Investigation of the antifungal properties of garlic: A prospective bio-pesticide for food crop protection

Stella Kounadi[a], Ian Clark[b], Murree Groom[c] and Chris Hamilton[a]

[a]School of Pharmacy, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, [b]School of Biological Sciences, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, [c]ECOspray Ltd., Grange Farm, Hilborough, Norfolk IP26 5BT.

s.kounadi@uea.ac.uk

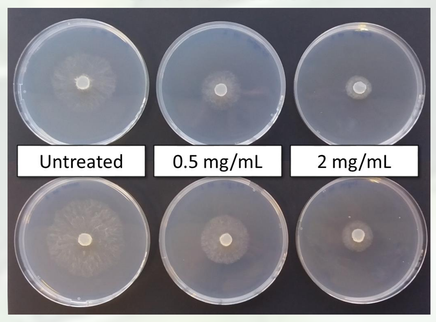
Abstract

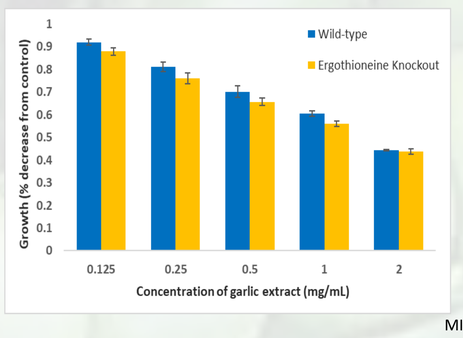
Garlic is a popular cooking ingredient but also renowned for its health benefits and antimicrobial properties. It contains a number of organosulfur compounds, called diallyl polysulfides (DAS), with interesting biological activities, however their exact mode of action is not yet fully understood. Garlic bioactives are used for agricultural protection and they consist a natural solution with no risks for the environment or human health. Herein, we investigate the mode of action of garlic-derived diallyl polysulfides in fungal plant pathogens.

Mode of action of garlic actives

Garlic polysulfides are known to have antifungal activity. Herein, we aim to elucidate the mode of action of each polysulfide using the model organism *Neurospora crassa*. Polysulfides are known to react with low molecular weight (LMW) thiols once they get inside cells, causing oxidative stress. Fungi produce a unique LMW thiol, called Ergothioneine, which possibly reacts with garlic polysulfides. Here, we use a wild-type strain and an Ergothioneine Knockout strain of *N. crassa* in order to study the effect of DAS.

Garlic extract treatment



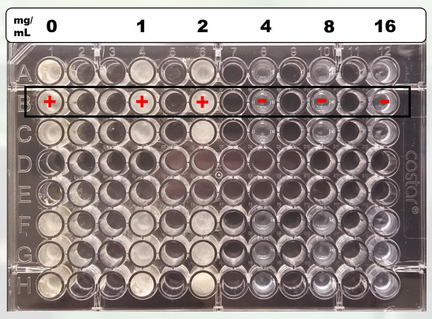


N. crassa wild-type	MIC	MFC
DAS2	4	4
DAS3	0.5	1
DAS4	0.25	0.5
DAS5	0.125	0.25
DAS6	0.25	0.25

N. crassa EGT knockout	MIC	MFC
DAS2	4	4
DAS3	1	1
DAS4	0.25	0.5
DAS5	0.25	0.5
DAS6	0.25	0.5

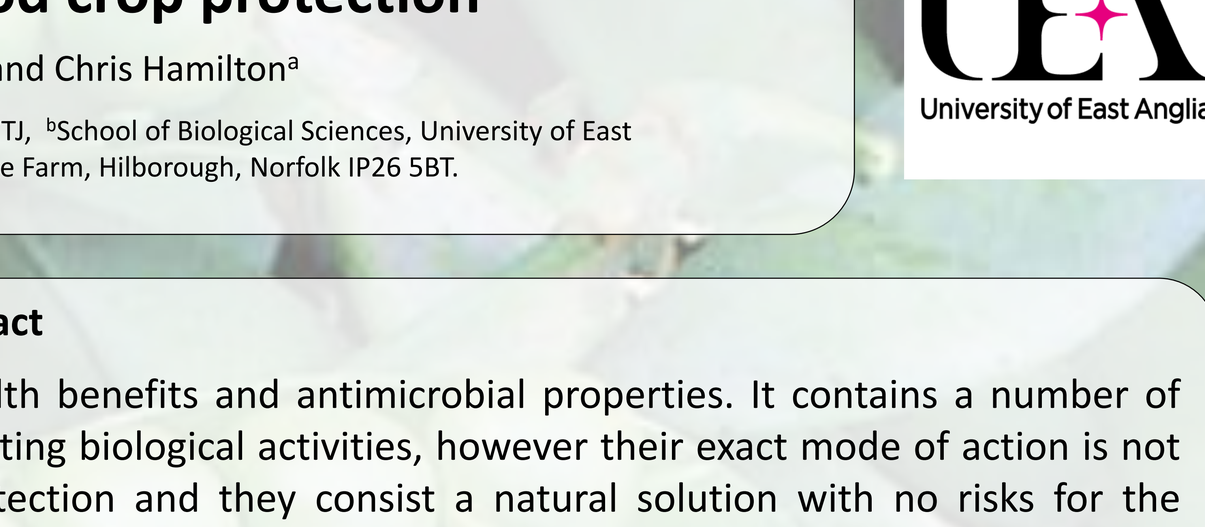
MIC=Minimum inhibitory concentration
MFC=Minimum fungicidal concentration
(mg/mL)

DAS2 treatment



- Garlic extract delays the growth of *N. crassa*
- Decrease in growth is higher in Ergothioneine knockout than in wild-type
- Polysulfide potency depends on polysulfide chain length

Organosulfur compounds of garlic



Antifungal effect of garlic extract for pea crop protection

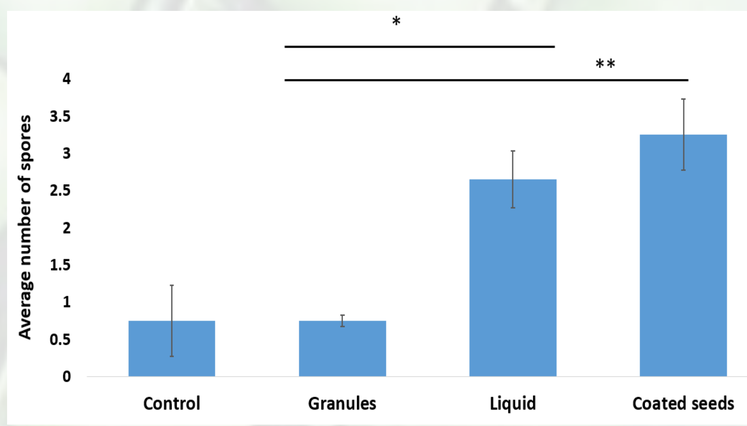
Soil borne diseases caused by fungal plant pathogens consist a real threat for pea production. They spread rapidly causing stunted growth and eventually lead to losses in crop yield and extensive economic damage.

Healthy and diseased pea crops

Garlic extract for pea protection

In order to study the effect of garlic extract against soil pathogens, we conducted a pea pot experiment. A commercial variety of pea seeds was planted in soil collected from a diseased pea crop with poor yield. Two different formulations of garlic extract (Granules and Liquid) were tested in various concentrations and time points.

* Treatments are equivalent to granules treatments
** Seeds were soaked in 4% w/v solution of Nemguard SC for 1 hour before planting



The treatments include granules, liquid and coated seeds.
Each treatment was tested in 4 replicates.

- Garlic extract substantially resulted in germination of more pea seeds in treated pots compared to control
- The liquid formulation was more efficient than the granules (p value=0.0005)
- The coated seeds treatment was more efficient than the granules (p=0.0109) but not significantly different than the liquid treatments

Acknowledgements

This work is funded by a BBSRC Industrial Case studentship and Ecospray Ltd (2017-2021)

References

(1) Block, E., (Ed.) (2010) Garlic and other Alliums, The Lore and the Science, RSC Publishing, Cambridge.

(2) Münchberg, U., Anwar, A., Mecklenburg, S., and Jacob, C. (2007) Polysulfides as biologically active ingredients of garlic, Organic & Biomolecular Chemistry 5, 15051518.

(3) Lawson, L. D. (1993) Bioactive organosulfur compounds of garlic and garlic products - Role in reducing blood-lipids, Acs Symposium Series 534, 306-330.