Beneficial Soil Microbes

Their function and benefits for incorporation into peat-free growing media

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PlantWorks background

- PlantWorks is a science-based microbe producer based in Kent
- 20 years of experience in tuning and producing mycorrhizal fungi and bacteria
- Extensive trials in the UK and Europe (including independent registration trials in Hungary)
- PlantWorks is one of the largest producers of Mycorrhizal fungi in Europe and one of the largest producers of beneficial bacteria in the UK

CORE TECHNOLOGIES:

Fungi: Mycorrhizal Fungi (AMF)

Bacteria: Plant Growth Promoting Rhizobacteria (PGPR)

IMPROVED SOIL BIOLOGY

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IMPROVED NUTRIENT USE EFFICIENCY (NUE)

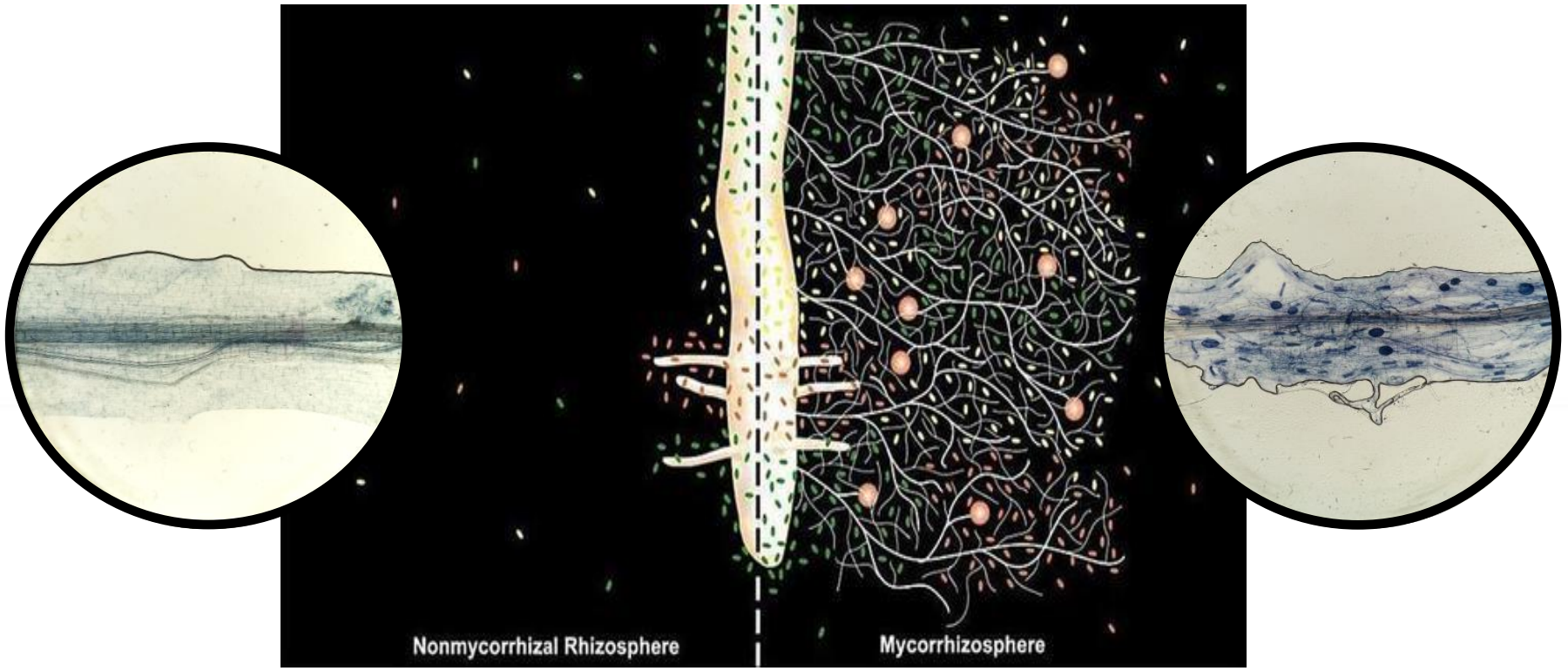
Microbiology in action

1 2 3 4 5

<u>Inoculation conditions</u>

1. No inoculation – negative control
2. *<u>Sterilised</u>* AMF inoculum
3. PGPR granule only
4. AMF granule only
5. AMF and PGPR

What is plant efficiency?

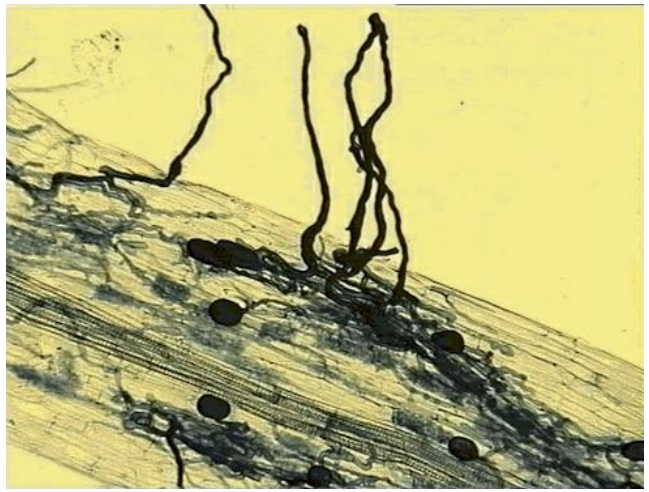


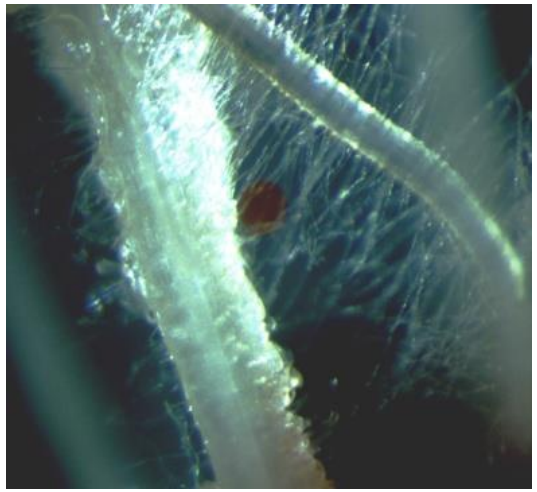
700 X effective root area

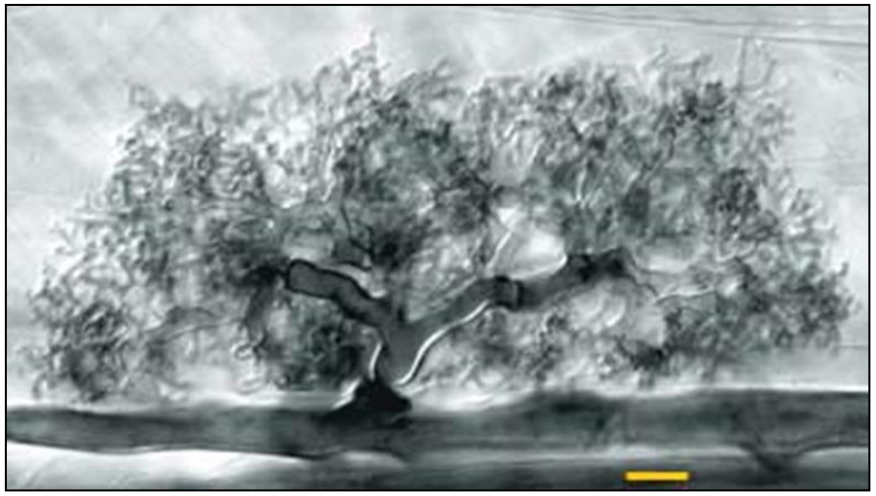
Arbuscular mycorrhizal fungi (AMF)

Symbiotic association between a fungus and the roots of a plant

Obligate mutualistic symbiosis with >80% vascular plant families including grasses

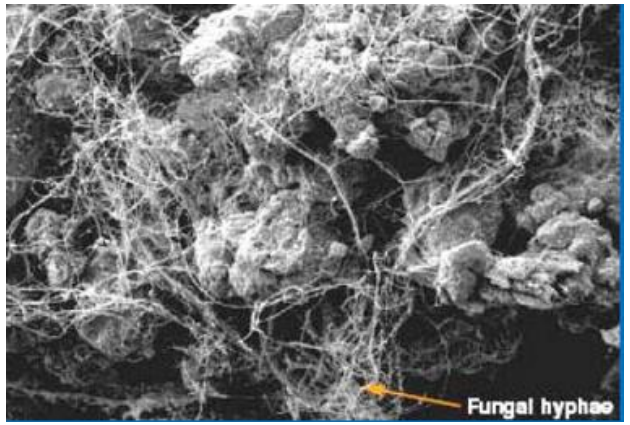


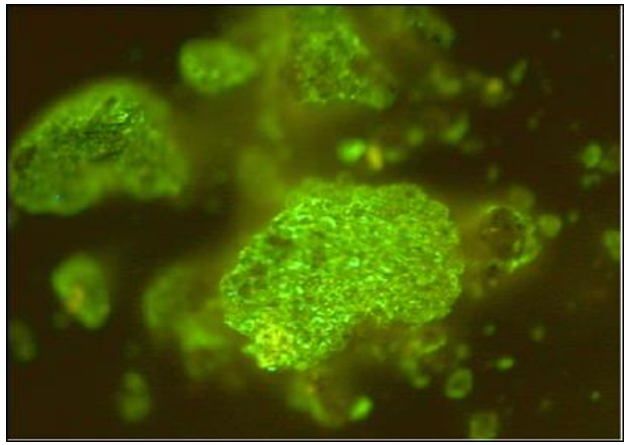




Arbuscular mycorrhizal fungi:

Sticky substance, glomalin (fluorescent green), produced by mycorrhizal fungi helps in soil aggregation and contains of 1/3 of carbon in the soil



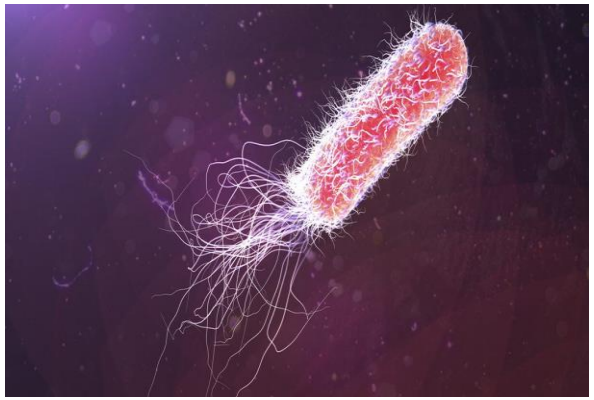


Effects of mycorrhizal fungi to their hosts

- Improves establishment and early growth
- Can reduce irrigation and chemical fertiliser application
- Higher resilience to drought and other stresses
- Improves nutrient uptake making plant more efficient
- Increased carbon lock up – Glomalin

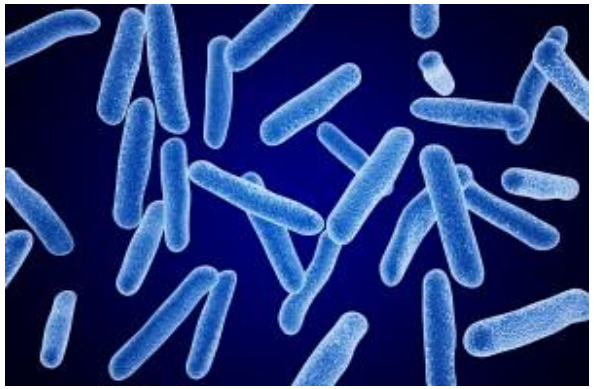
Plant growth promoting rhizobacteria (PGPR)

Bacillus



Pseudomonas

Rhizobium



Azotobacter

Plant growth promoting bacteria (PGPR) *functions*

Enhanced nutrition

- N-fixation
- P-solubilisation
- Increased iron uptake

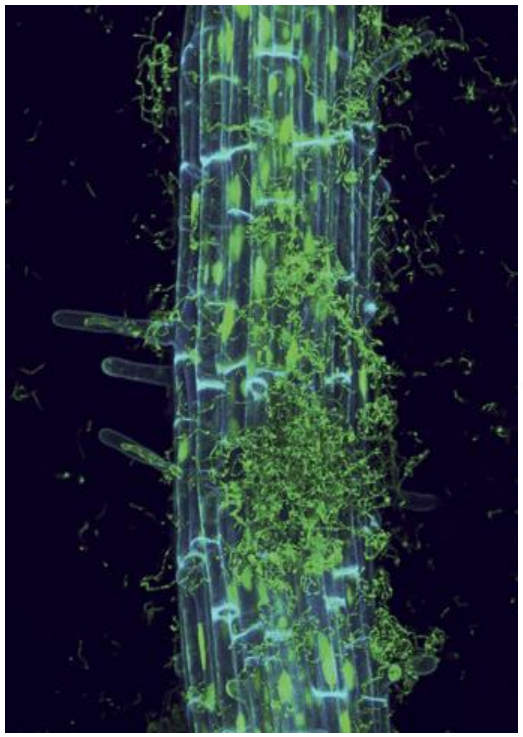
Plant protection

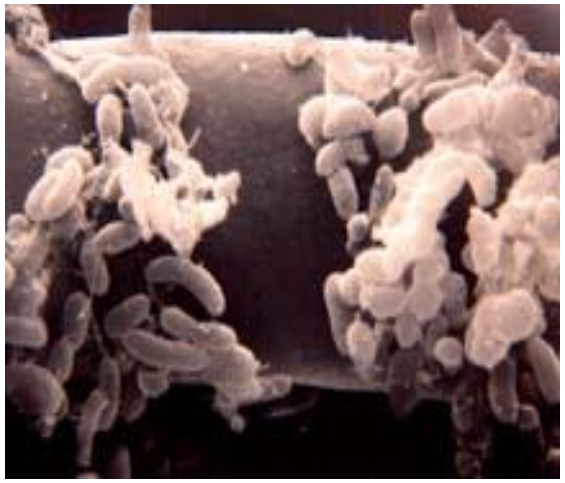
- Competitive exclusion of pathogens
- AMF helper
- Induced systemic resistance

Crop development

- Phytohormone production – stimulating top growth and root development

Rhizosphere bacteria on a root





PGPR and their functions

PGPR consortium	
PGPR ID	**Known plant growth promotion mechanisms**
Bacillus amyloliquefaciens (B)	N fixer, gibberellin, P-solubiliser, K-solubiliser, cytokine and auxin producer, ISR inducer, phychelator producer, etc.
Rhizobium laguerreae (H)	N fixer, P-solubiliser, cytokine and auxin producer, ISR inducer, phychelator producer, etc.
Phyllobacterium brassicacearum (I)	N fixer, P-solubiliser, cytokine and auxin producer, ISR inducer, etc.
Azospirillum brassilense (A)	N fixer, cytokine and auxin producer, ACC deaminase and ABA producer, ISR inducer, etc.
Rhizobium (Agrobacterium) strain (F)	An endophytic N fixer, cytokine and auxin producer, ACC deaminase producer, ISR inducer, etc.

How can PGPR help improve peat-free performance?

Challenges	PGPR mitigation
Higher pH than peat media	• Production of the organic acids • Plant roots' uptake of ammonium ions (from N-fixation)
Higher conductivity than peat media	• N-fixers • P, K, Zn solubilisers • Nutrients recycling - therefore, reducing the base level of NPK requirement
Leach nutrients more readily	• More microorganisms generally results in increased carbon content • Bacteria, being at the bottom of the food chain serve as an important sink for NPK elements, as they support the fungal and larger microorganism populations at the top of the food chain that play vital roles in decomposition and nutrient recycling
Lacking beneficial microbes – susceptible to various stresses	• Competitive exclusion of pathogenic microbes • Induction of systemic resistance to biotic and abiotic stresses- ACC deaminase, abscisic acids

Proving PGPR efficacy in peat-free media

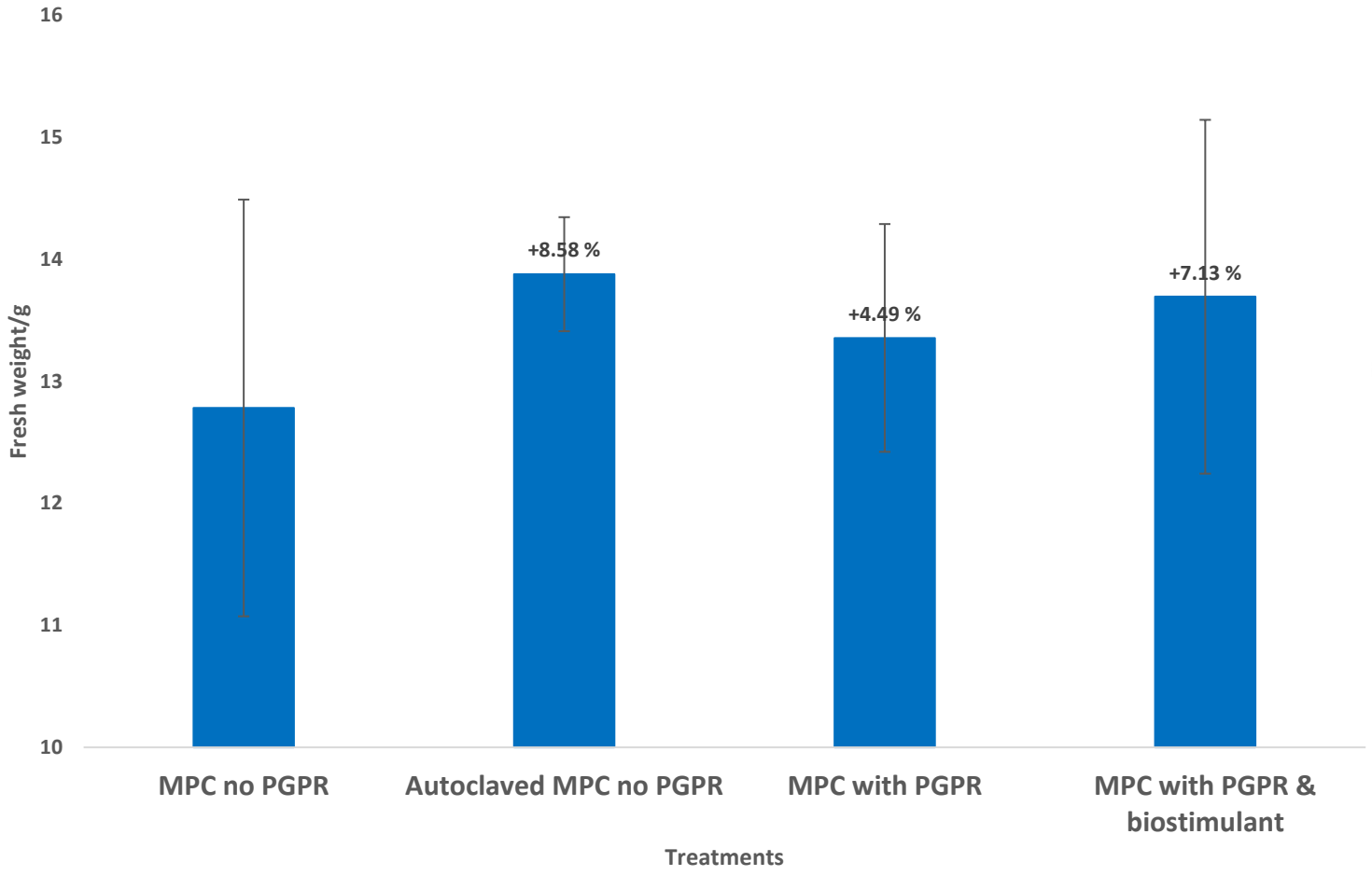
Clover growth exp set up Experimental set up

Treatment reference	Treatment	Clover	Number of replicates	Replicate reference
1	MPC no PGPR	1g	6	a,b,c,d,e,f
2	Autoclaved MPC no PGPR	1g	6	a,b,c,d,e,f
3	MPC with *PGPR	1g	6	a,b,c,d,e,f
4	MPC with *PGPR + **biostimulant	1g	6	a,b,c,d,e,f

*10^8cfu of PGPR per litre of compost

** 0.1ml liquid Biostimulant per litre of compost

Clover growth exp Observations



Clover growth exp Observations

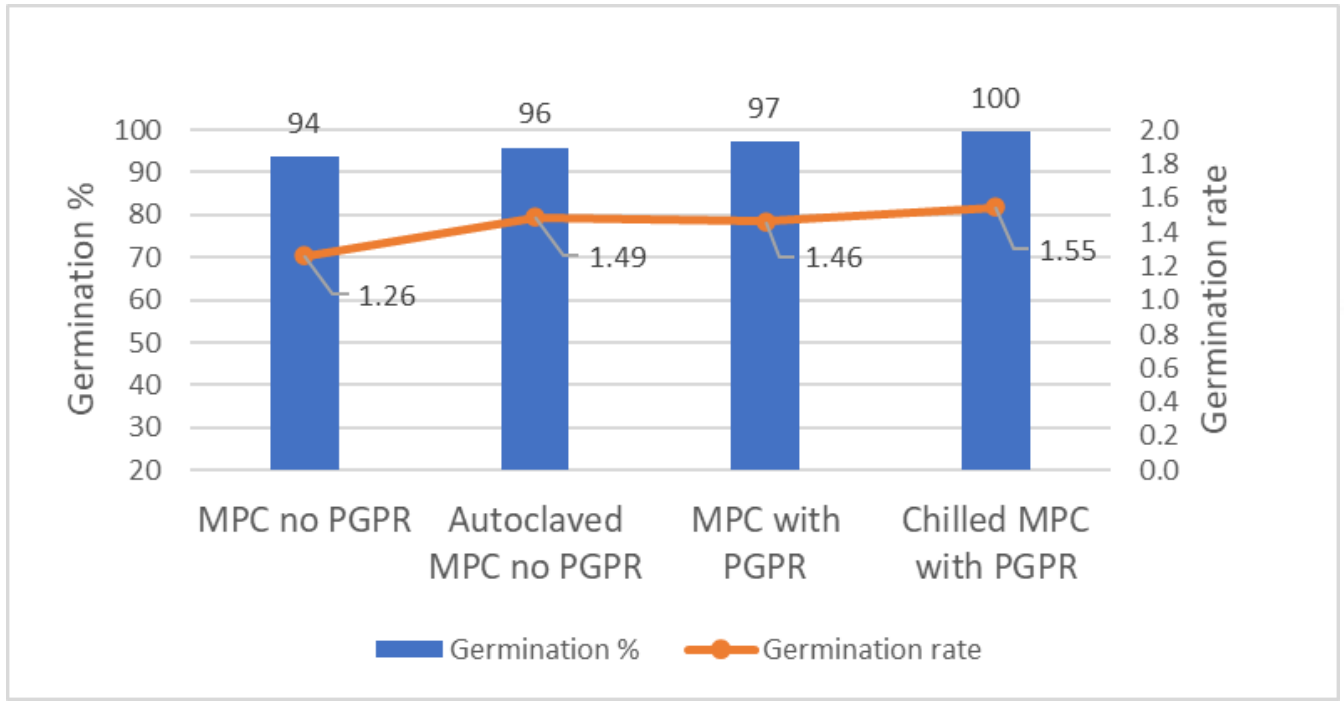
- PGPR treatment yielded heavier plant biomass – *due to phytohormone production, improvement of NPK availability and acquisition, organic acid production etc.*
- Biostimulant and PGPR treatment yielded heaviest plant biomass
- Plant based biostimulant also serving as nutrients for bacterial establishment

Methods of delivery

- Liquid formulation in sterile bags
- Can be applied to inert carriers such as perlite for mixing into media
- Spray directly onto media at production or mixing stage
- Spray onto crops in growing unit – tests underway to look at effects when mixed with adjuvants
- Apply through irrigation lines via Dosatron

Can PGPR survive and function after months of storage in peat-free media

Onion seed germination 3 months after inoculation



- PGPR promoted better germination % and rate in the first 3 months after bacterial treatment - *due to the production of phytohormones*
- The impact of PGPR on germination rate was significantly greater under warmer temperature

Statistics: $P<0.05$ was observed between MPC no PGPR vs other treatments in both germination % and rate except with the germination % of the Autoclaved MPC no PGPR.

Results of trial research

PGPR Growth development on carrot

- Treated carrots show more uniformity
- Higher crop weight
- More saleable yield
- Improved stress resistance

Results of trial research

PGPR growth development in tomatoes

PGPR treated plants yielded 7.9% increase in total yield of fruit compared to the untreated control, with 5.5% increase in the total number of fruit

Results of trial research

Cyclamen – Hort Week Report Extract:

Sowing sustainability: Fargro and Ferring Nurseries' peat-free triumph 9 October 2023

While, organic fertilisers arrive as part of a complex organic matrix, tightly bound and less susceptible to leaching. Yet, the nutrients they contain are not immediately accessible to the plant. Instead, soil microbes play a critical role in breaking down organic fertilisers into their mineral form, which the plant can then absorb. Importantly, this microbial activity closely aligns with the plant's metabolism, ensuring that nutrition was available when needed. This synchronisation minimises the risk of root burn and encourages the development of a robust root system.

Summary

- PGPR are probably the most relevant organisms to consider
- PGPR proven to the stable in peat-free media
- Easy delivery to media predelivery to site or through irrigation
- Improves uniformity of crop
- Increases germination rate
- Direct effect on NUE

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