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Agri-Food Canada

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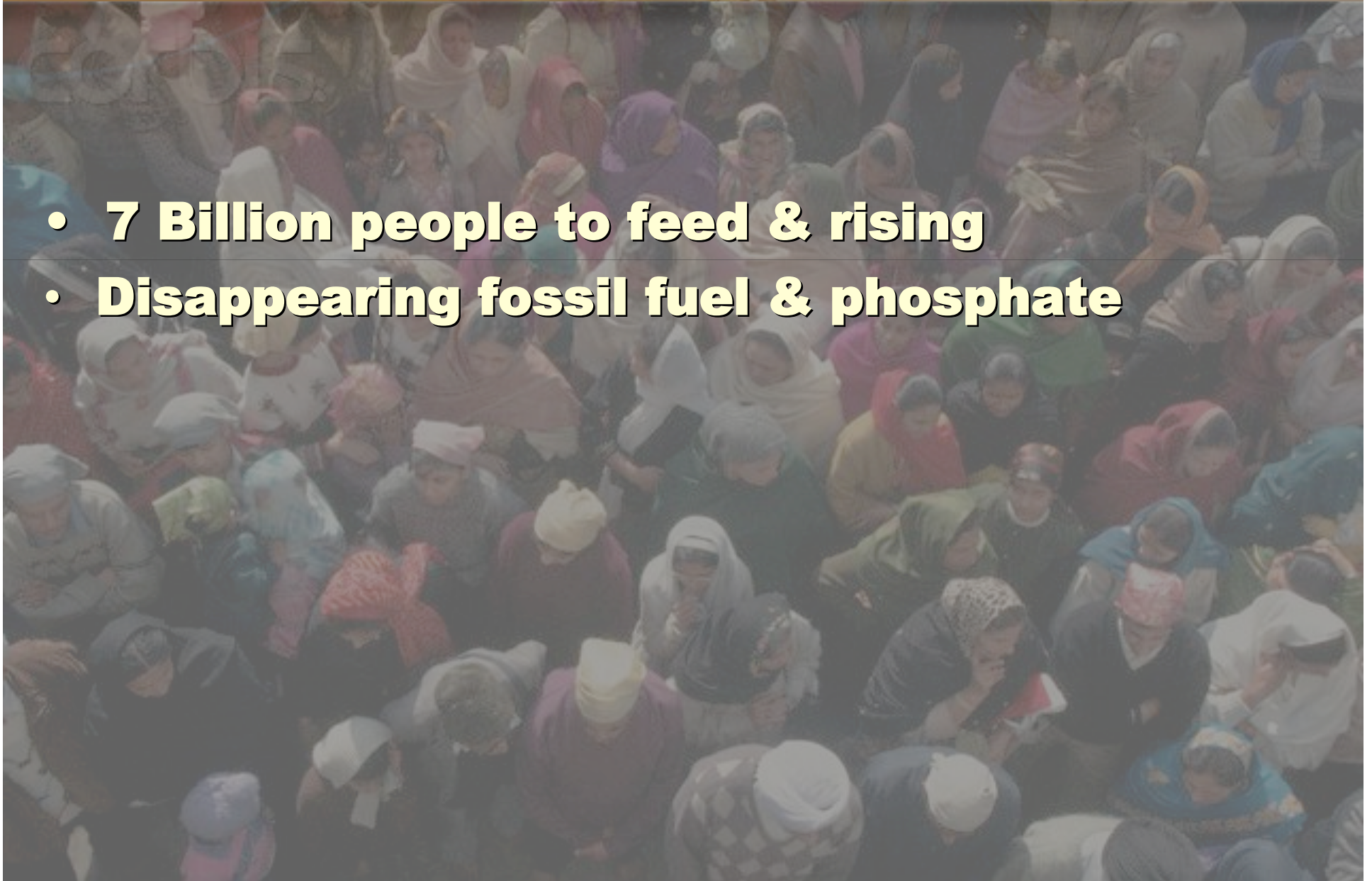
Flower power
Chemical ecology
to feed a sustainable world bread and chickpea

Chantal Hamel, Semiarid Prairie Agricultural Research Centre

Canada

Efficiency of production needed

- **7 Billion people to feed & rising**
- **Disappearing fossil fuel & phosphate**



Efficiency of production needed

- **7 Billion people to feed & rising**
- **Disappearing fossil fuel & phosphate**

**Canada is a leading wheat exporting country,
in the top 5 chickpea producing countries
Chickpea 3rd leguminous food crop**

Overall goal

**Ecology for
effective nutrient use by crops with
better plant-microbe associations**

Pythium

Azospirillum

Mycorrhiza

Rhizobium

Ascochyta

Fusarium

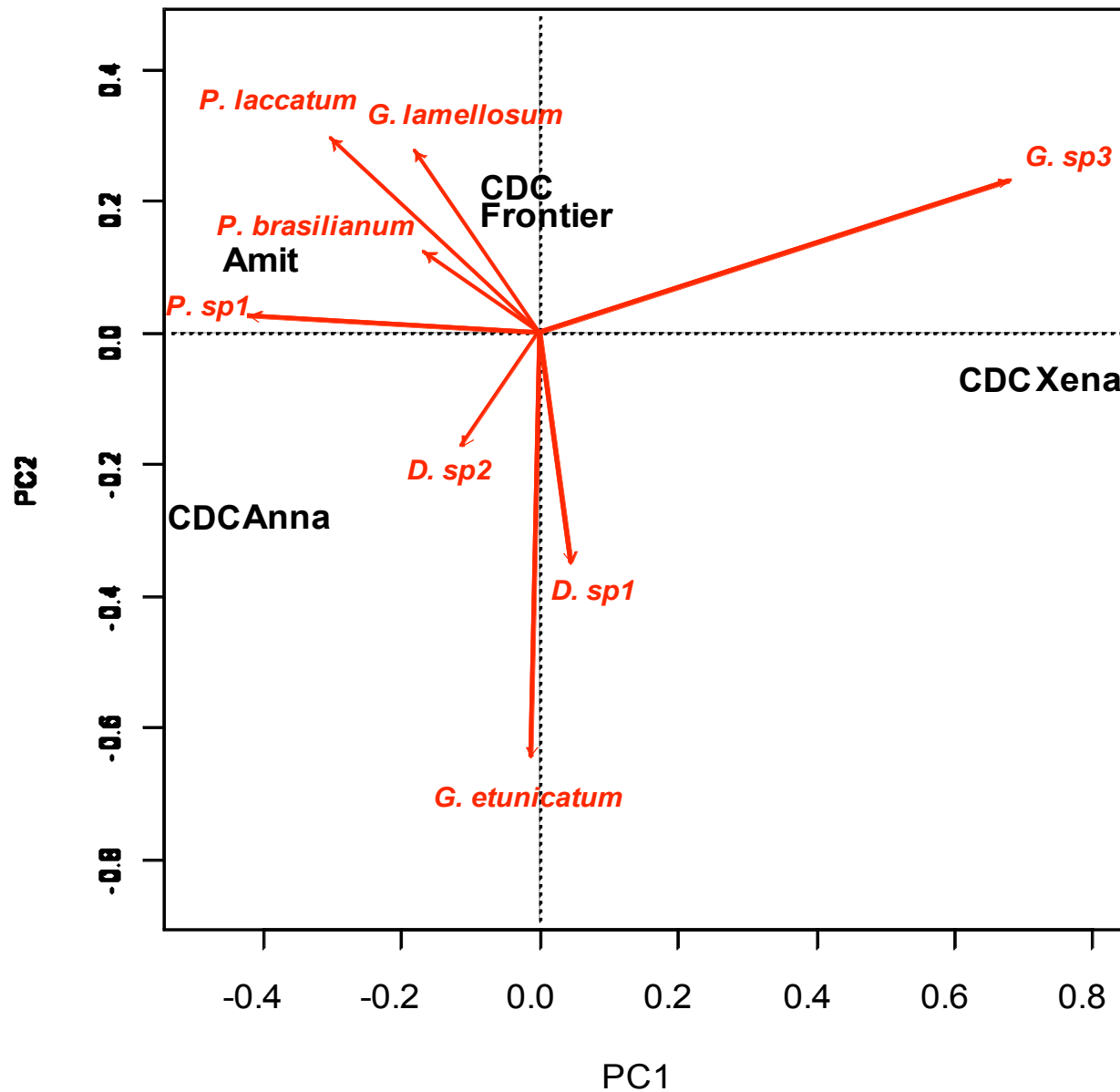
Trichoderma

Penicillium

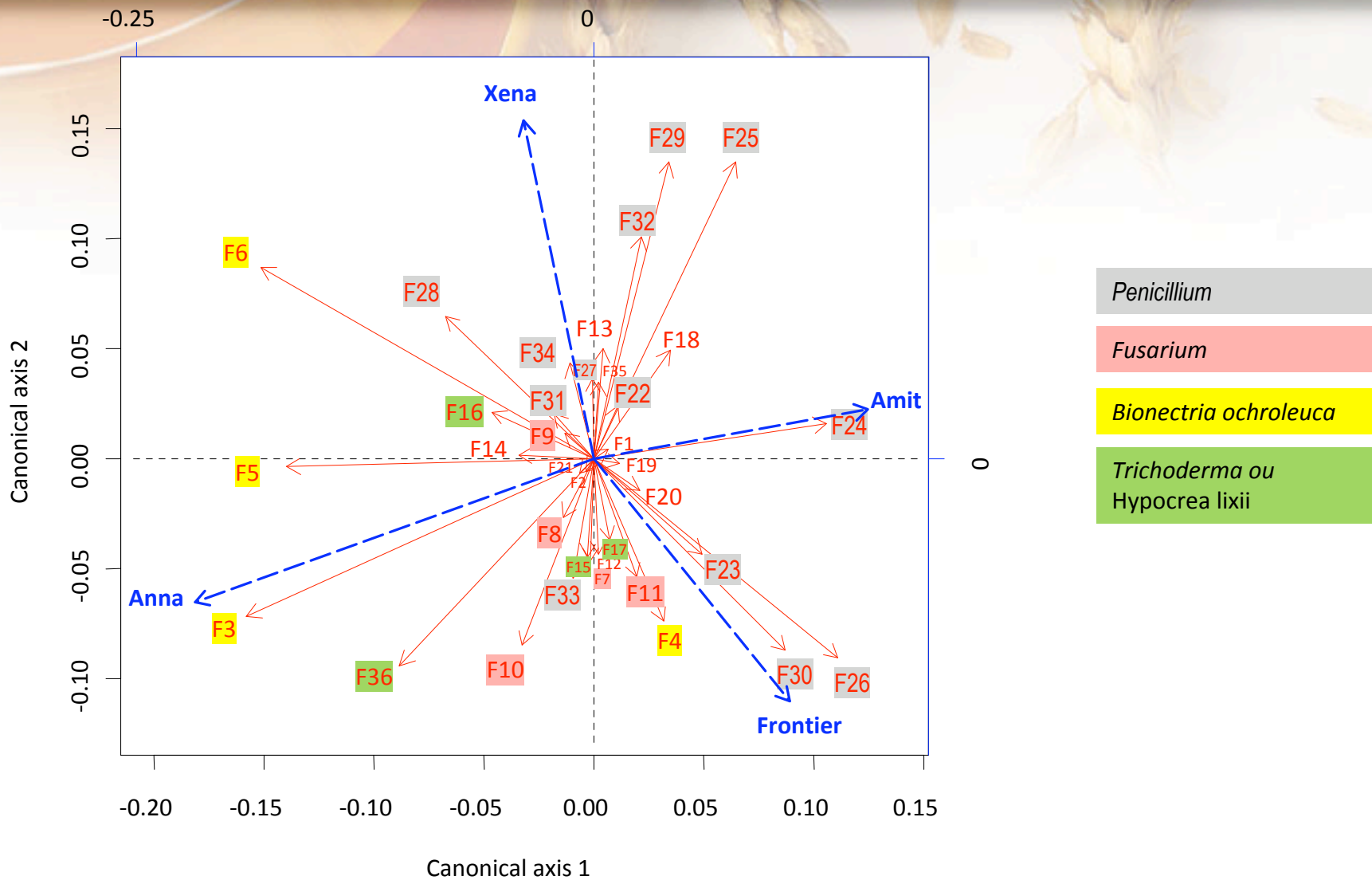
Plant friends and foes



Selective effect of chickpea cultivars on symbiotic soil fungi



Selective effect of chickpea cultivars on soil fungi



Crop plants have poor environmental adaptation



Adapted plants live in harmony. How?



Dynamic equilibrium through multiple interactions



Foes

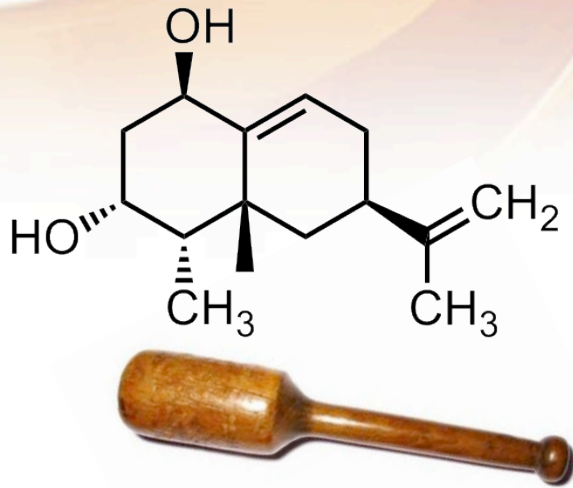
- Herbivory
- Pathology



Friends

- Growth promotion
- Nutrition
- Protection
- Pollination
- Dissemination

Dynamic equilibrium through multiple interactions



Foes

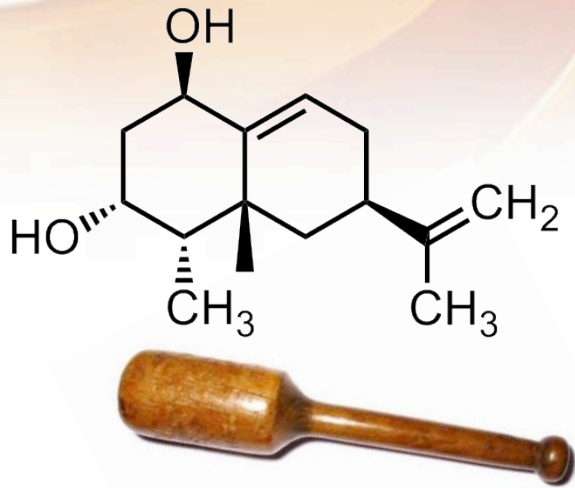
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Friends

- Growth promotion
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Dynamic equilibrium through multiple interactions



Foes

- Herbivory
- Pathology



Friends

- Growth promotion
- Nutrition
- Protection
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Plants use chemical signals and weapons



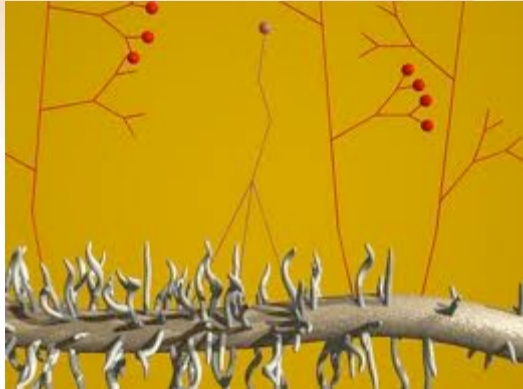
Phytochemicals can...



- Orient friends
- Control fungal pests
- Orient foes
- Alert relatives



To find phytochemicals that...



AM fungi



Fusarium

- Orient friends
- Control fungal pests



Chickpea – Wheat



Seeking phytochemicals orienting AM fungi



3 Kabuli Chickpea: 2 Desi Chickpea:

- Amit
- CDC Xena
- CDC Frontier

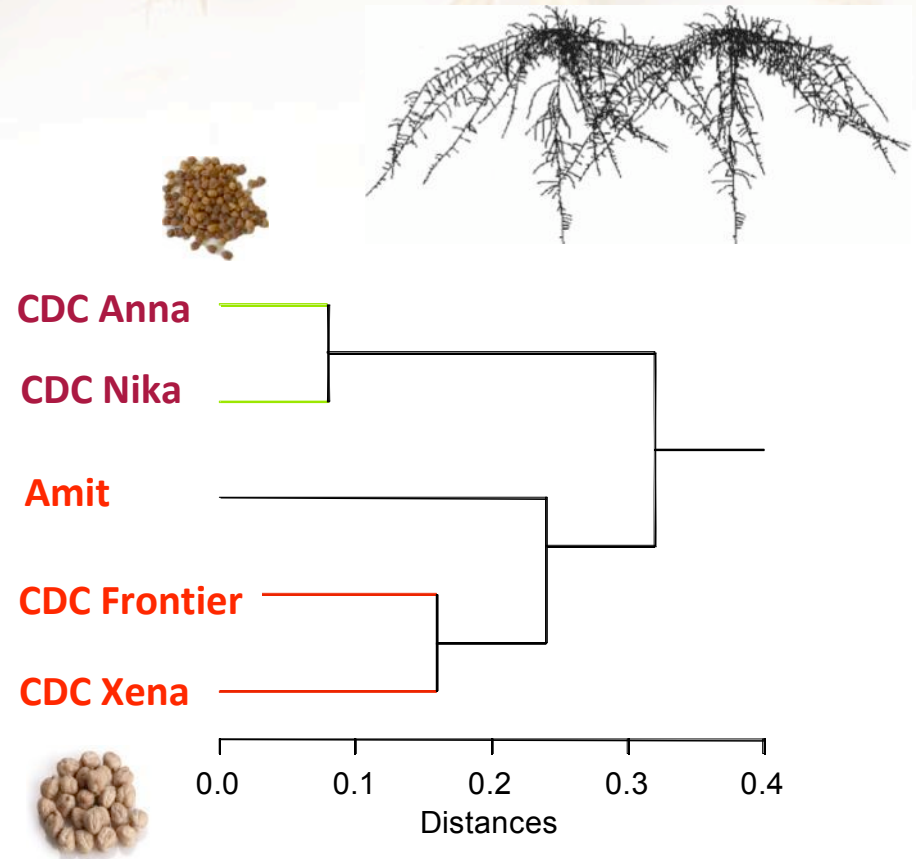
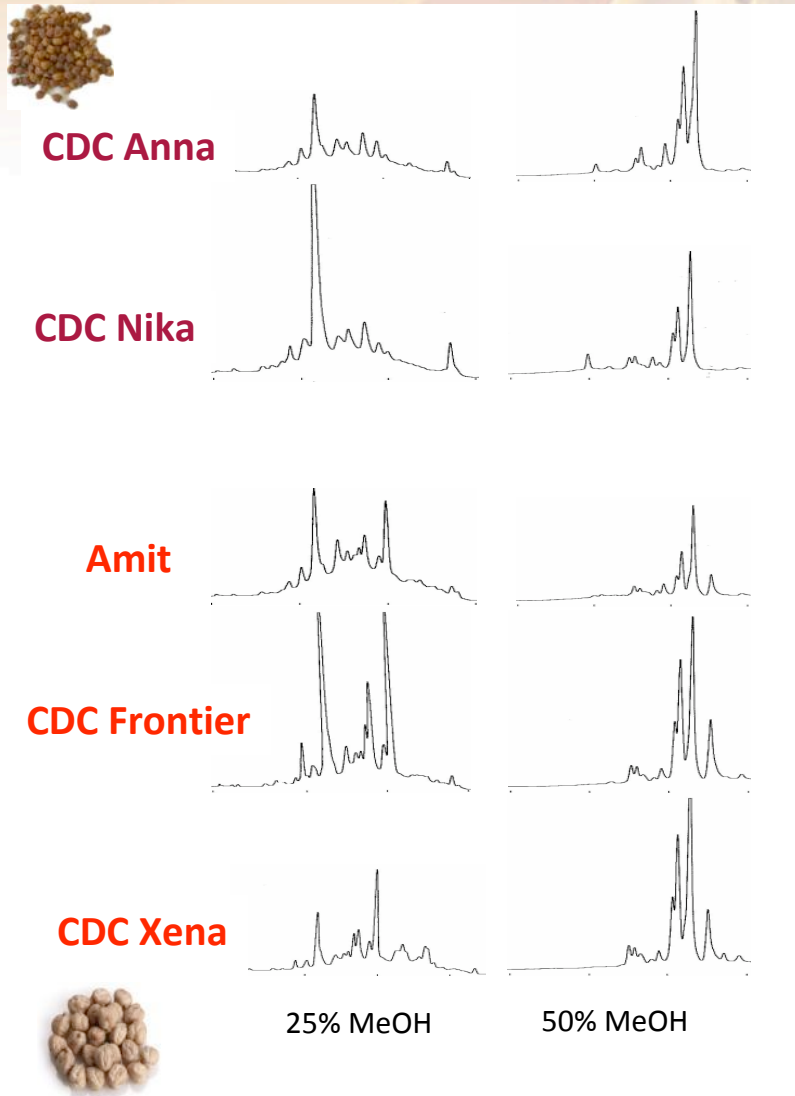
- CDC Anna
- CDC Nika



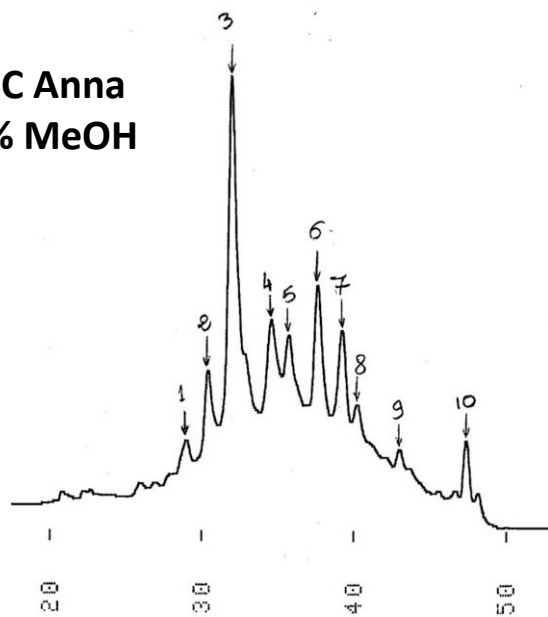
- Calcined clay
- 500 g roots per genotype, no replicates
- MeOH extract
- Flash chromatophy based solubility in MeOH
- HPLC separation
- Bioassay on AM fungi spores



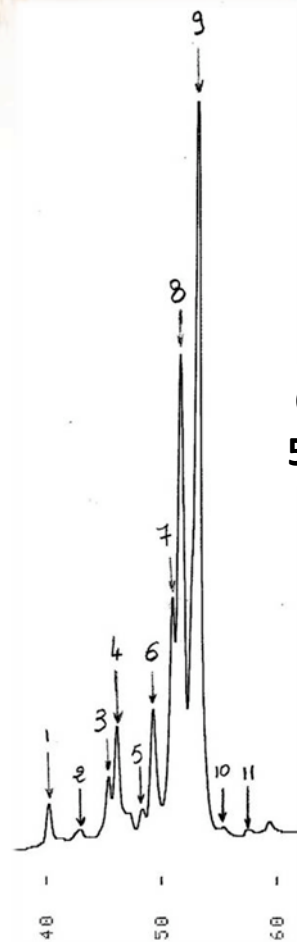
Variations in the composition of chickpea bioactive root extract fractions, as shown by HPLC profiles and UPGMC clustering



**CDC Anna
25% MeOH**



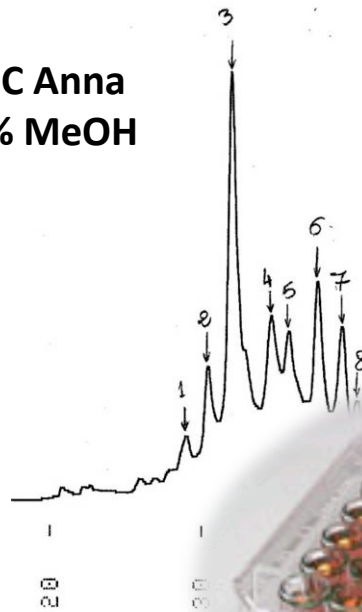
**CDC Anna
50% MeOH**



Assess the bioactivity of HPLC fractions on AM fungi

21 peaks were collected and assayed

CDC Anna
25% MeOH



0.0 g
0.1 g
0.5 g
1.0 g

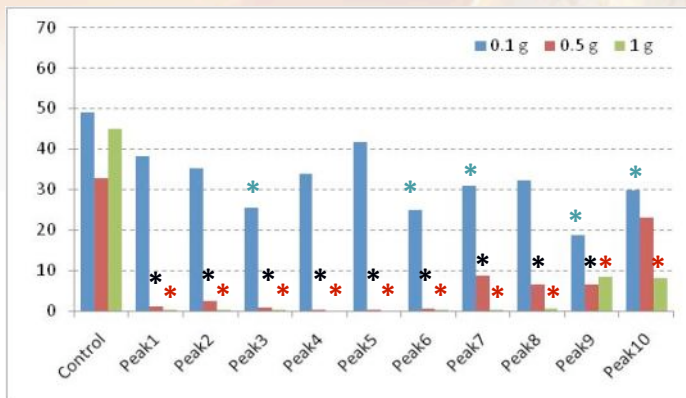
CDC Anna
50% MeOH



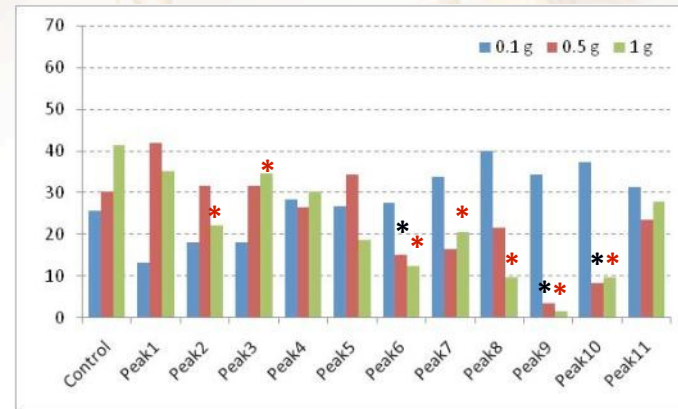
% inhibitory effect of HPLC fractions on AM fungi spore germination

($P < 0.007$)

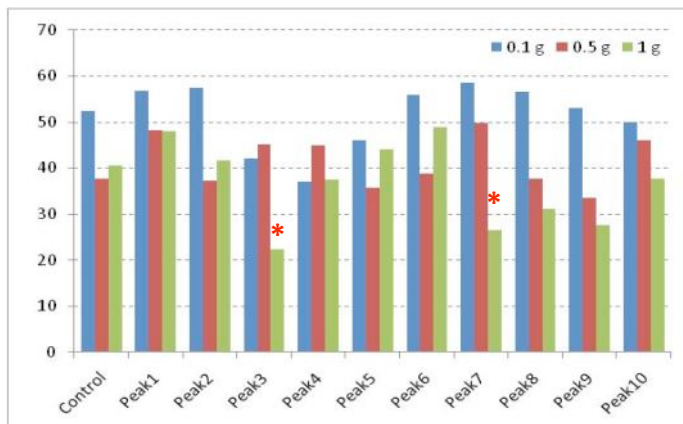
G. etunicatum 25% MeOH



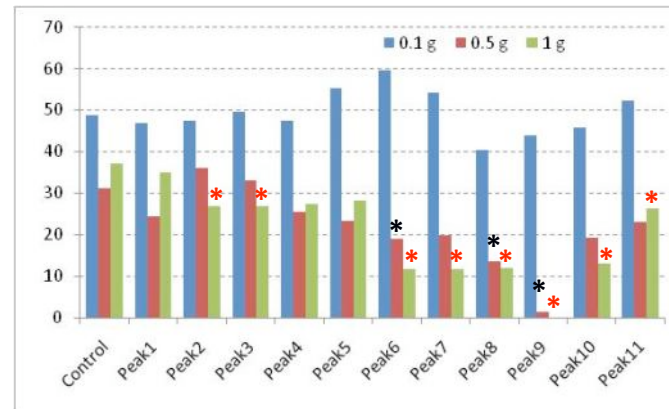
G. etunicatum 50% MeOH



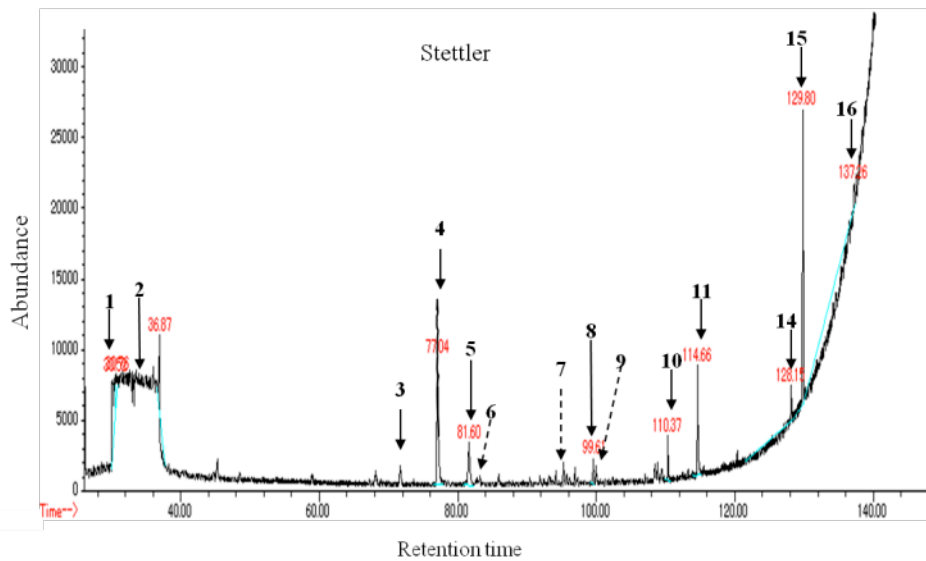
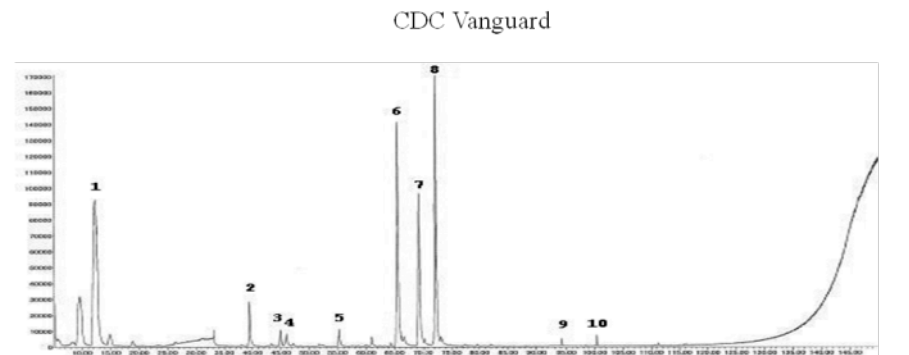
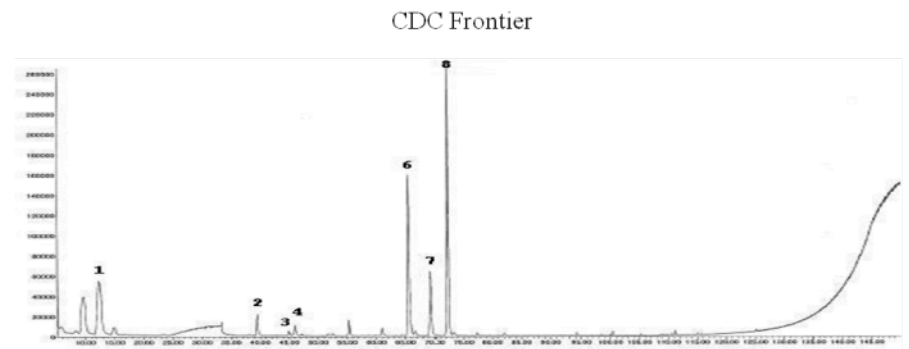
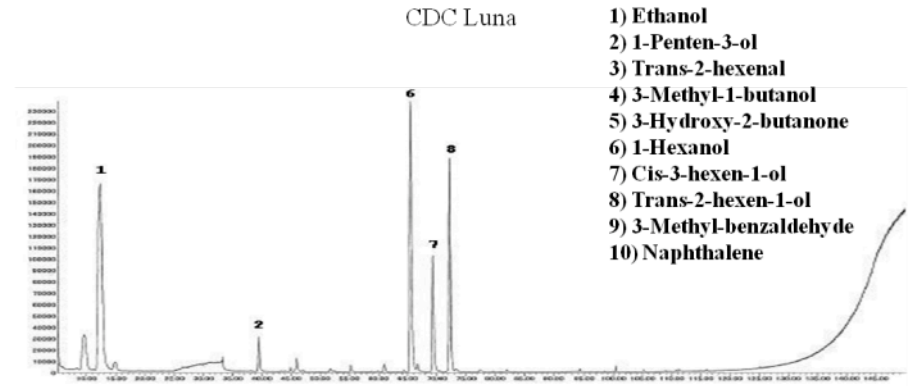
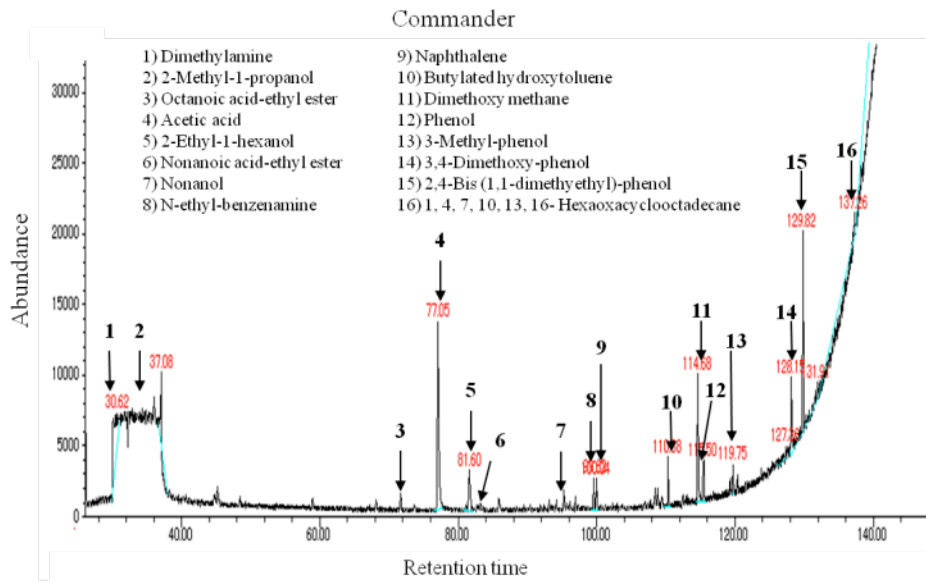
Gi. rosea 25% MeOH



Gi. rosea 50% MeOH



GC-MS analysis of wheat and chickpea volatiles phytochemicals



Seeking potency against *Fusarium*

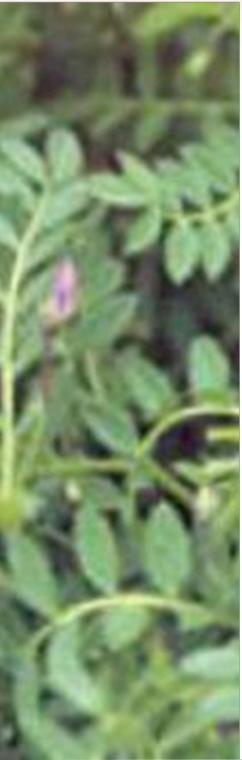
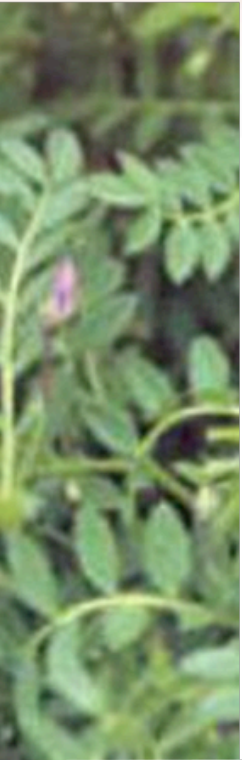
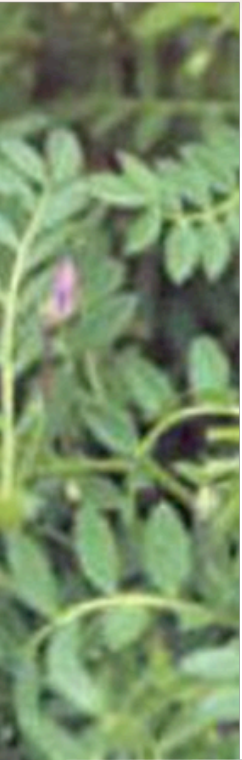
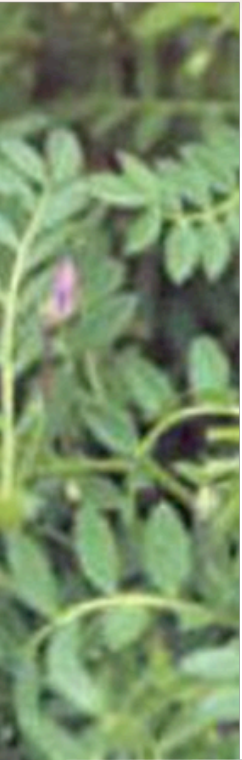



Fusarium graminearum
Fusarium avenaceum

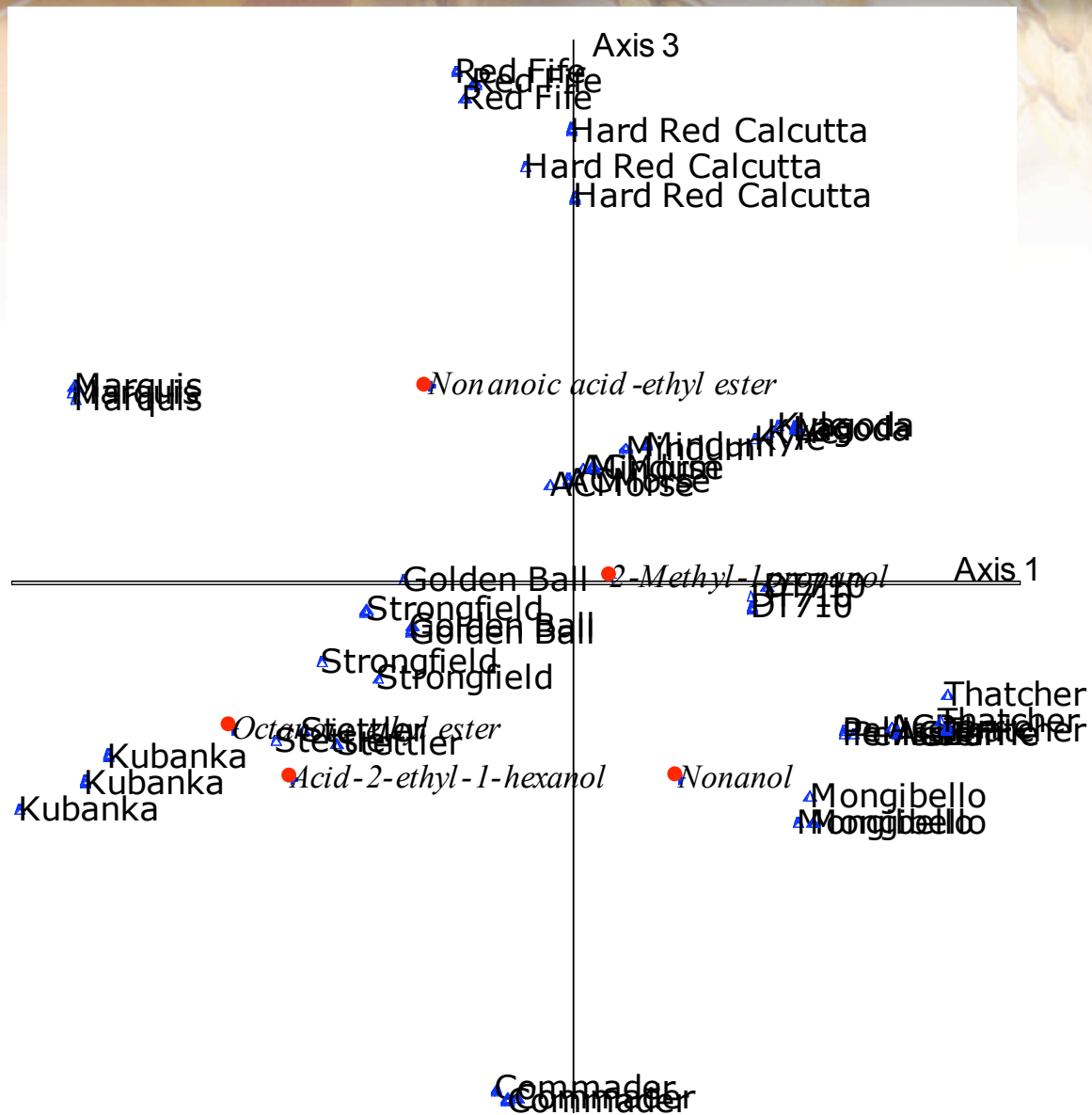
0, 2, 10, 50 μ L

Fusarium inhibition by volatiles from chickpea and wheat

Radial growth as % of control

	Amount (μL)	<i>F. avenaceum</i>	<i>F. graminearum</i>	
	Cis-3-hexen-1-ol	2	99	87
		10	86	75
		50	0	0
	1- Hexanol	2	92	93
		10	0	81
		50	0	0
	Trans-2-hexenal	2	0	45
		10	0	0
		50	0	0
	Trans-2-hexen-1-ol	2	0	88
		10	0	14
		50	0	0
	2-ethyl-1-hexanol	2	24	16
		10	0	0
		50	0	0

Application: Have crops produce appropriate phytochemicals



In summary

- Efficiency of fertilizer use must increase
- Pathogens reduce / PGPM raise fertilizer use efficiency
- Seeking a 'stick and carrot' strategy to improve crop microbial environment we found:
 - i) phytochemicals inhibiting AM fungi germination
 - ii) phytochemicals inhibiting *Fusarium* growth
- Phytochemicals are tools to raise fertilizer use efficiency



Research team and sponsors



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Thank you for your attention



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