Wrocław University of Science and Technology

Sprouts enriched with microelements: application of hydrogel fertilizers with controlled release of micronutrients

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Thomas Edison (1847 – 1931)

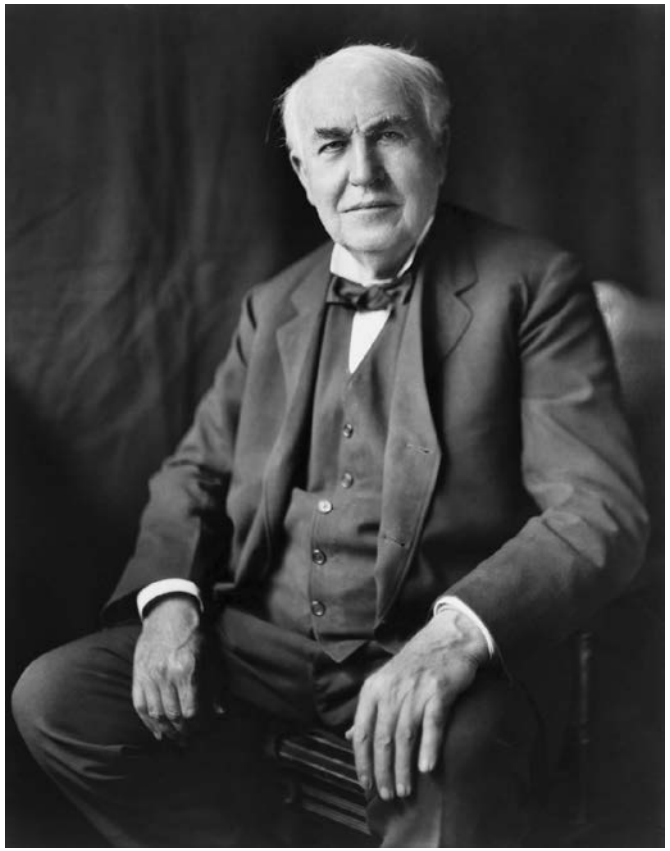


Fig.1 *Thomas Edison*

„The doctor of the future will no longer treat the human frame with drugs, but rather will cure and prevent disease with nutrition”

Problem of hidden hunger

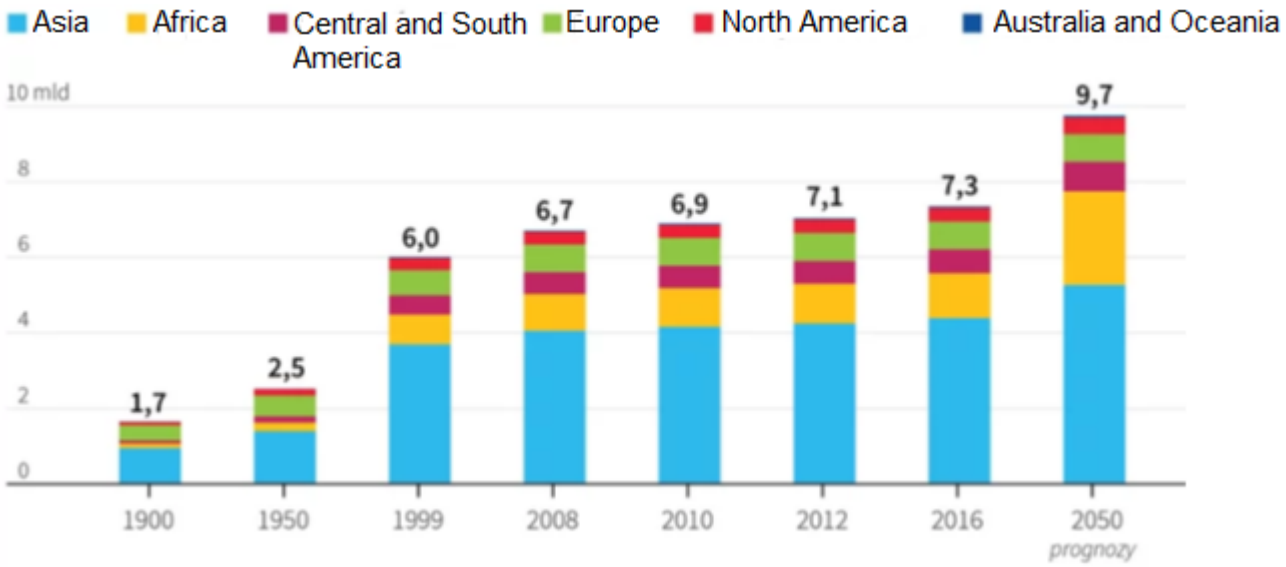


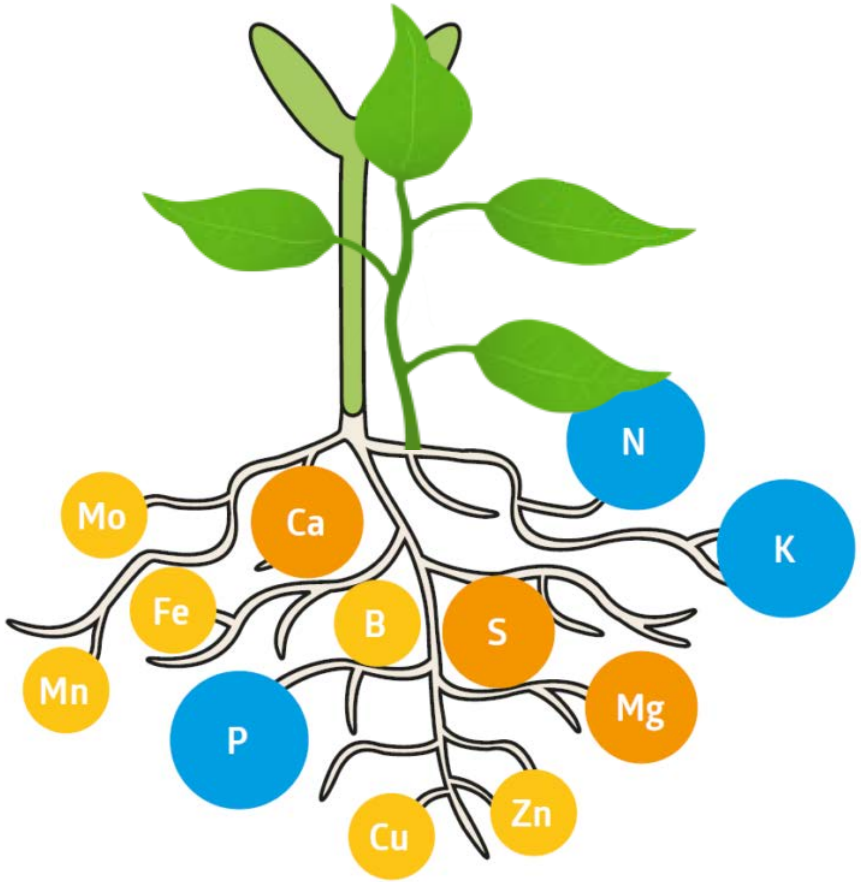
Fig.2 *Population growth worldwide*

1.5 billion people worldwide suffer from micronutrient deficiency

SUPLEMENTATION
(mineral salts or chelates in tablets or drinks)
➢ low bioavailability
➢ absorption less than 10%

Microelements as a key nutrients

Role:
- chlorophyll component
- components of enzymes
- are involved in photolysis
- inactivate free radicals
- participate in gene expression
- regulate metabolic pathways
- regulate macronutrient intake

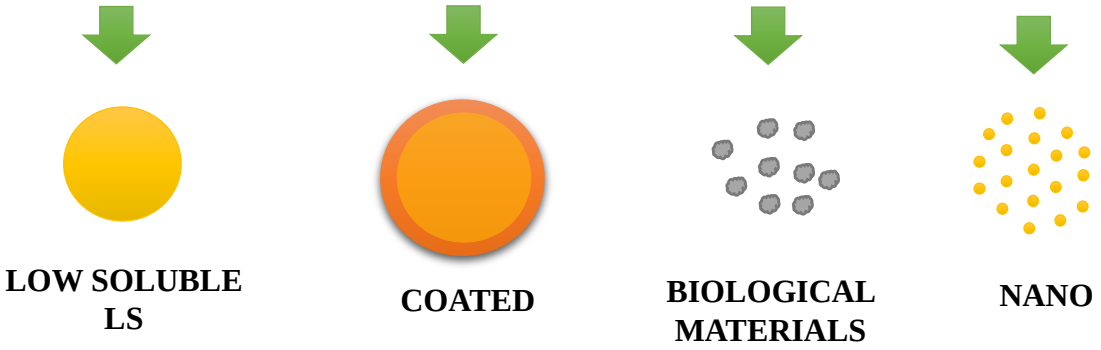


Deficiency:
- chlorosis
- reduced yield
- stem deformations
- stem and flower dying
- seed formation defects

Innovations in plant fertilization

PRECISE FERTILIZATION → **RELEASE OF COMPONENTS DEPENDING ON THE PLANT GROWTH STAGE**

CONTROLLED/SLOW-RELEASE FERTILISERS



LS – release depending on atm conditions.;

C – synthetic polymer coating;

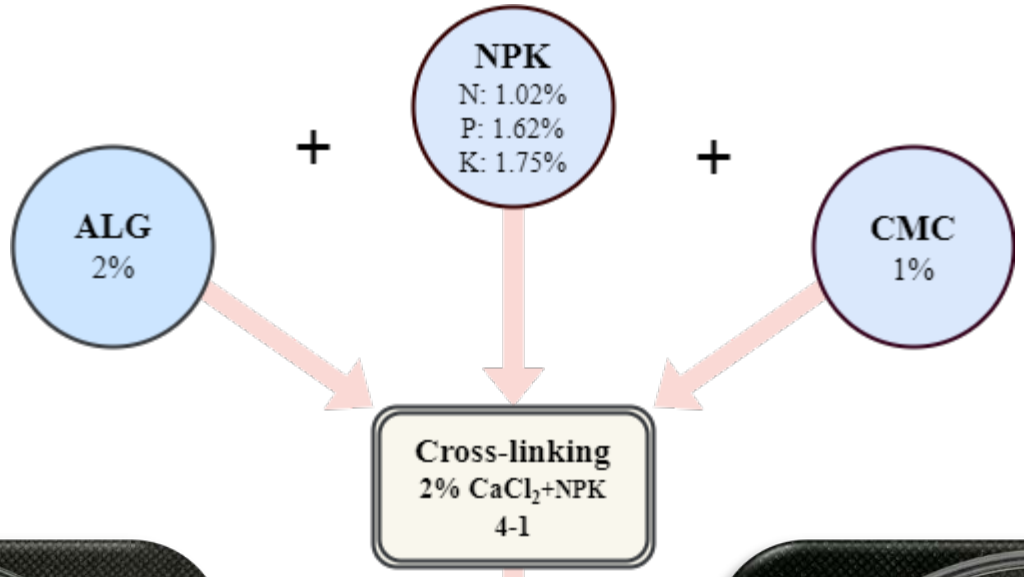
MB – no 100% control over the release of nutrients;

NN – complicated production procedure; high process costs;

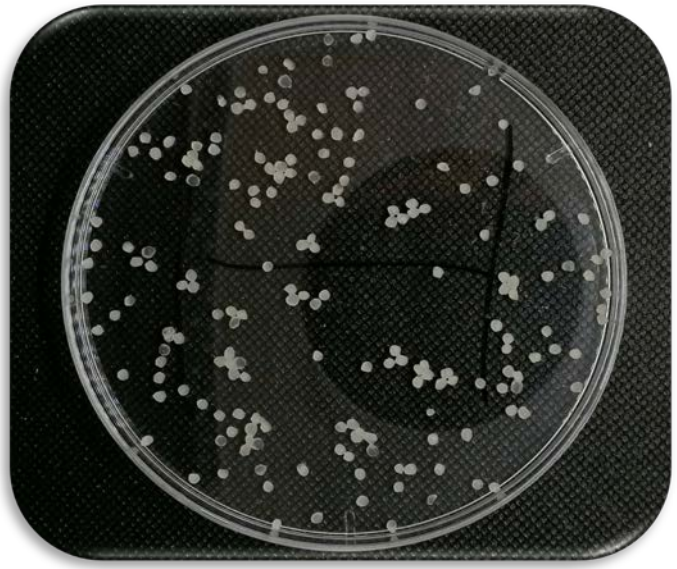
Hydrogel fertilizers

based on sodium alginate (ALG) and carboxylmetyhlocelulose (CMC)

Aqueous solutions:



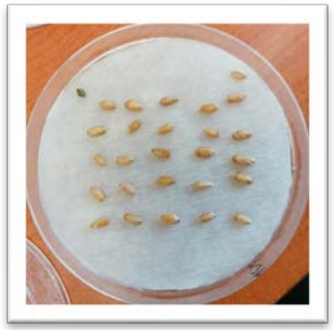
Wet hydrogel fertilizer - after cross-linking



Dry hydrogel fertilizer - after the drying process

Germination Tests

In order to check the effectiveness of hydrogel fertilizers, germination tests were carried out on wheat.



Wheat germ measurements after 7 days

7 days

Tab. 1. *The composition of the elements in plants*

Sample	N	K	P
[-]		[%]	
Liquid fertilizer -NPK	3,92	1,34	0,56
50%*	3,66	1,00	0,42
75%*	4,04	1,21	0,50
100%*	3,87	1,27	0,52
200%*	4,19	1,69	0,58

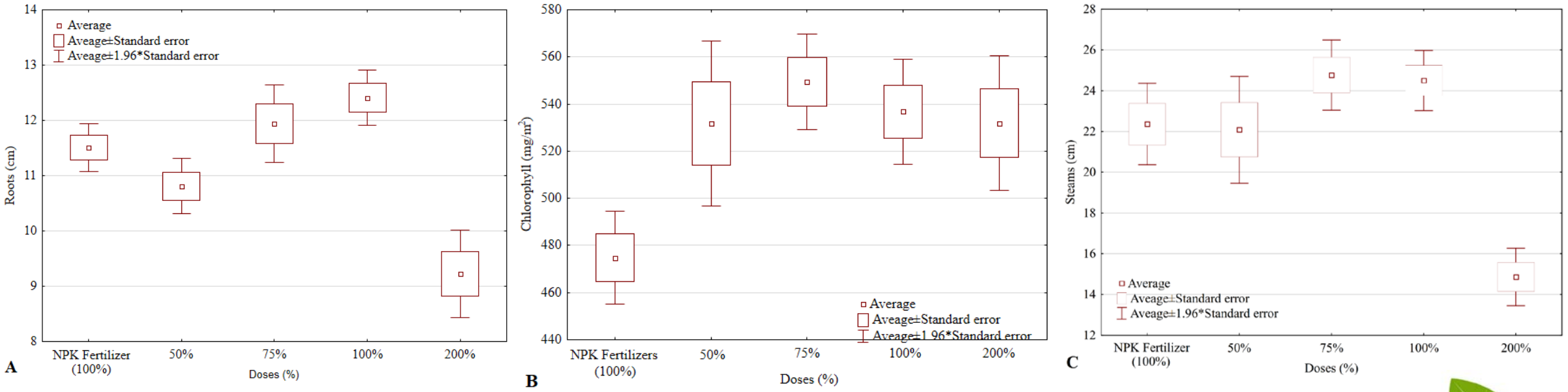
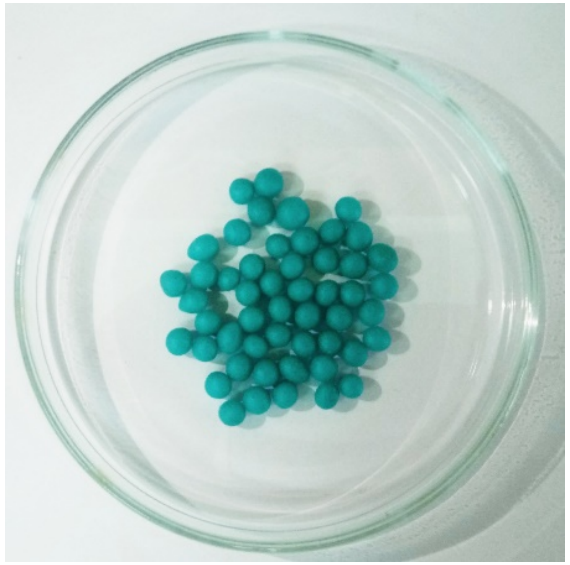


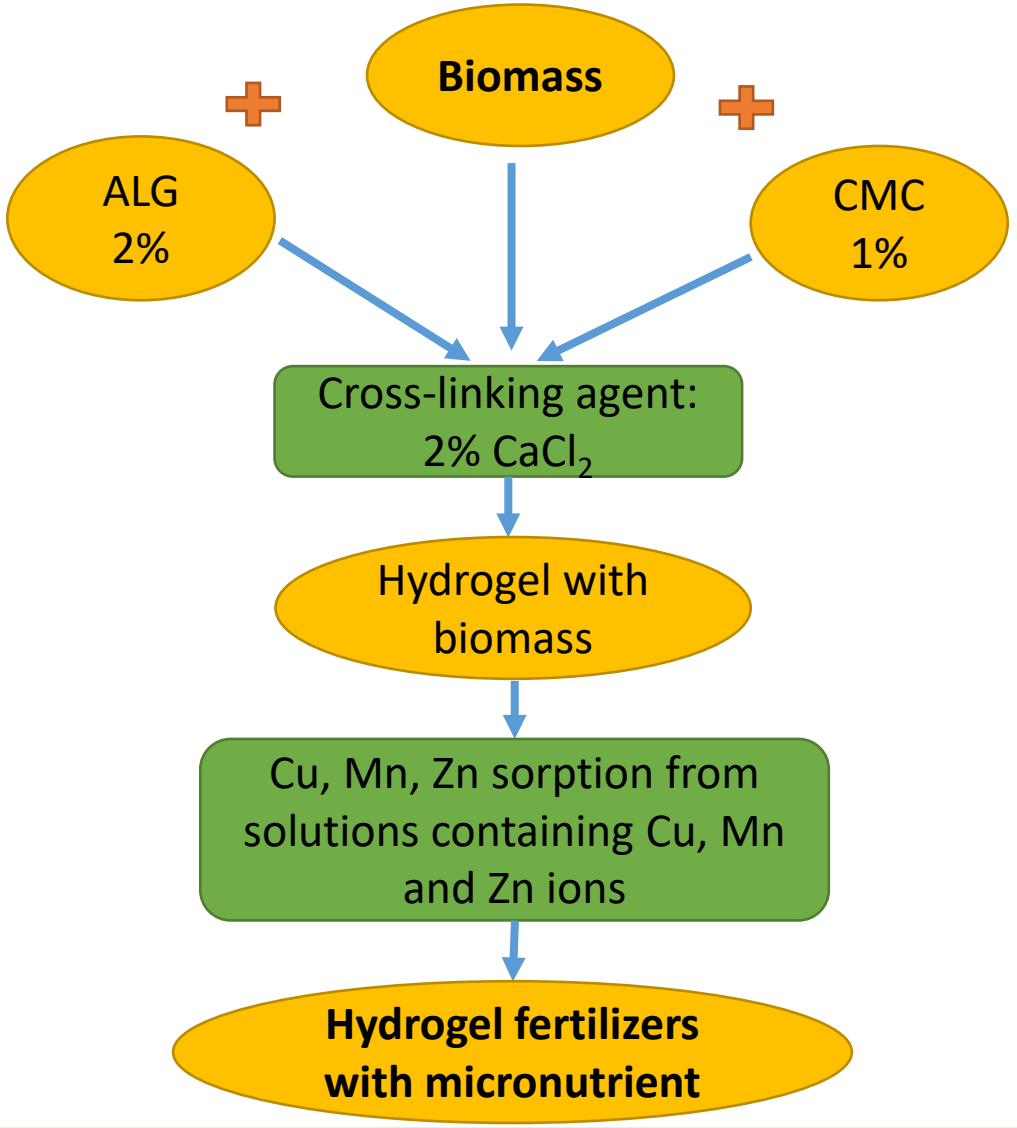
Fig. 3. *Plant growth parameters: root length (A), chlorophyll content (B), and stem length (C)*

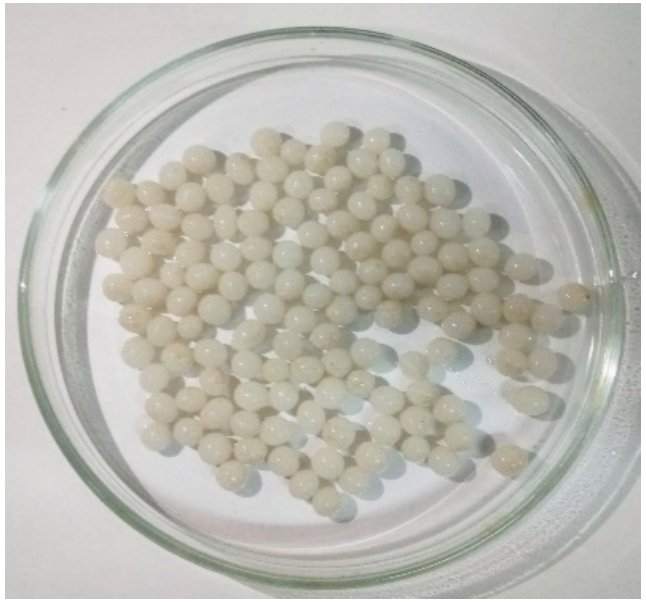
** Reference dose for nitrogen [140kg/ha]*

Hydrogels with micronutrient fabrication



Hydrogels with copper





Hydrogels with zinc

Enrichment of sprouts with single micronutrient

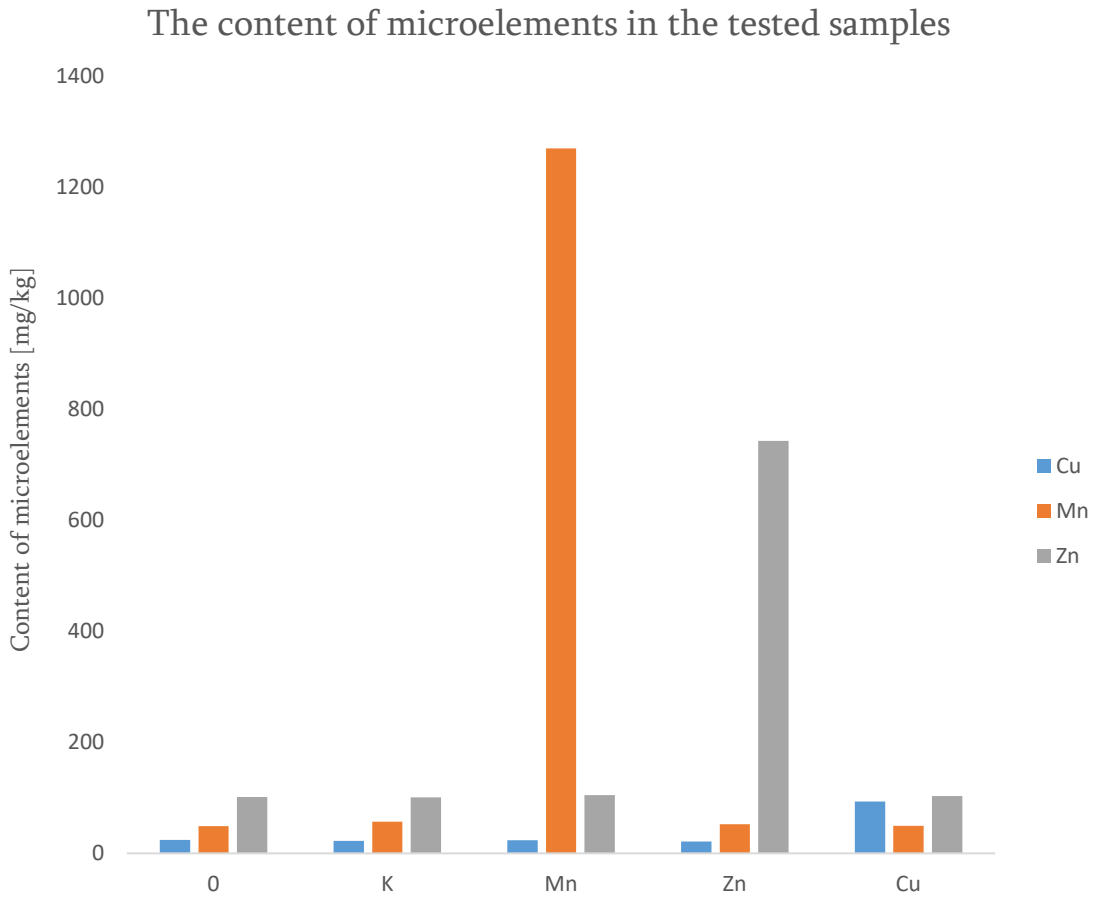
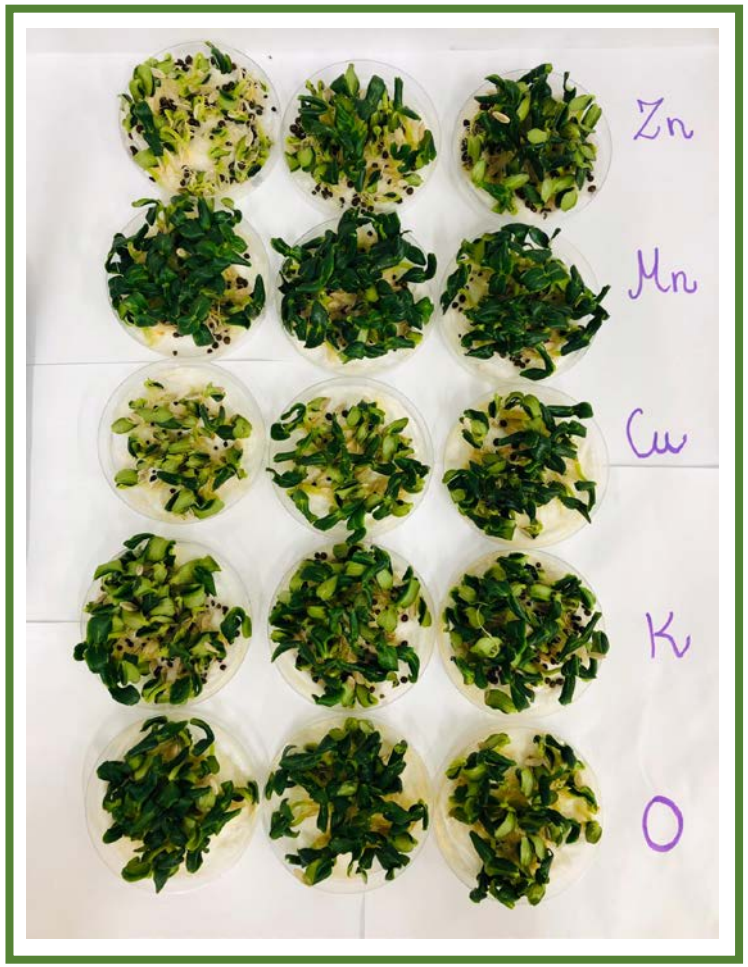


Fig. 4 *Content of microelements in sprouts dry mass*



10,8 mg Zn^{2+}

8,19 mg Mn^{2+}

1,45 mg Cu^{2+}

Composites without enrichment

Control sample (no hydrogels)

Enrichment of sprouts with 3 micronutrients

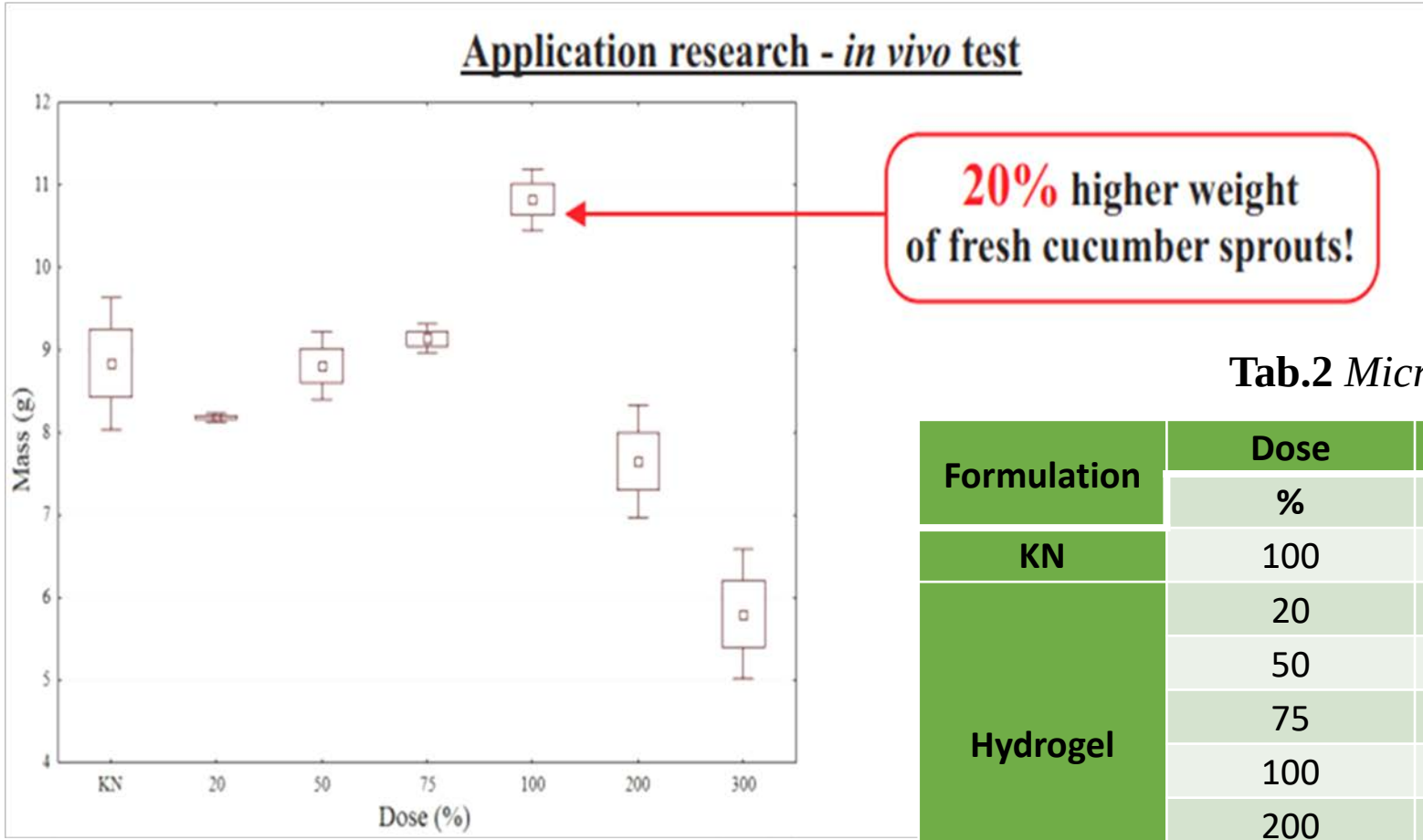


Fig. 5 *Impact of microelements dose on 50 cucumber sprouts fresh weight*

Tab.2 *Microelements dose in germination test*

Formulation	Dose	Cu	Mn	Zn
	%	µg/dish	µg/dish	µg/dish
KN	100	200	400	1000
Hydrogel	20	40	80	200
	50	100	200	500
	75	150	300	750
	100	200	400	1000
	200	400	800	1500
	300	600	1200	3000

Microelements transfer factor

Tab.3 *Impact of microelement dose on the bioavailability (TF) for micronutrients*

Formulation	Dose	TF_{Cu}	TF_{Mn}	TF_{Zn}
	%	%	%	%
KN	100	19,6±8,56	25,5±3,28	6,06±1,25
Hydrogles	20	57.97±16.85	91.76±1.25	72.41±0.48
	50	31.22±0.69	77.58±2.82	55.71±0.28
	75	25.69[a]±1.29	64.26±3.08	47.86±2.39
	100	20.52±0.81	54.68 ±0.99	39.86±1.08
	200	9.72±0.81	48.73 ±1.22	33.80±0.78
	300	5.79±0.62	36.29 ±0.41	30.55±1.48

Transfer Factor (TF)

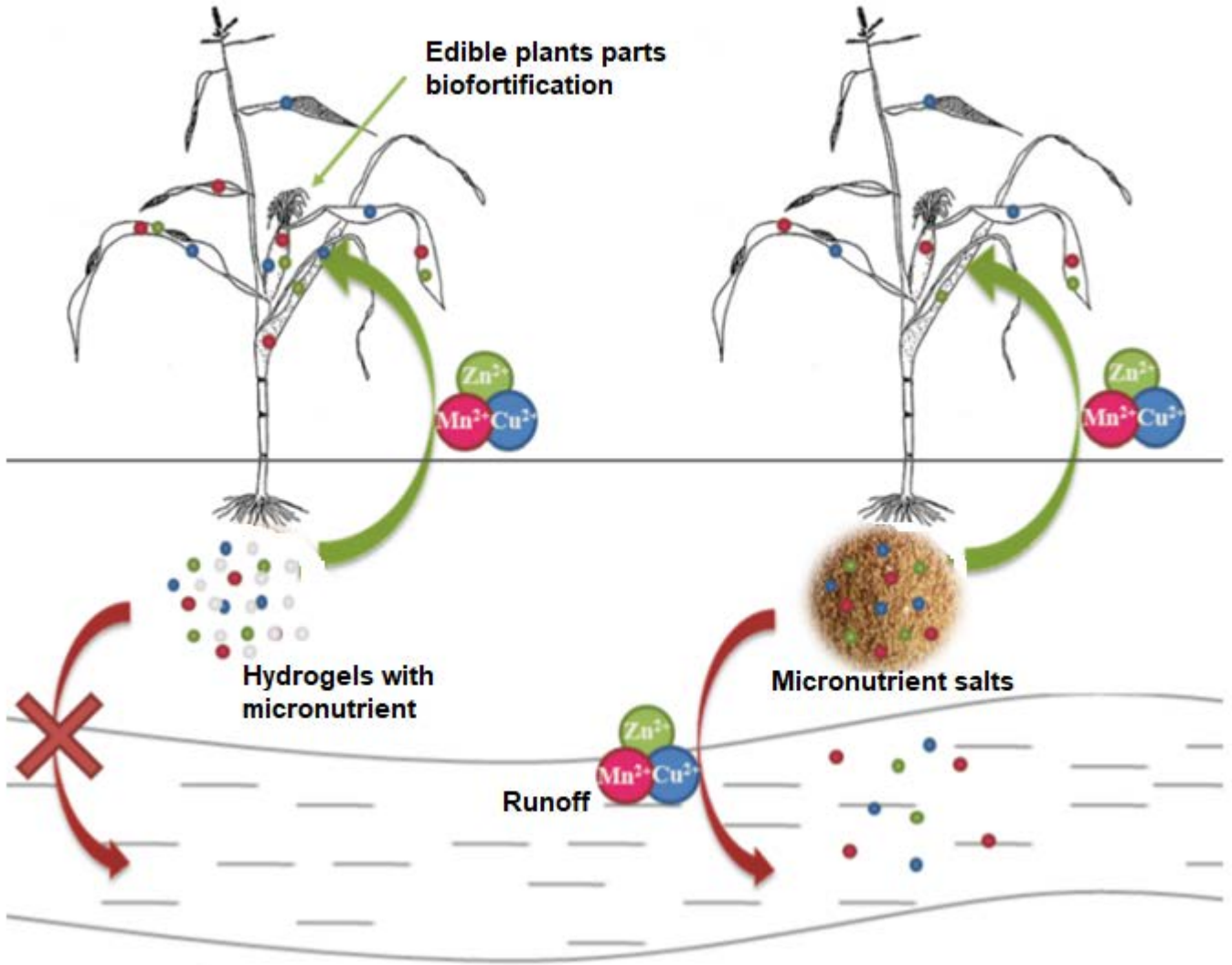
$$TF = \frac{C_{plant}}{C_{substrate}} \cdot 100\%$$

C_{plant} - *Micronutrients present in the substrate (mg/group)*

$C_{substrate}$ - *Micronutrients present in the substrate (mg/group)*

TF - *Micronutrients transfer from the substrate to the plant (%)*

Biofortification of plant edible parts



THANK YOU FOR YOUR ATTENTION