A. Macagnano[1,2], G. Scarascia-Mugnozza[2], F. De Cesare[2,1]

A MODEL OF ELECTROSPUN POLYMER SYSTEM FOR SUSTAINABLE AGRICULTURE

Email: antonella.macagnano@cnr.it

AIM: designing a model to both preserve the soil ecosystem and develop resource-efficient, green and competitive approaches for agricultural systems based on the use of eco-sustainable materials.

CONCEPT: providing iron-chelating molecules to the plants surrounding environment according to natural principles in order to make available the insoluble iron (Fe III), since the limitation of iron accessibility is a crucial condition in plant nutrition.

PROPOSAL: testing properly designed nanofibrous polymer fabrics mimicking the nongraminaceous and graminaceous species strategies in capturing Fe, based on electrospun bio-derived and biodegradable nanofibrous textiles, capable of delivering two kinds of natural iron-chelators into soil/water by controlled rates (depending on the membrane morphology).

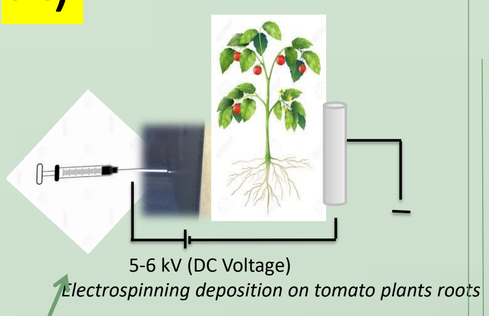
Eco-compatible (biodegradable and biocompatible) nanofibrous smart fabrics with potentials in promoting plant growth

Biostimulants → ***Nutrient-mobilizing molecules***

Mugineic Acid to Plants
phytosiderophore extracted from root exudates of selected cultures of graminaceous plants - barley

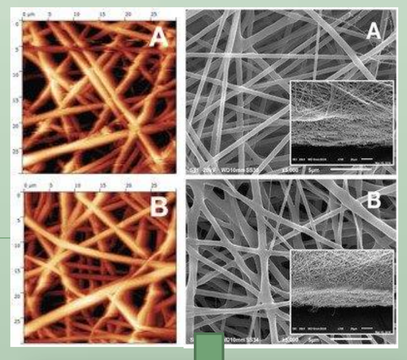
Cathecol to Plants
molecule produced by bacteria such as Rhizobium RA-I, a symbiont of cowpea

A) **Root coatings**

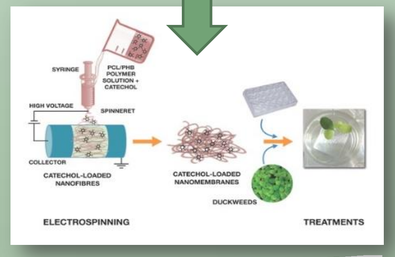


Free-standing fabrics

PHB + PCL



B) **Free-standing fabrics**



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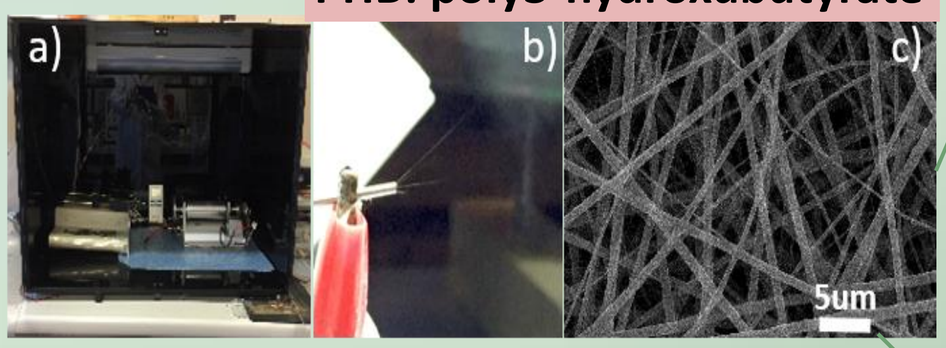
PHB: poly3-hydroxubutyrate



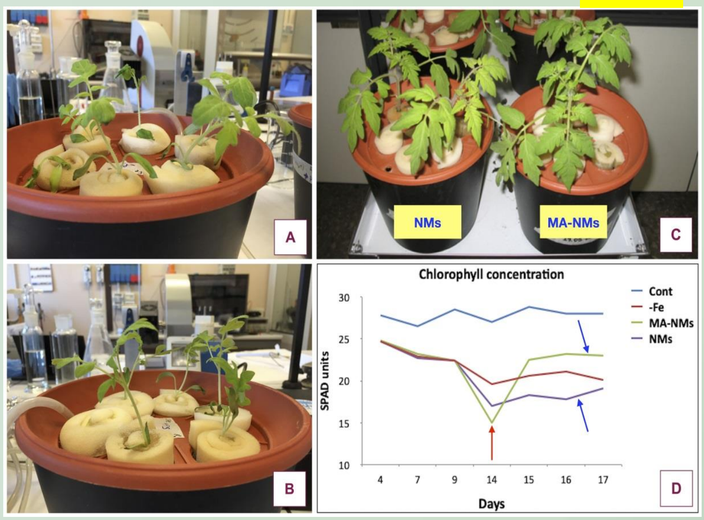
Electrospinning deposition set up, Taylor cone, SEM micrograph of nanofibers

EXPERIMENTS:

The fabrics were designed to be water insoluble, low environmental impact, and thermally resistant.

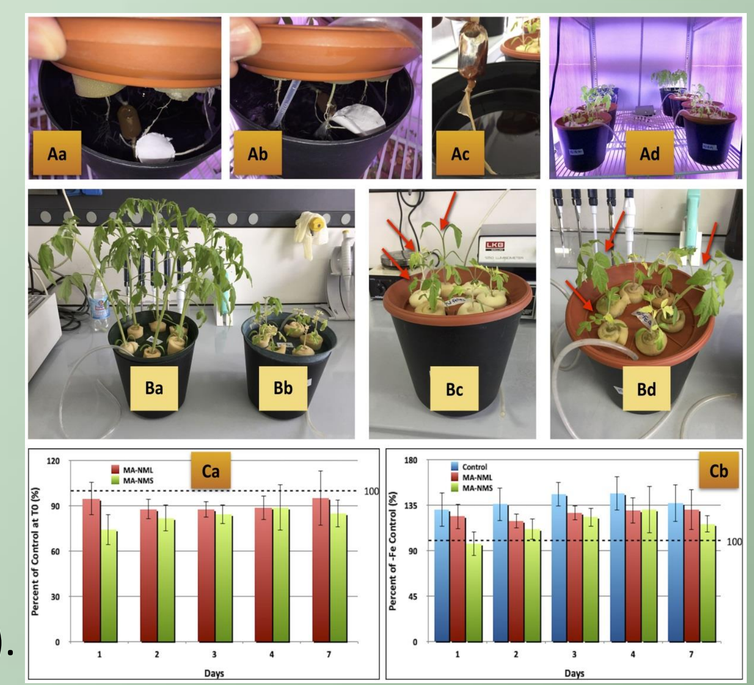
STRATEGIES:

(A)



A)Plants at T0 pre-treated in Fe deficiency and then treated with NMs + Feins (NMs).
B) Plants as in A) but added with MA-NMs + Feins (MA-NMs).
C)Tomato plants soon after treatments: NMs (left), MA-NMs (right).
D)Chlorophyll content of tomato plants measured by a SPAD meter during the pre-treatments and treatments as follows: Cont, -Fe, MA-NMs, and NMs. The red arrow indicates the beginning of treatments (T0). Blue arrows highlight the treatments with NMs in the presence or absence of MA, as in the legend

(B)



(**Aa and Ab**) plants added with 5 cm and 10 cm diameter disc-shaped NMs; (Ac) dialysis membrane sack containing the Fe_{ins} ($FeCl_3$) solution; (Ad) tomato plants incubated in a growth chamber.
(**Ba**) totally soluble Fe (Control); (**B**b) -Fe; Bc) MA-NMS; Bd) MA-NML.
Ca) chlorophyll content percent relative to Control at T_0; **Cb**) Percent relative to -Fe samples at the same date.

The effectiveness and toxicity of both functional systems mimicking Strategy I and II concepts and dynamics were tested in two different plant cultures.

PERSPECTIVES

Such sustainable agricultural practices based on the use of natural sources and waste, followed by their conversions into new arrangements and applications thanks to electrospinning technology, should improve health and environmental conditions, as required by the original principles of circular economy. Furthermore they could be powerful in improving crop production and consequently contributing in fulfilling the demand by human populations for healthy and safe foods and environment preservation.

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AFFILIATIONS:
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