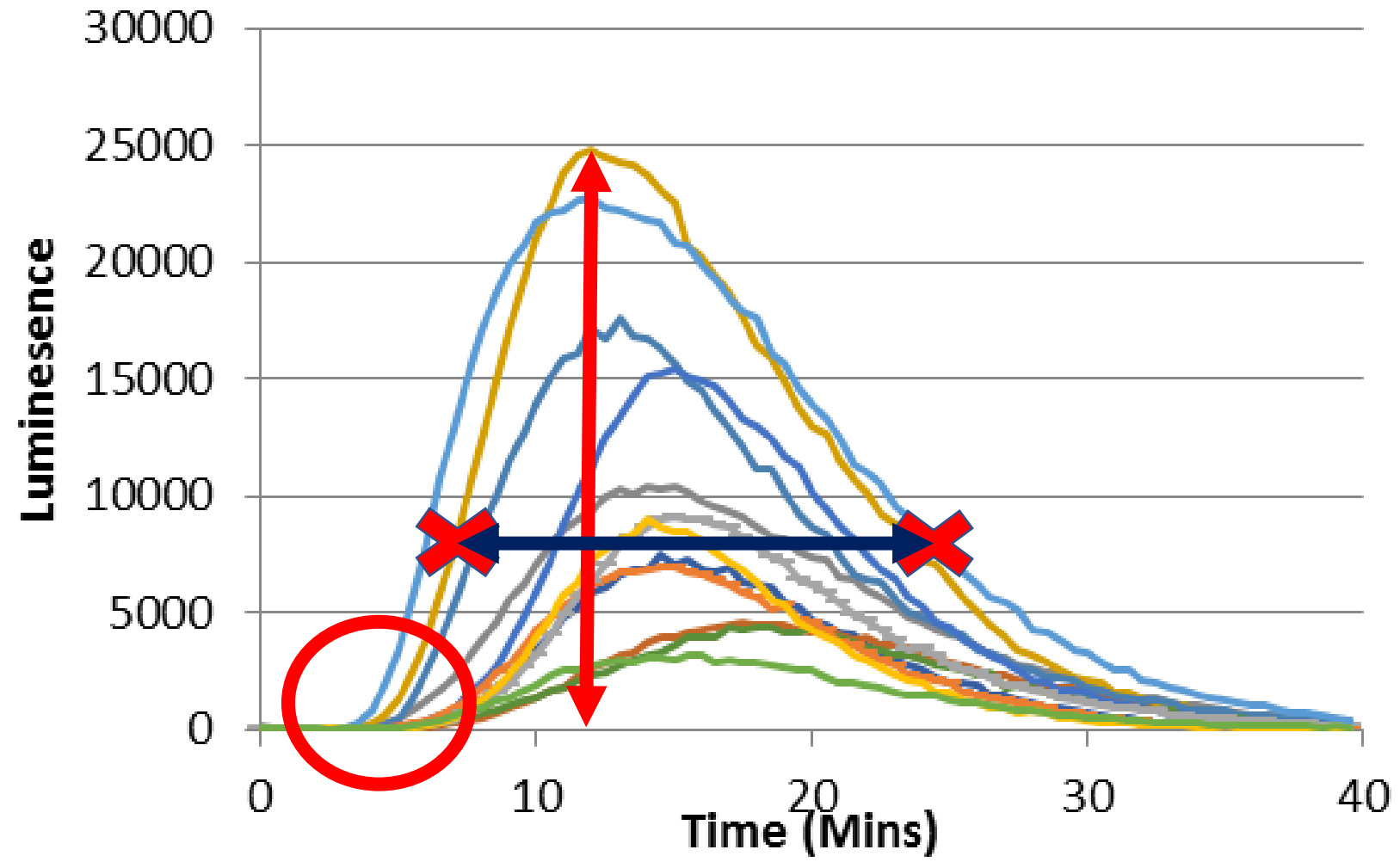
**Potentially durable and broad-spectrum**



*Resistance genes*

# Transient ROS response to PAMPs

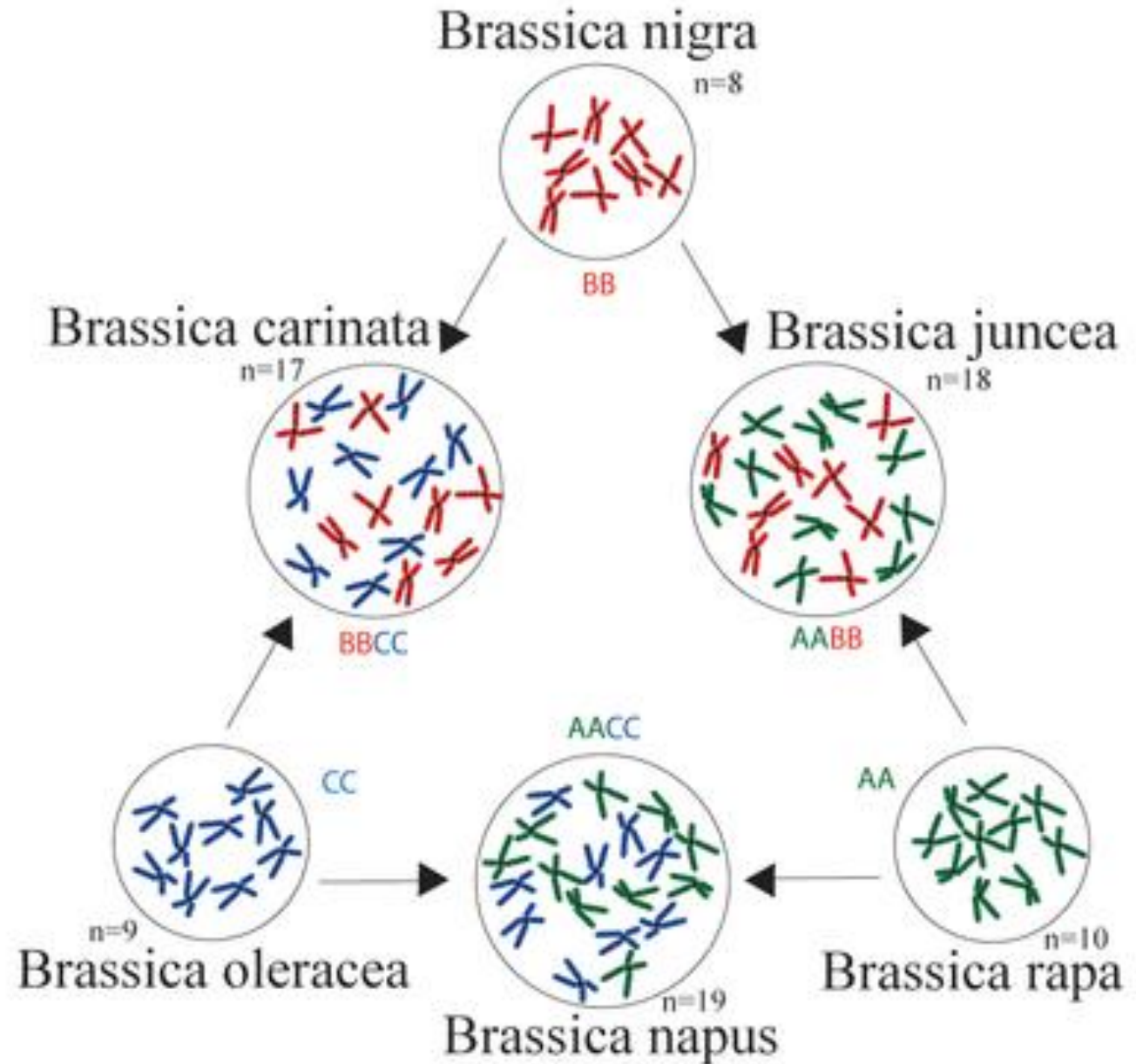
Flg 22



# The Triangle of U

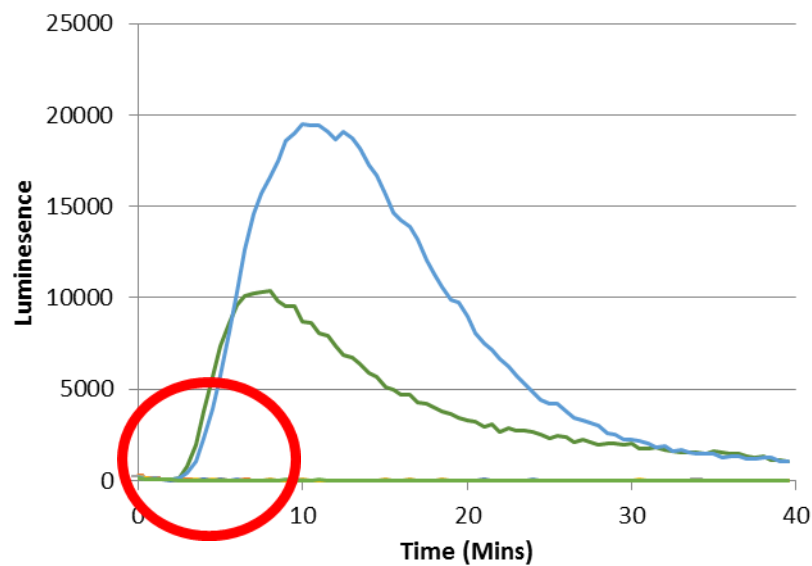
12 lines of each species

B. Nigra (BB)	Black mustard
B. Carinata (BBCC)	Ethiopian mustard/rape
B. Oleracea (CC)	Cabbage, broccoli, sprouts etc
B. Napus (AACC)	Oil seed rape
B. Rapa (AA)	Turnips, bok choi
B. Juncea (AABB)	mustards



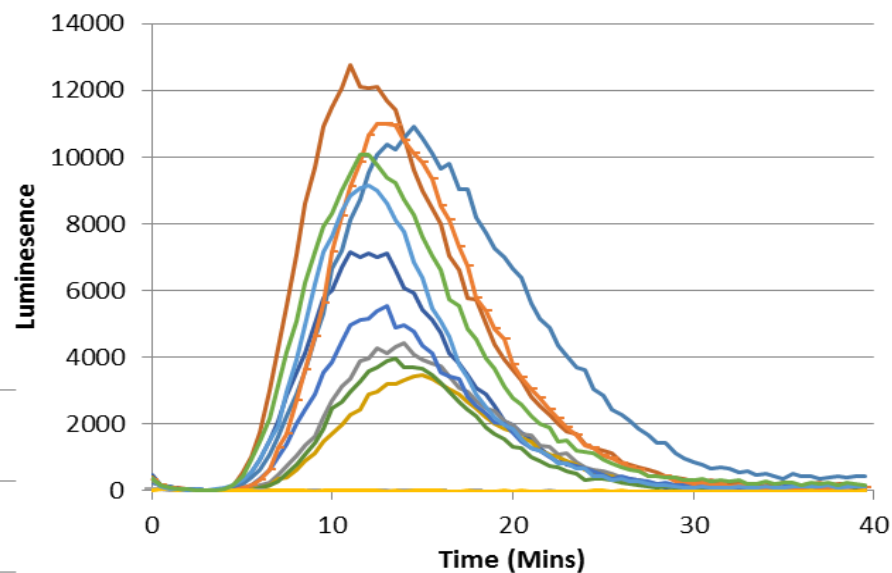
# Brassica napus

BcNEP2

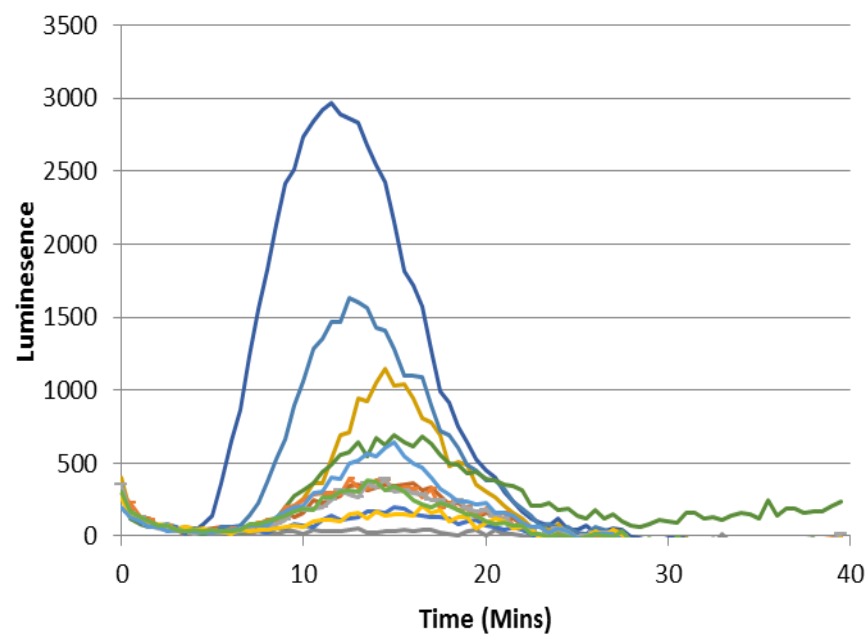


A subset of B.napus (rep 2 sowing A)

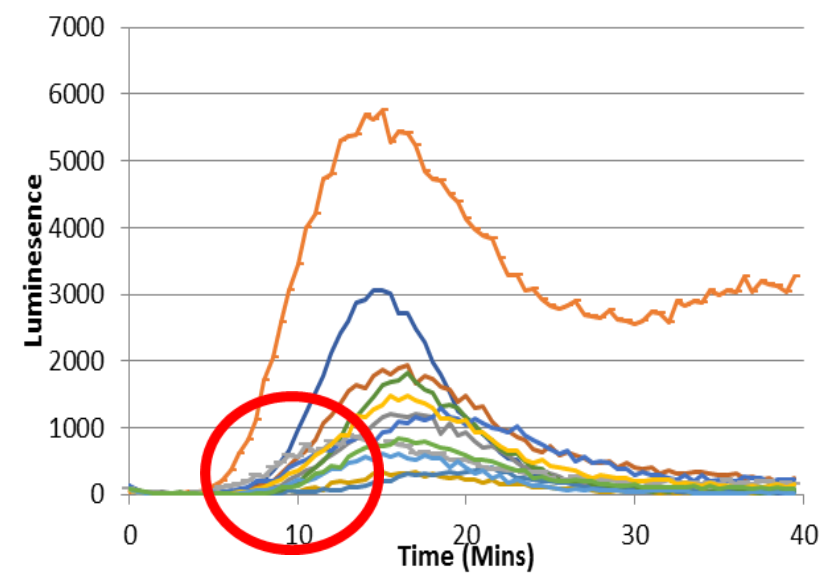
flg22



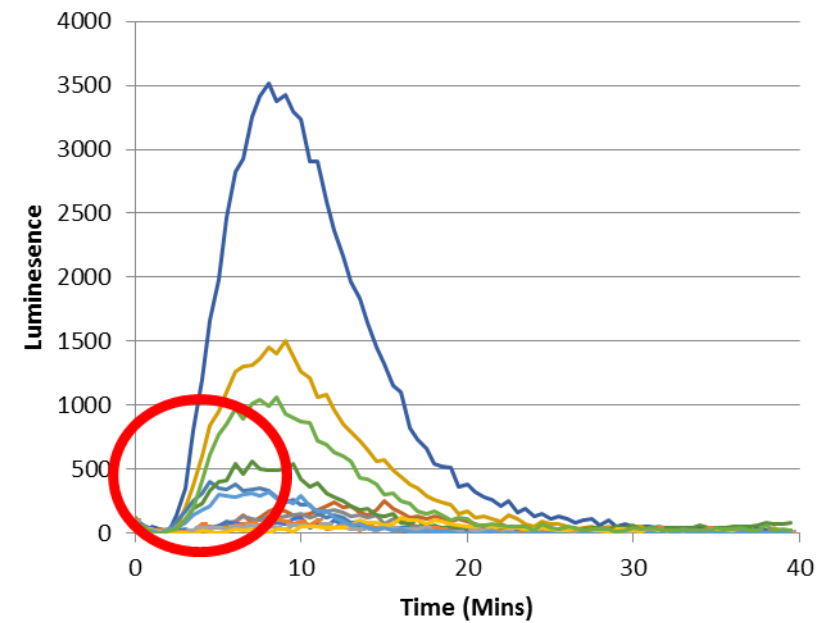
Elf 18



xylanase



chitin



# Average time of 12 lines taken for response to start

B. oleracea	cc
PAMP	Minutes
chitin	7
BcNEP2	
flg22	10
elf18	11
xylanase	13

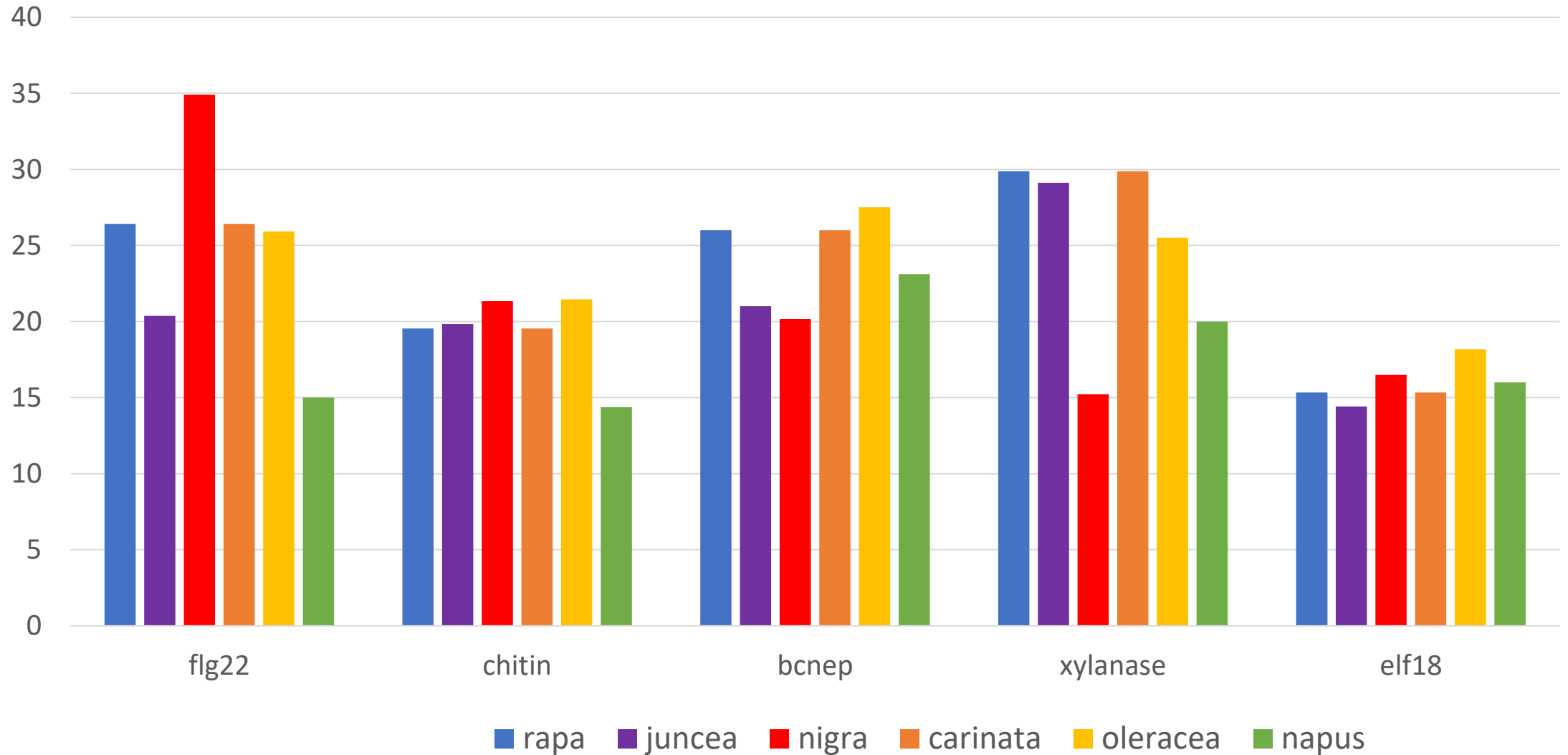


Napus	AACC
PAMP	Minutes
chitin	4
BcNEP2	4
flg22	8
elf18	9
xylanase	10



Rapa	AA
PAMP	Minutes
chitin	5
BcNEP2	5
flg22	9
elf18	10
xylanase	11

# Average Peak width of ROS reponse

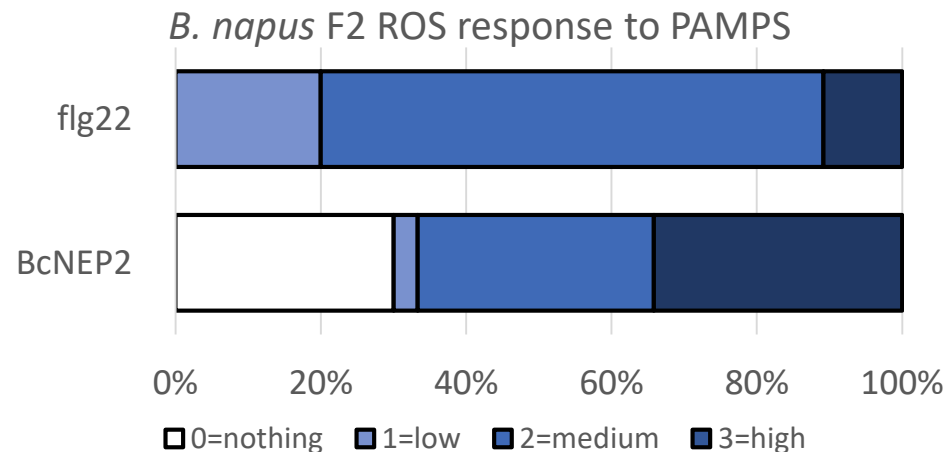


# Variation in ROS-response

- Most PAMPs recognised by every species
- In most species there is a distribution in response strength and timing among the 12 lines tested
- Flg22 the strongest response
- BcNEP2 gives strong response, in those lines that recognise it.

# Heritability of BcNEP2 response

- All or nothing response among lines of each species
- Cross contrasting *B. napus* lines:
  - responding Ningyou1 X non-responding Ningyou7
- All F1s DO respond
- F2 segregates, to be used for Bulk Segregant Analysis
  - 120 offspring tested: fit single dominant gene for on/off
  - Combined with other gene for strength of response.



# Thanks!!



## Ridout Group

Chris Ridout

Simon Lloyd

Sam Holt

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Hicret Asli Yalcin

Emma Verbeek

## Crop Genetics

Rachel Wells

Martin Trick

Mike Ambrose



## Horticultural services

### Zipfel group

### Utrecht University

Guido van den Ackerveken

Tom Raaymakers

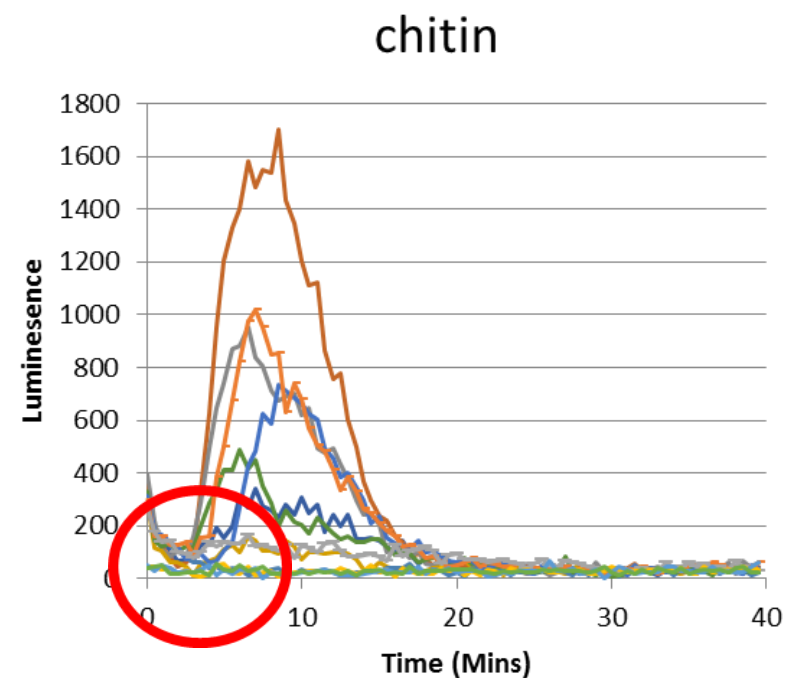
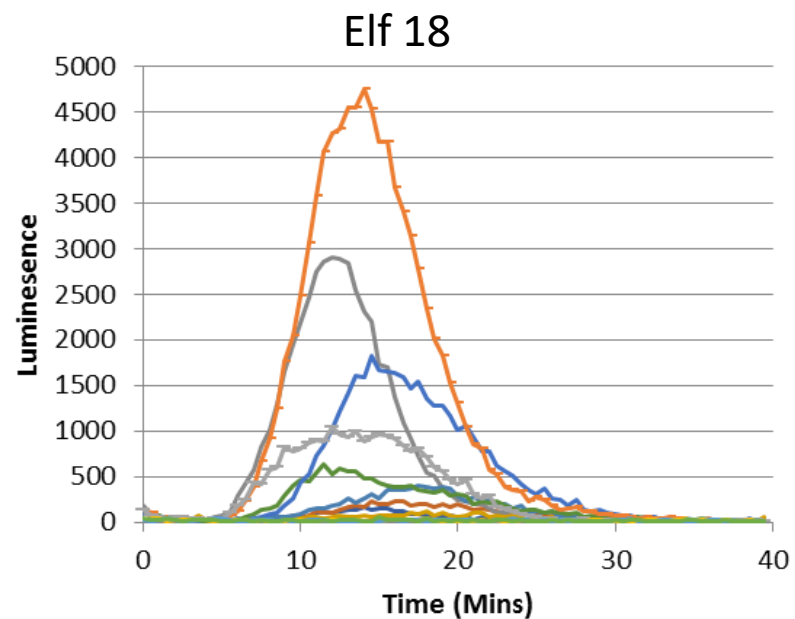
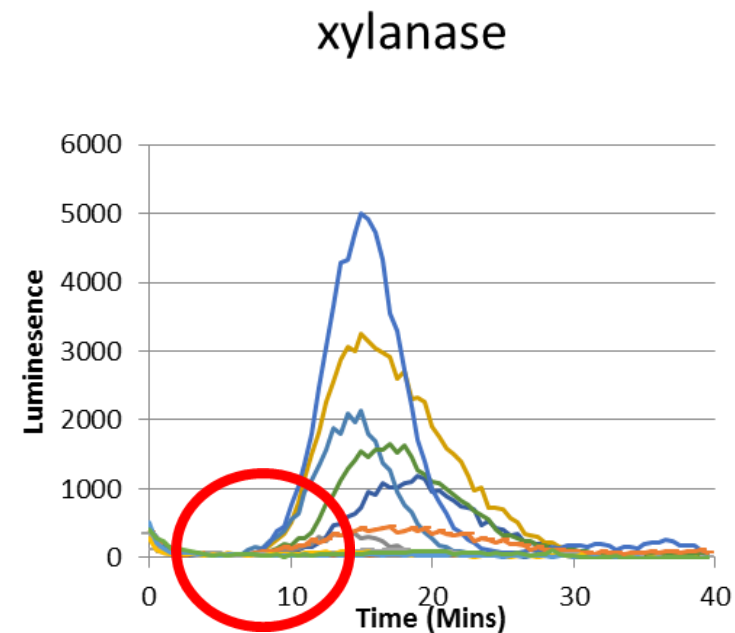
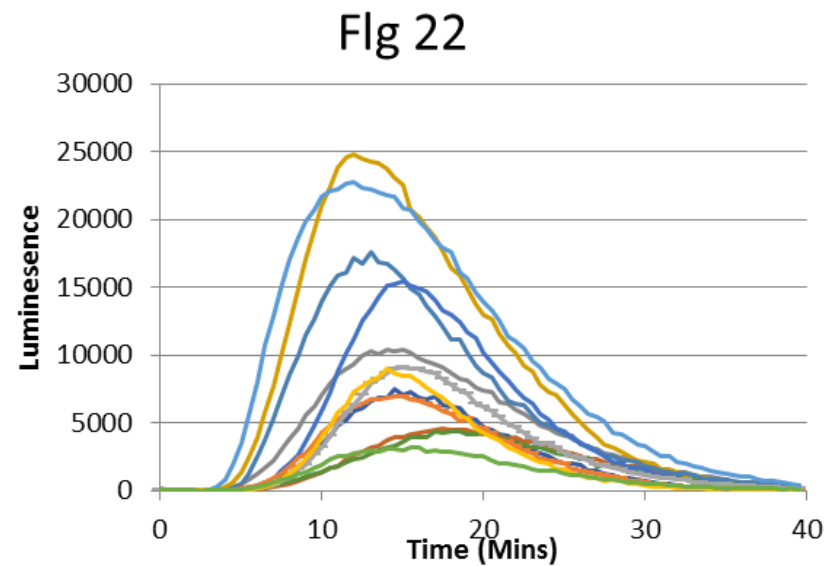
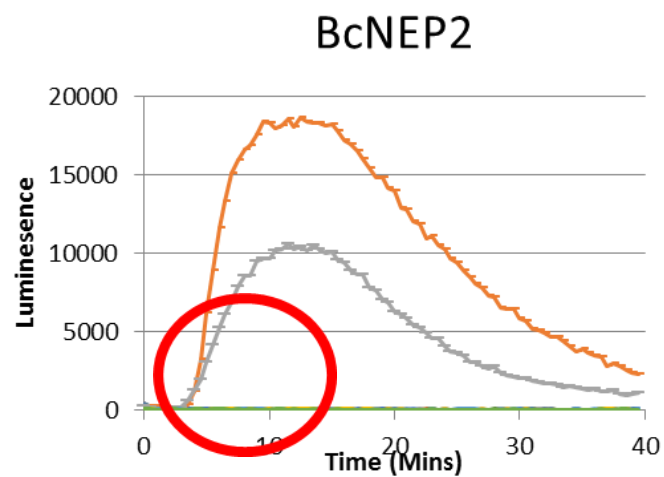




# PAMPs

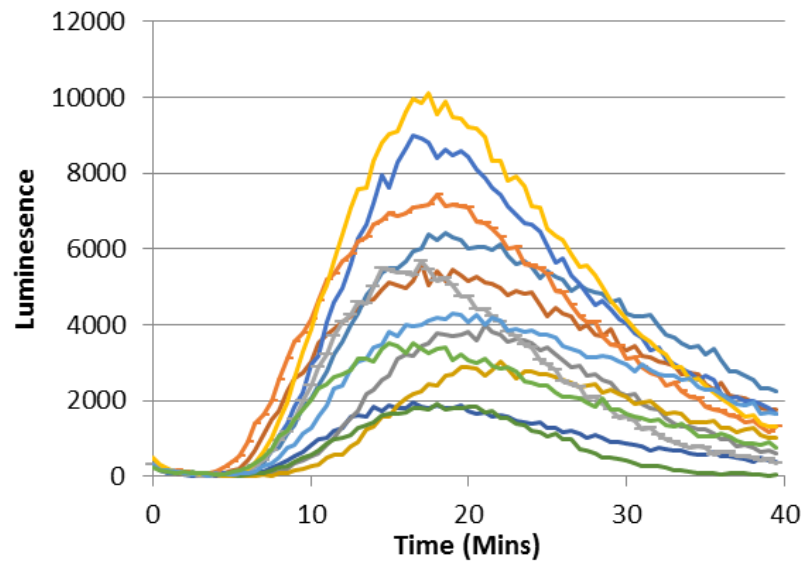
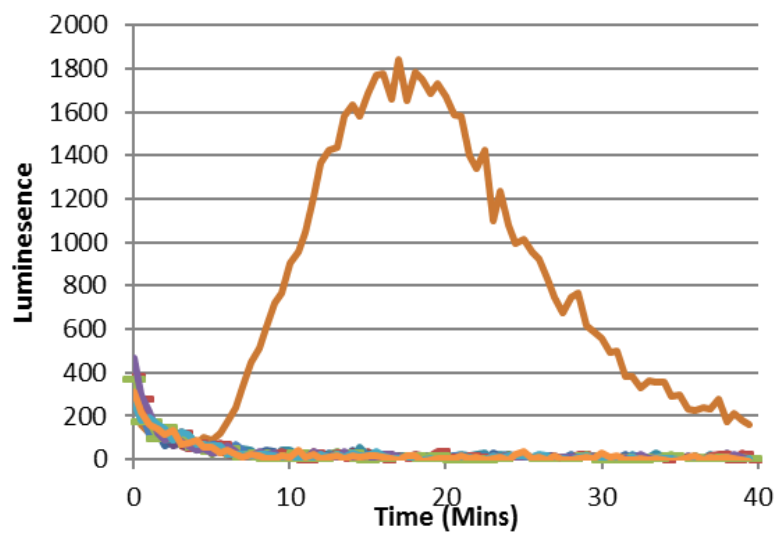
PAMP NAME	ORIGIN
Flg22	A protein from the flagella of bacteria
Elf 18	Elongation factor in bacteria
Chitin	Component of fungal cell wall
xylanase	Cell wall degrading enzyme from fungi
BcNEP2	Necrosis and ethylene inducing protein from fungi

# B. rapa

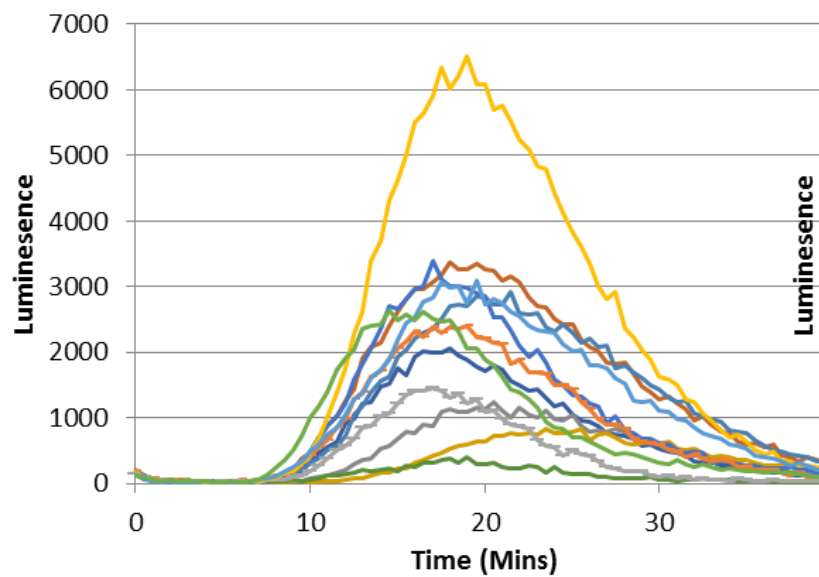


# B. oleracea

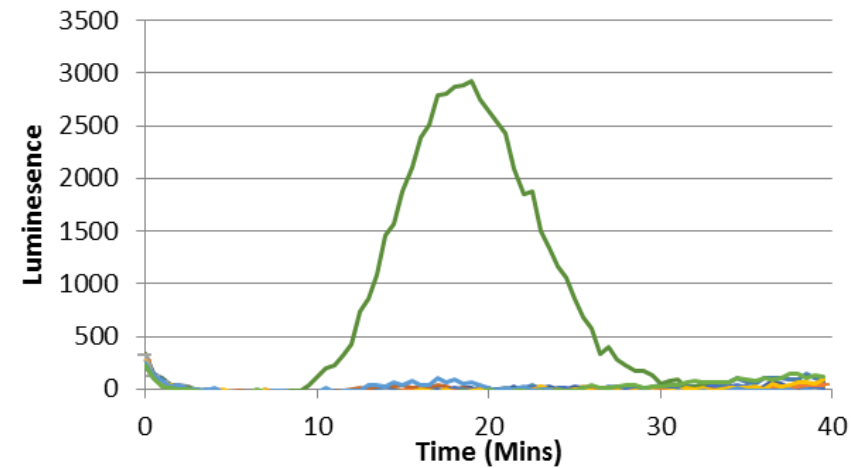
## BcNEP2



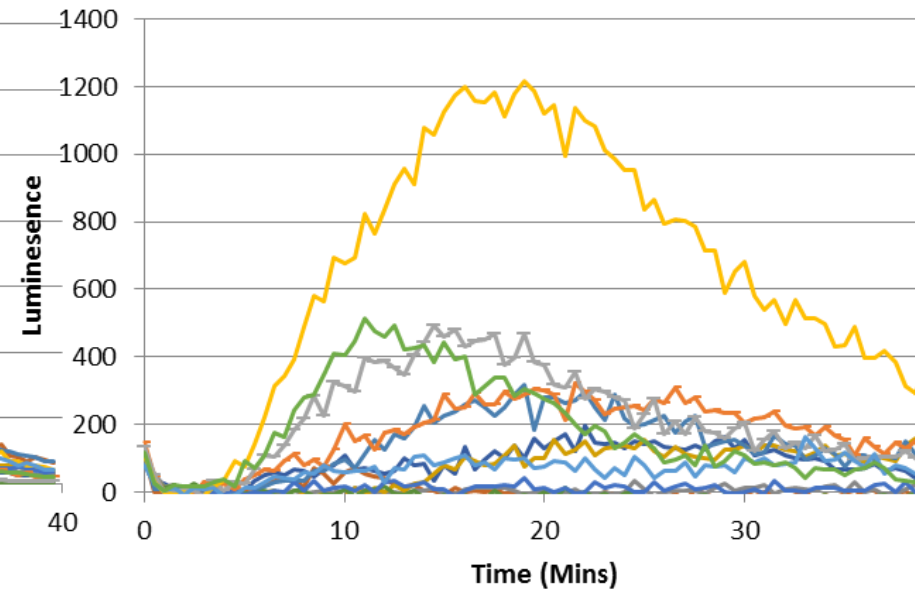
## elf18



## xylanase

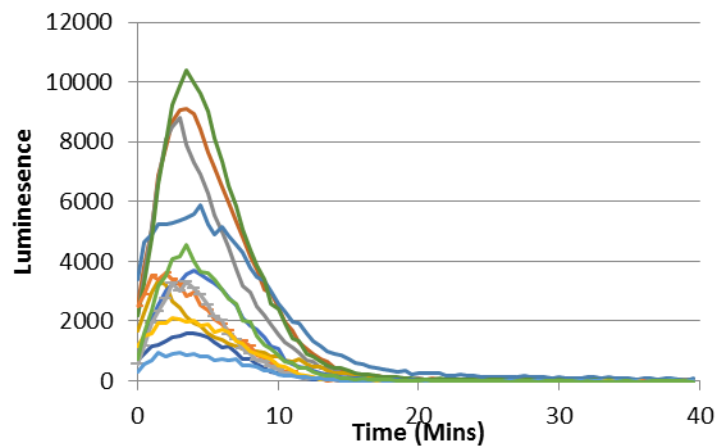


## chitin

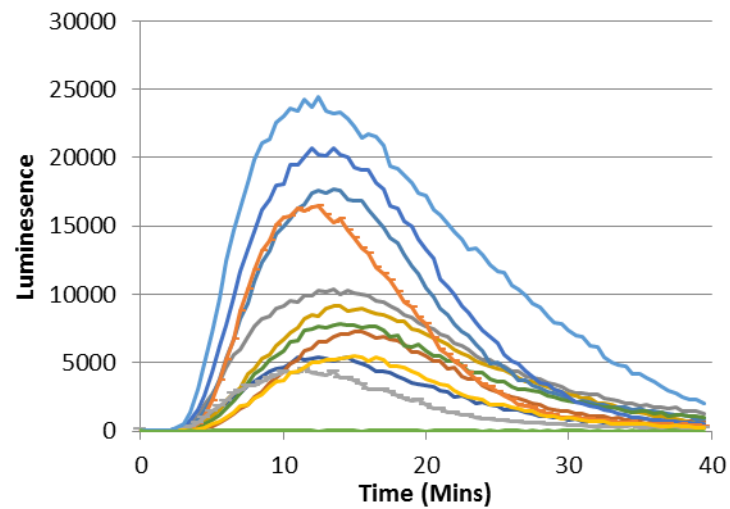


# Brassica juncea

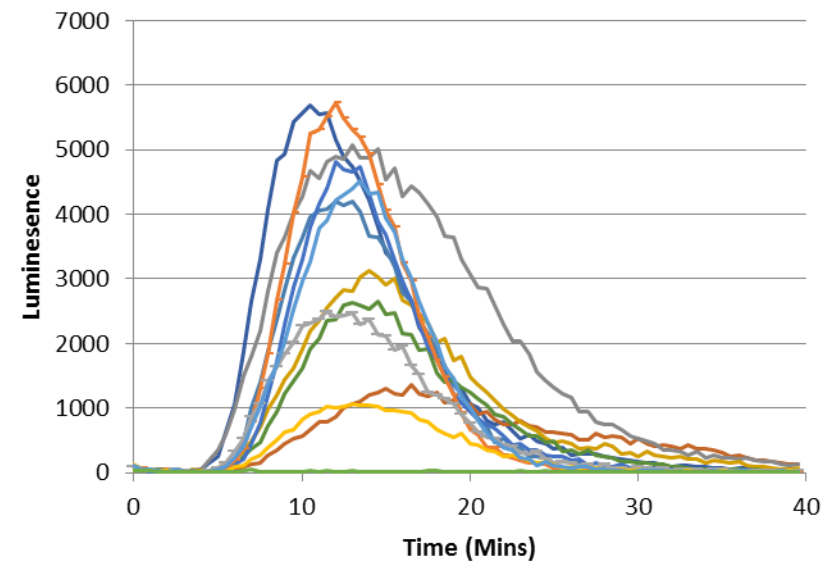
chitin



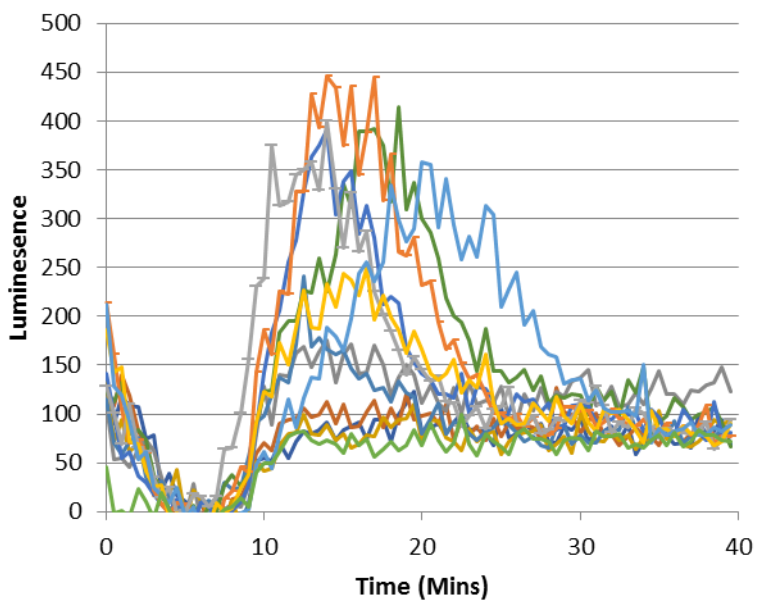
flg22



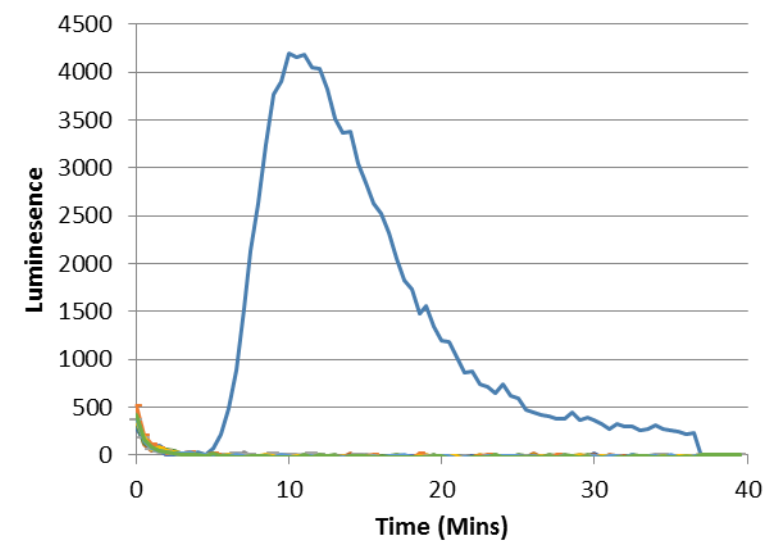
Elf 18



xylanase

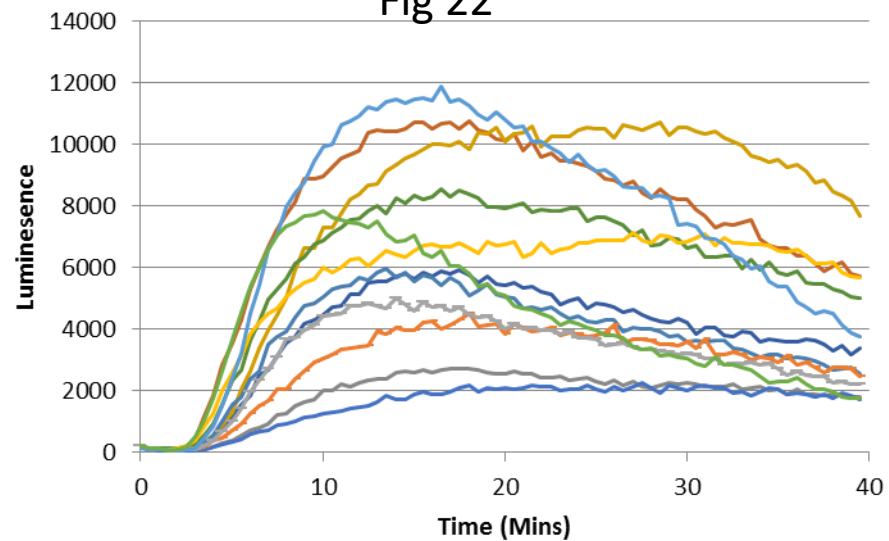


BcNEP2

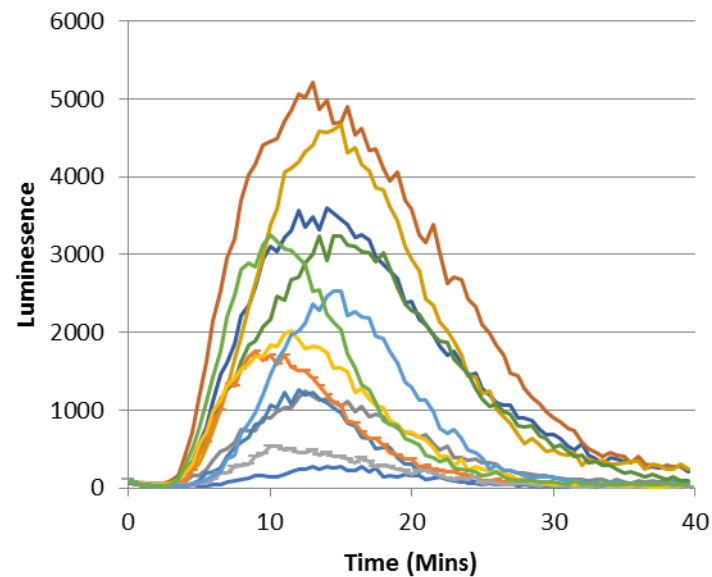


# Brassica nigra

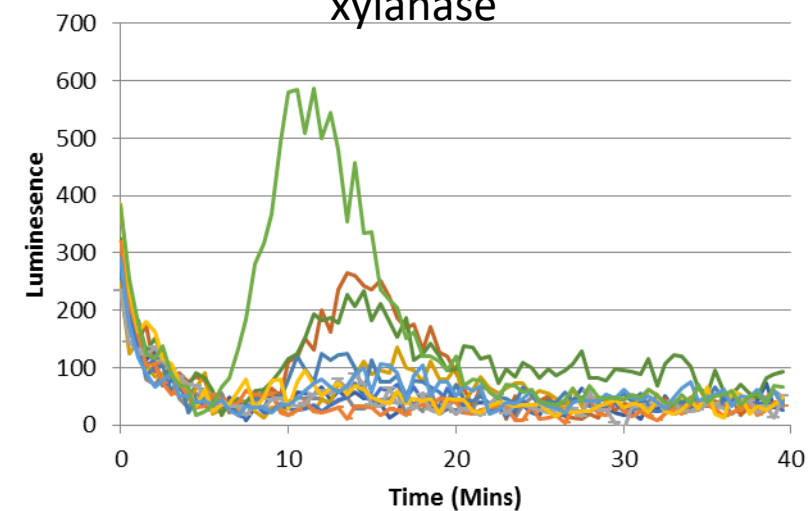
## Flg 22



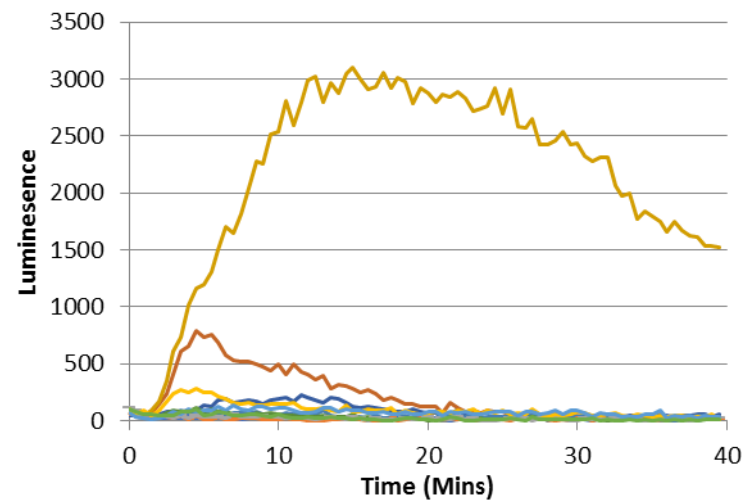
## Elf 18



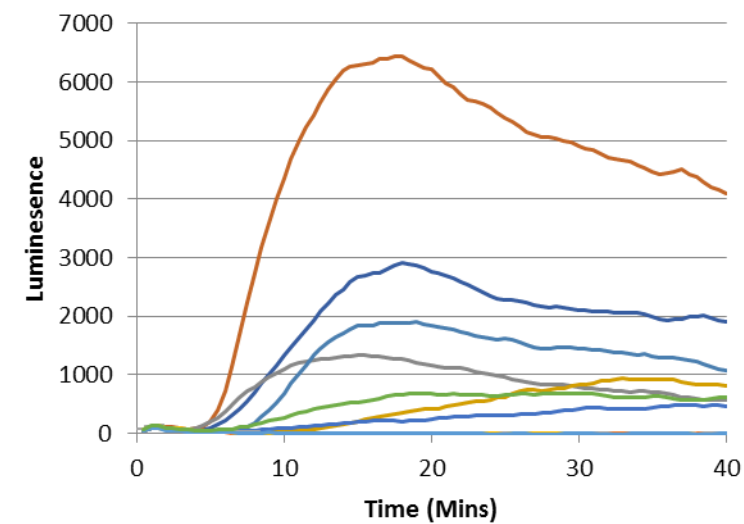
## xylanase



## chitin



## BcNEP2



# Average time taken for the peak to go up to 1/3 of max peak

Rapa	AA
PAMP	Minutes
chitin	5
BcNEP2	5
flg22	9
elf18	10
xylanase	11



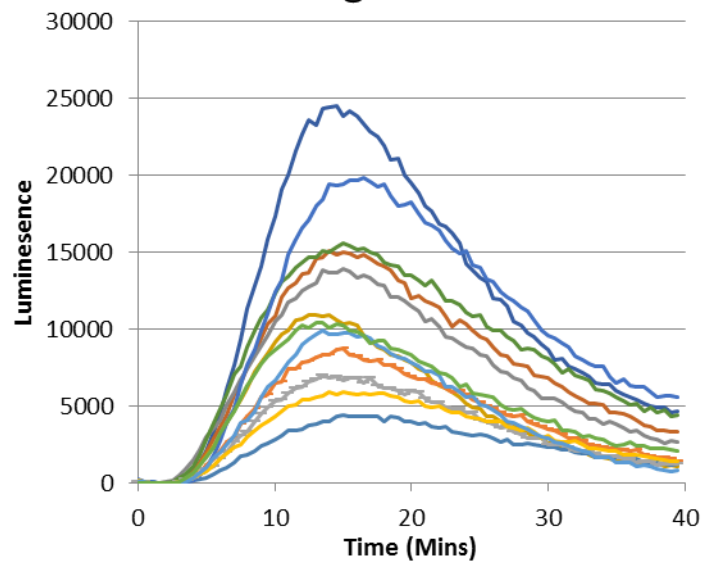
Juncea	AABB
PAMP	Minutes
chitin	2
BcNEP2	7
flg22	6
elf18	7
xylanase	6



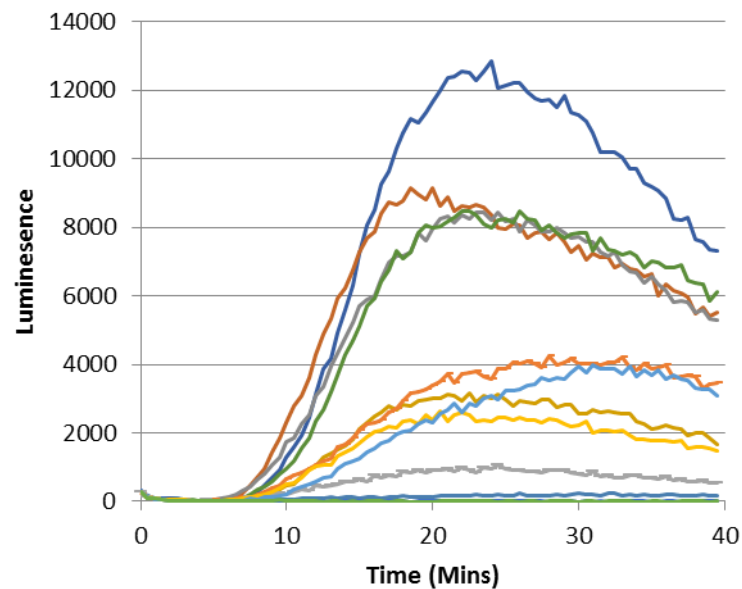
Nigra	BB
PAMP	Minutes
chitin	3
BcNEP2	10
flg22	6
elf18	7
xylanase	8

# Brassica carinata

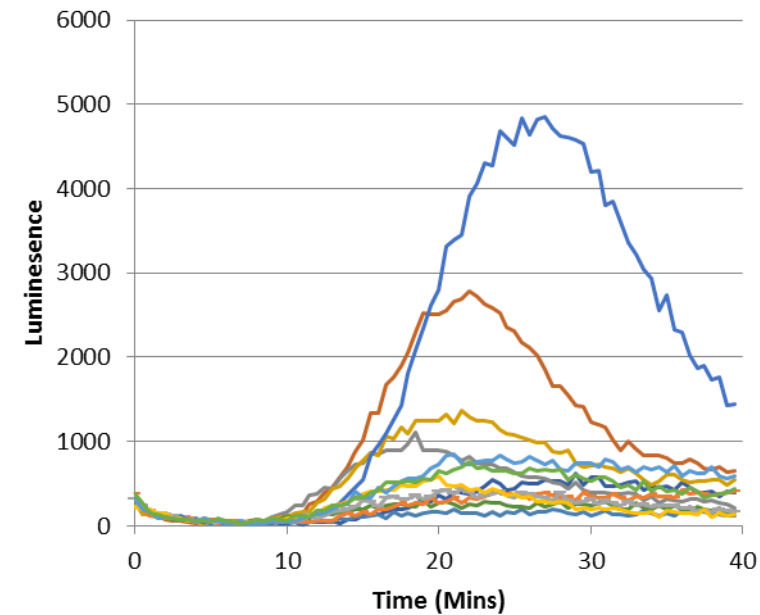
## flg22



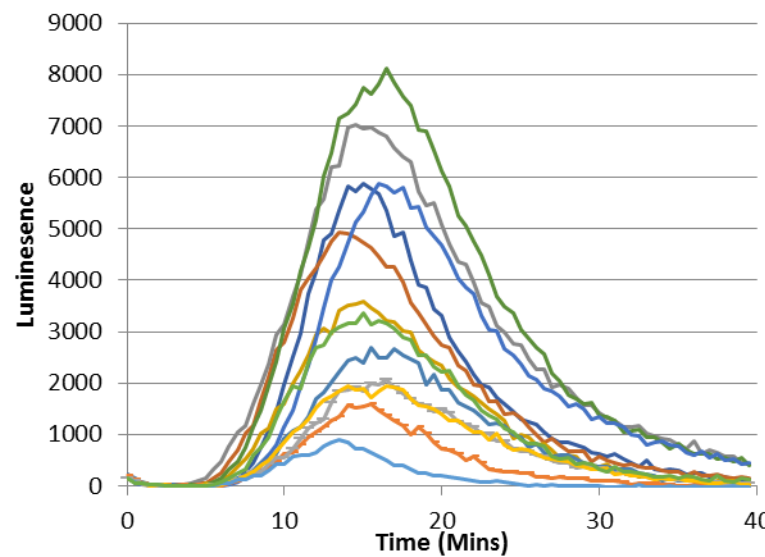
## BcNEP2



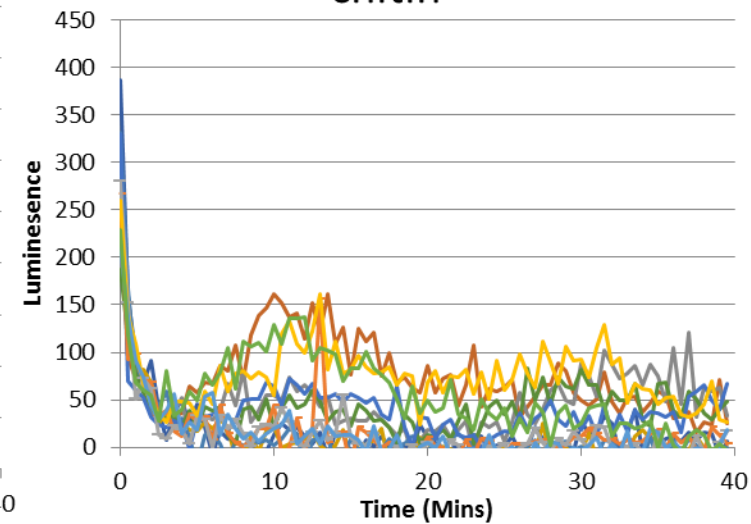
## xylanase



## elf18



## chitin



# Average time taken for the peak to go up to 1/3 of max peak

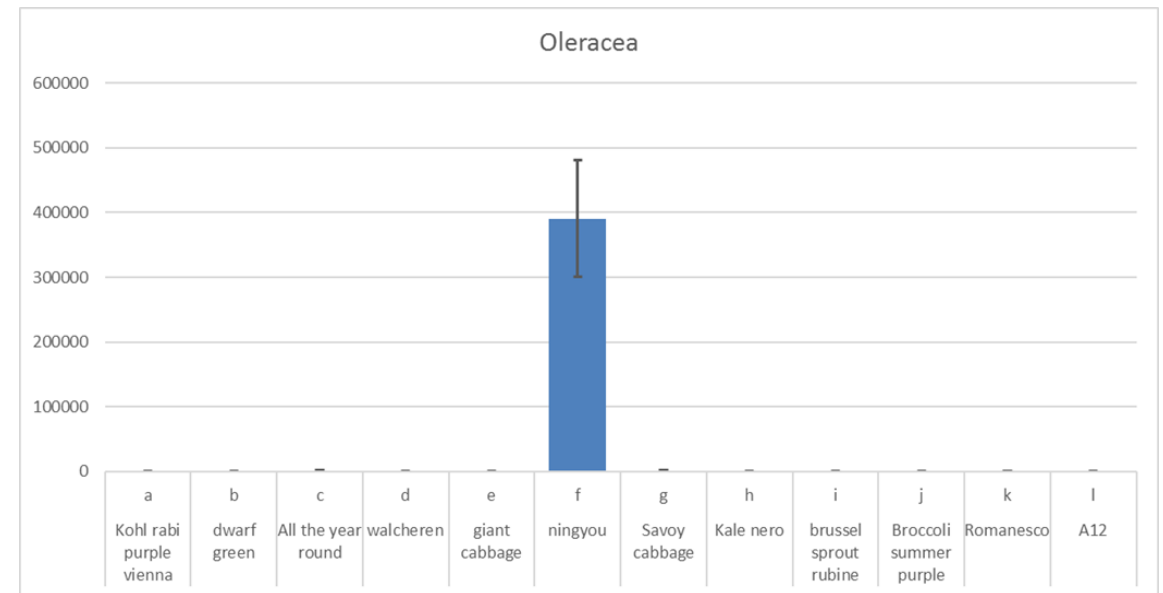
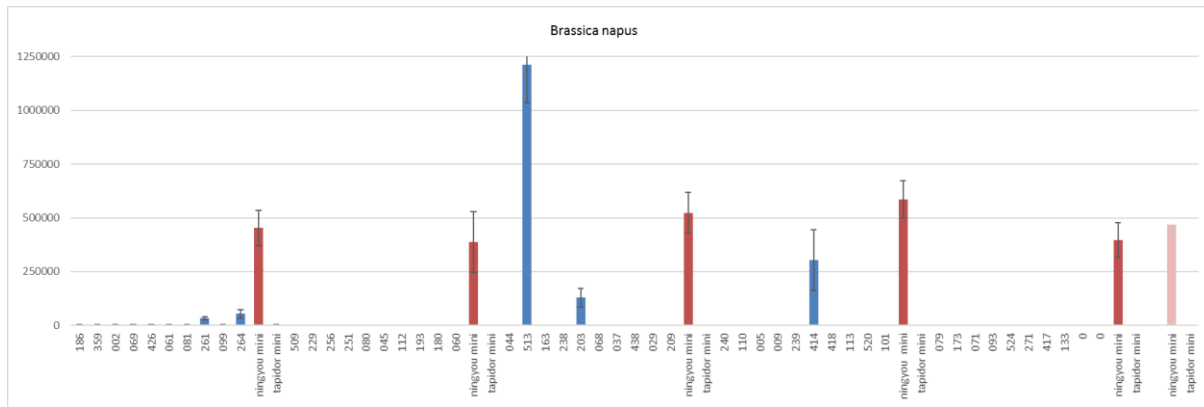
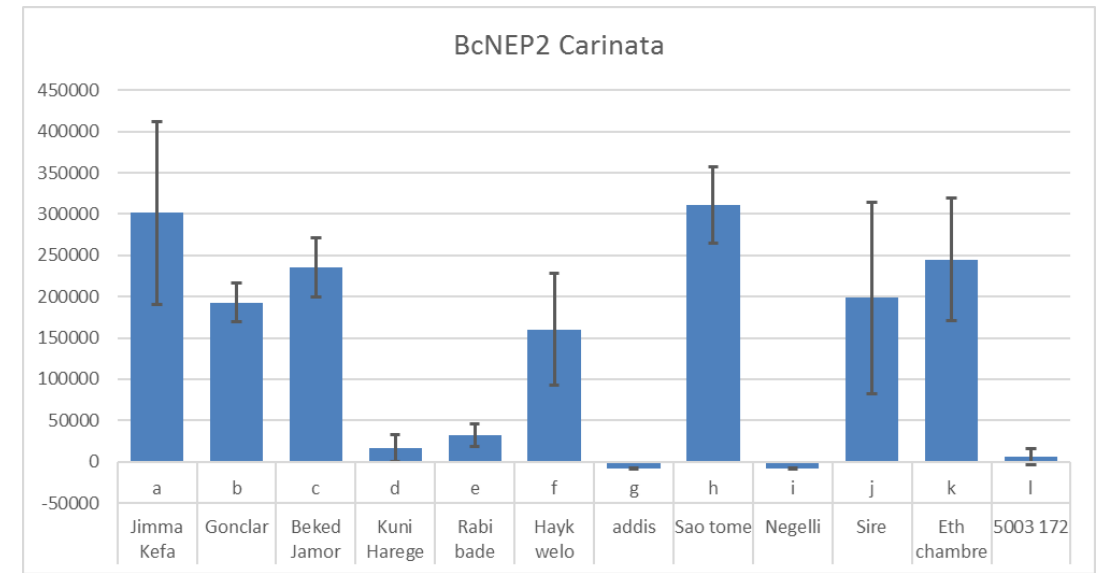
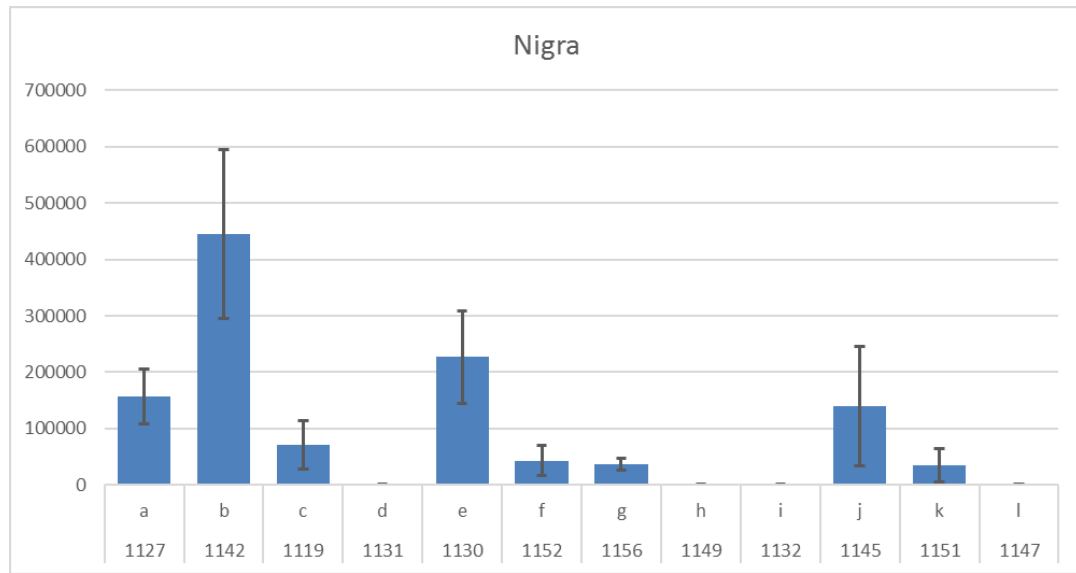
Nigra	BB
PAMP	Minutes
chitin	3
BcNEP2	10
flg22	6
elf18	7
xylanase	8



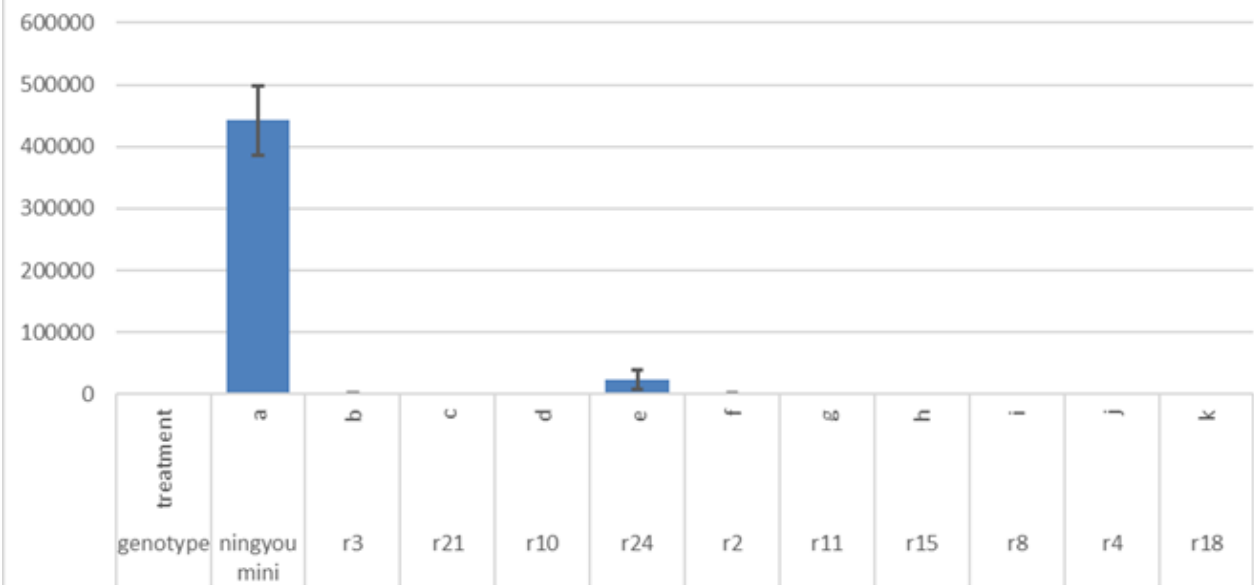
Carinata	BBCC
PAMP	Minutes
chitin	1
BcNEP2	12
flg22	7
elf18	10
xylanase	14



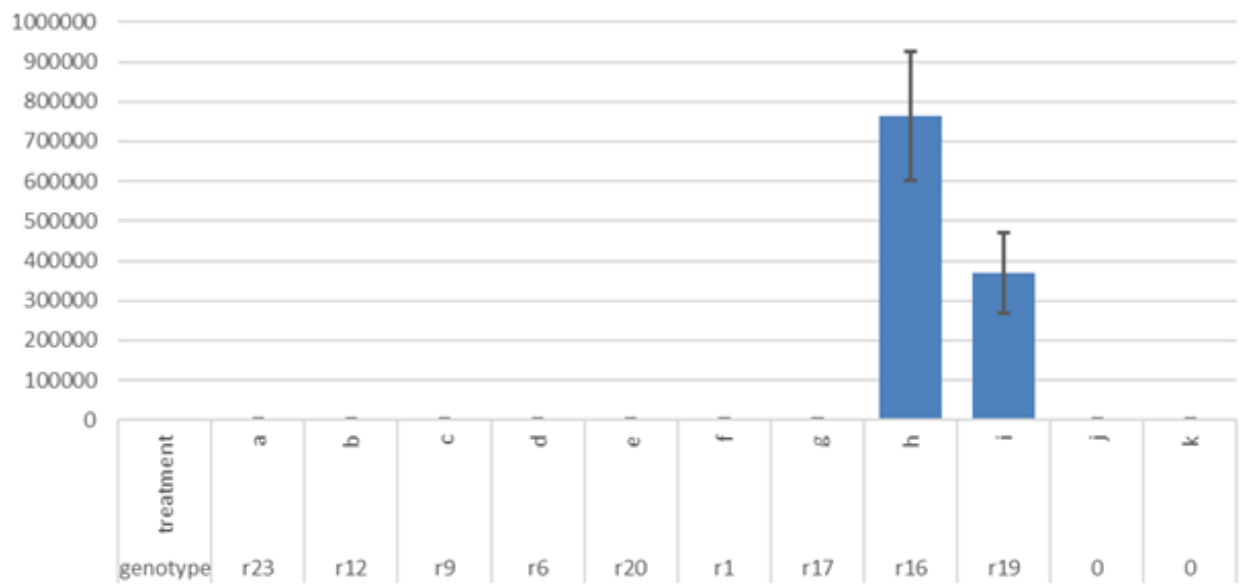
Oleracea	cc
PAMP	Minutes
chitin	7
BcNEP2	8
flg22	10
elf18	11
xylanase	13



Rapa 1



Rapa



Juncea

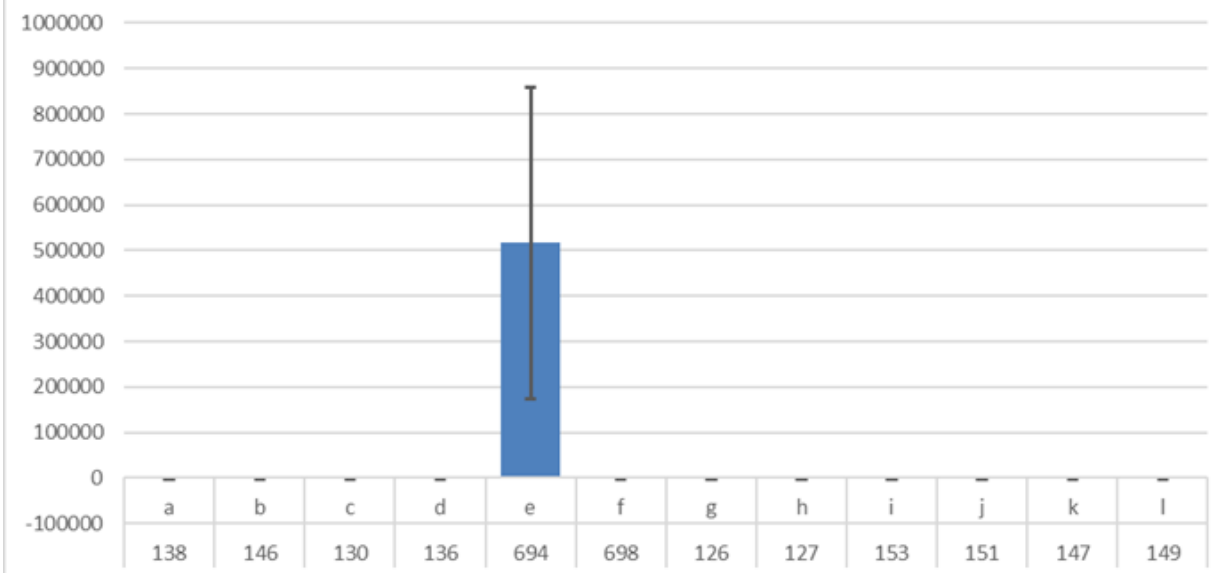
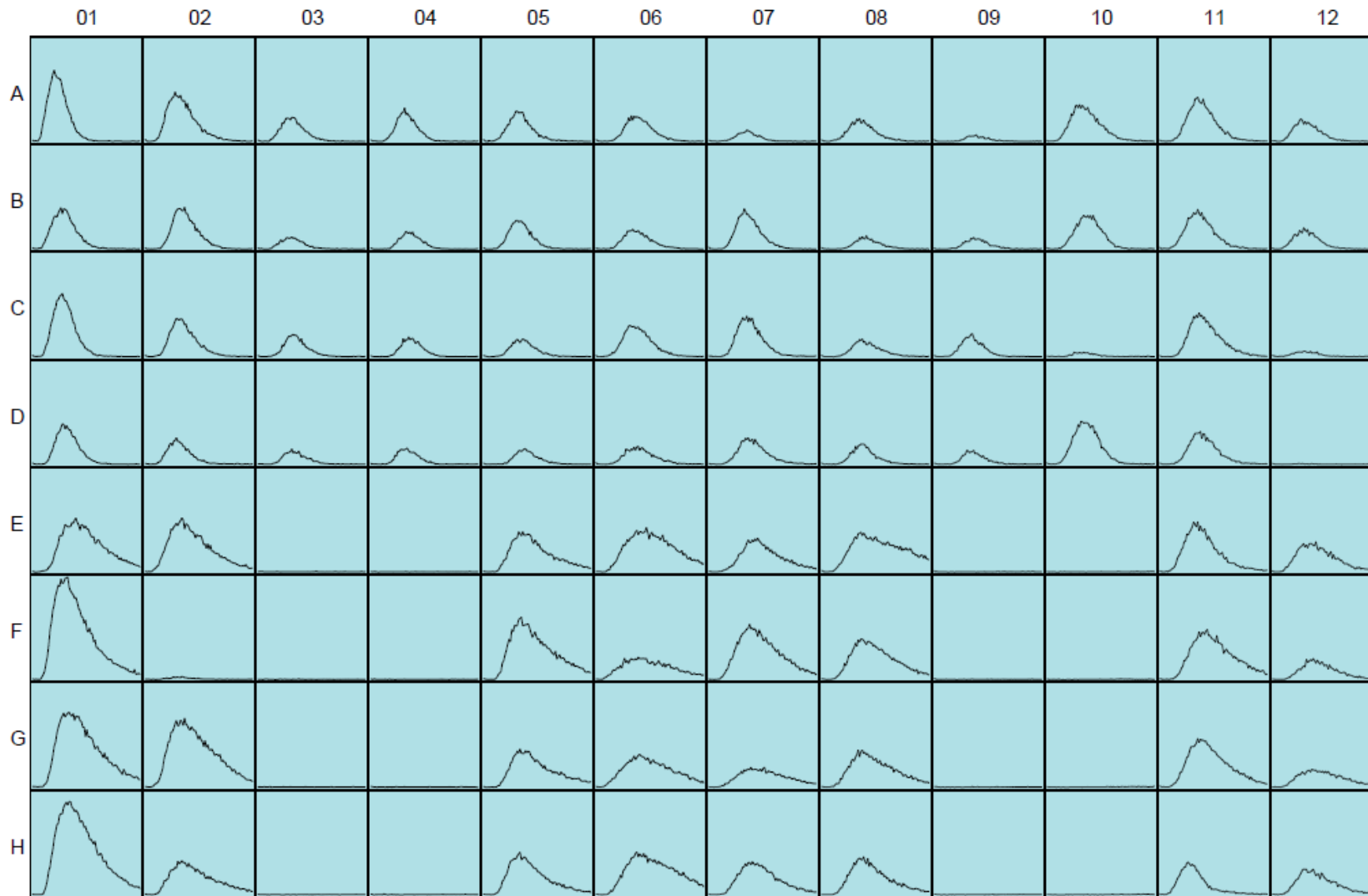
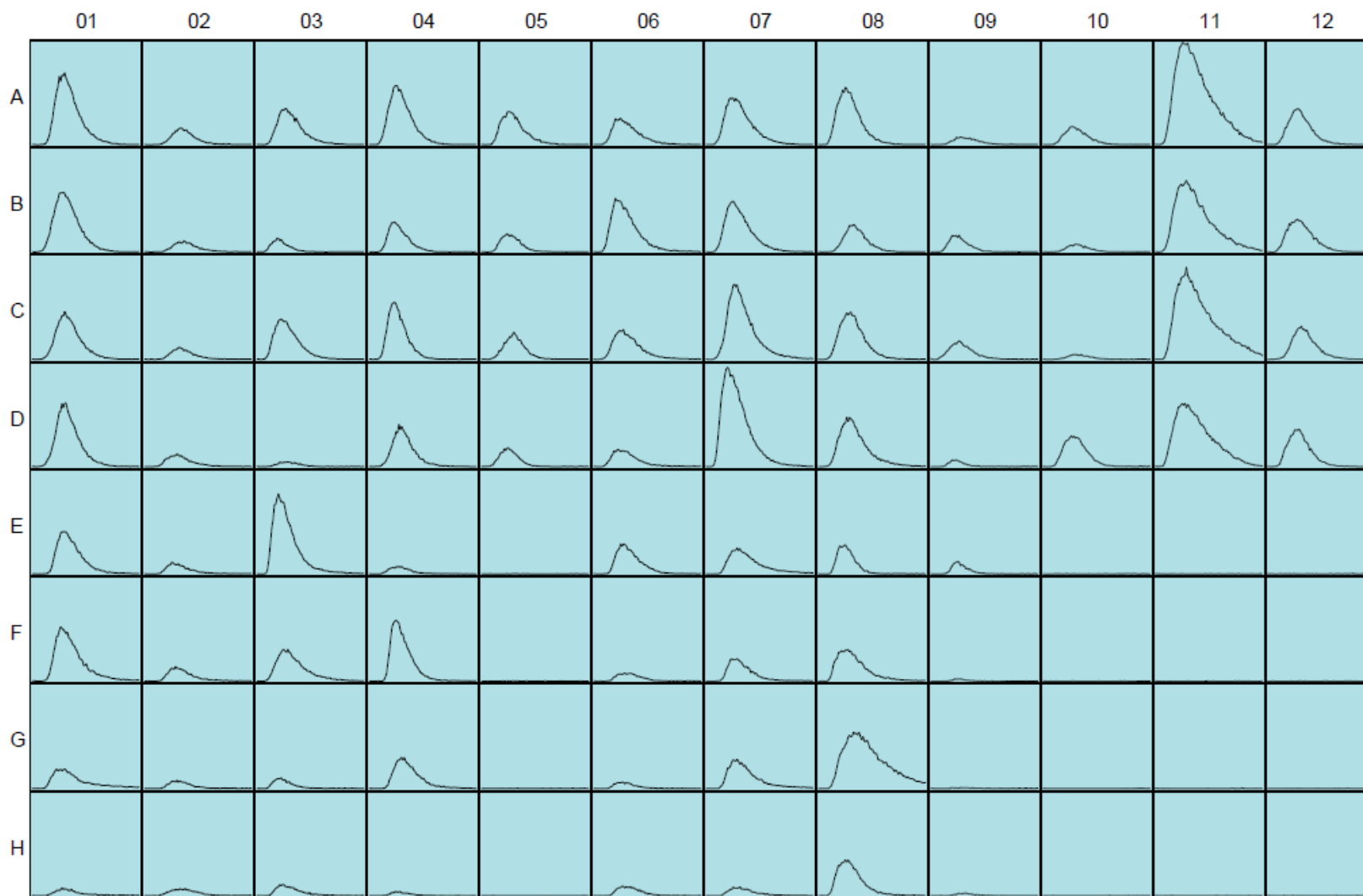


Plate 1: 1 - 0 nm, scale: -30.93 - 22106.1



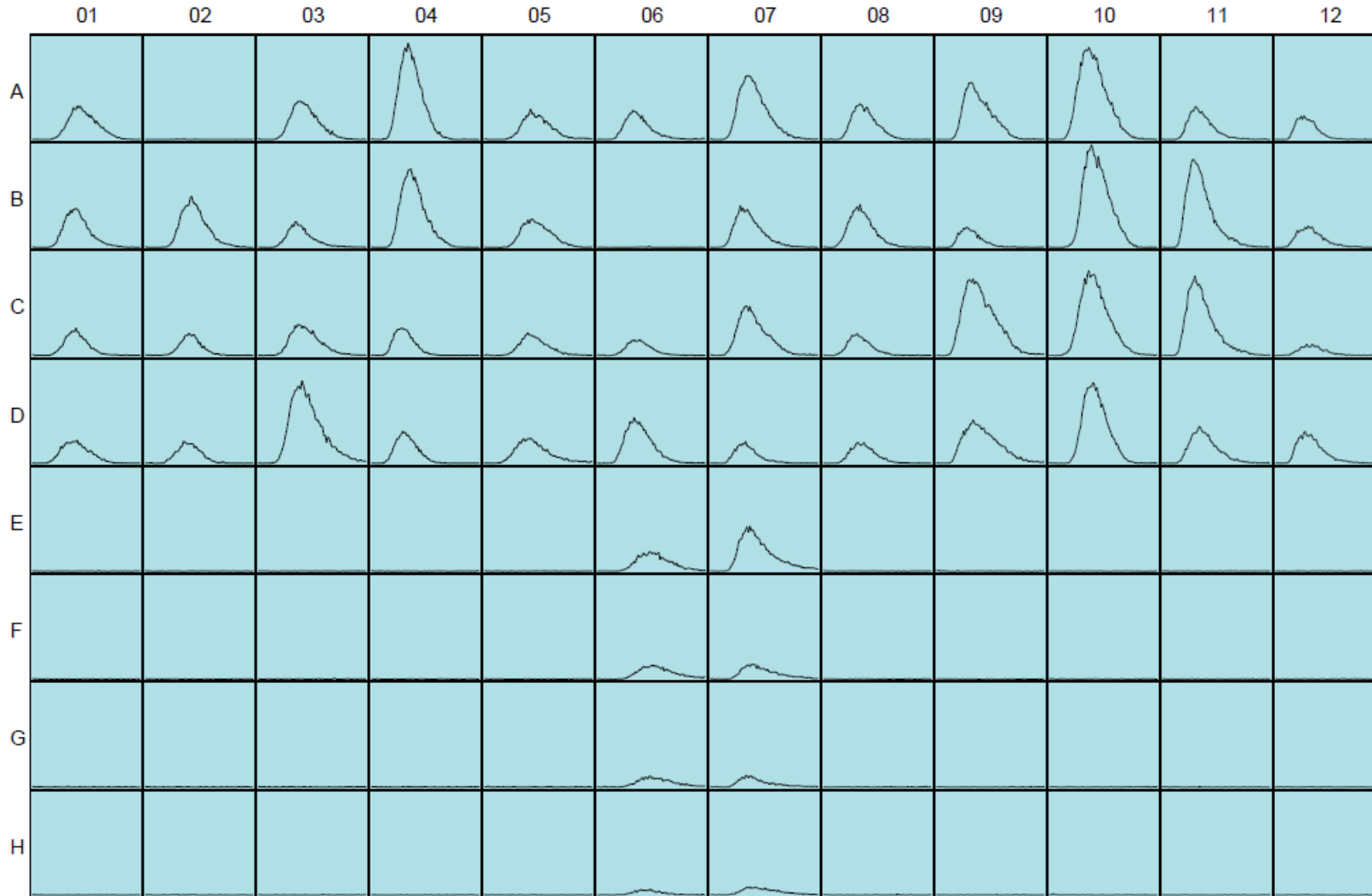
Brassica Rapa 1-4

Plate 1: 1 - 0 nm, scale: -19.698 - 39013.3



Brassica rapa 9-3

Plate 1: 1 - 0 nm, scale: -26.9 - 20889.1



Brassica rapa 9-1, 4, 5 all previously non-responding

