Micronutrients and Seaweed Extracts as Cold Stress Protectants during Early Growth of Maize
- From Lab to Field -

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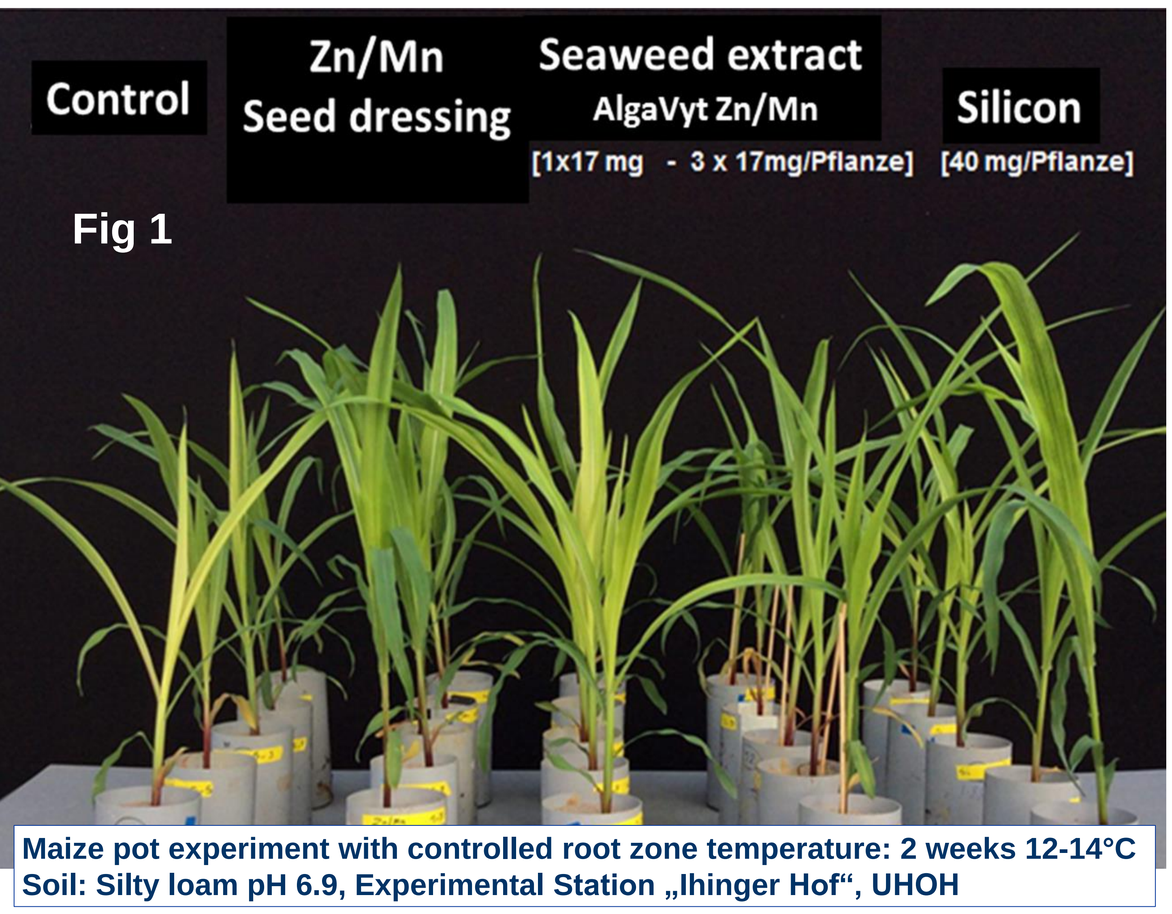
Introduction

- Low soil temperatures in spring (<12-14˚C) can easily induce micronutrient deficiencies (Zn, Mn, Fe) in tropical and subtropical crops, grown at temperate climates, even with sufficient nutrient supply due to inhibition of root growth and activity (Table 1).
- Consequences comprise impaired photosynthesis, oxidative leaf damage (chlorosis, necrosis, Fig. 1) and finally inhibition of shoot-,and root growth. Early supplementation of the respective micronutrients (e.g. seed treatments; Tab.1) can overcome these deficits. Similar protective effects were induced by treatments with silicon or micronutrient-rich seaweed extracts (Fig 1).
- The protective agents exhibit physiologically similar effects: (i) improved micronutrient status (ii) increased levels of antioxidants and enzyme activities involved in detoxification of free radicals, strongly dependent on sufficient micronutrient supply; (iii) lower levels of reactive oxygen species (ROS). (iv) iimproved plant growth as a consequence (Tab. 1).

Greenhouse Experiments



Maize pot experiment with controlled root zone temperature: 2 weeks 12-14°C
Soil: Silty loam pH 6.9, Experimental Station „Ihinger Hof“, UHOH

Table 1	Control 12°-14°C	Zn/Mn Seed-dressing	Silicon (40mg/Plant)	Seaweed ectract Algavyt Zn/Mn (17 mg/PLant)
Chlorophyll (SPAD)	19,4 b	30,1 a	27,7 a	24,1 ab
Shoot biomass [g]	1,5 b	2,1 a	2,1 a	2,0 a
Root length [m]	28,3 b	55,3 a	53,0 a	42 ab
	-	+	+	+
Zn Status	0,013 b	0,031 a	0,029 a	0,017 a
Mn Status	0,025 b	0,050 a	0,041 a	0,028 b
(mg /g Shoot-DM)	-	+	+	+
Antioxidants				
Total [%]	69,1 b	91,2 a	88,1 a	n.d
Phenolics (mg/g FM]	50,3 b	79,2 a	78,2	62,3 a
Enzymatic ROS-Defence				
Superoxide dismutase				
Shoot [U/g FM]	66,3 b	222,4 a	229,5 a	136,4 a
Root [U/g FM]	210,6 b	362,4 a	348,3 a	292,5 a
ROS Accumulation				
H_2O_2 Root	85,7a	39,8 b	32,5 b	35,7 b

Field Data

Year	Control	Zn/Mn	Silicon	Seaweed extract Algavyt ZnMn
2010				
Emergence	n.d	n.d	n.d	n.d
Yield [t/ha]	**7.9 b**	**9.1a**	n.d.	n.d.
2011				
Emergence	**3.0 b**	**3.7 a**	n.d.	n.d.
Yield [t/ha]	**11.7 b**	**13.4 a**	n.d.	n.d.
2015				
Emergence	**4.9 b**	**5.8 ab**	**5.3 ab**	**6.3 a**
Yield [t/ha]	**18.4 a**	**16.5 a**	**17.2 a**	**17.3 a**
2016				
Emergence	**44 c**	**56 b**	**72 a**	**45 c**
Yield [t/ha]	**7.1 d (16.1 b)**	**11.1 b (16.4 b)**	**12.9 a (17.8 a)**	**8.8 c (16.8 ab)**

Tab. 2: Maize Field Data between 2011 and 2016

- **2010/2011:** Exp. Station Heidfeldhof; silty loam pH 6.9; Corn: F030×F047; Seed soaking with Zn/Mn-Sulfate; Emergence, rating: Biomass (g/plant)
- **2015**: Exp. Station Ihinger Hof, silty Loam,pH 6.9; Silo maize cv Colisee ;
- Zn/Mn-seed dressing (Lebosol); Si und AlgaVyt: fertigation, Visual emergence rating
- **2016:** Exp. Station Ihinger Hof; Silo maize; ZnIMn seed dressing; Si: seed soaking; AlgaVyt: fertigation; Emergence rating [%]; Yield determination with (in brackets) and without re-sowing end of May 2016 – Sowing date in all years: end of April.

SUMMARY

- **Similar to the greenhouse experiments, the protective agents improved early growth of maize exposed to low soil temperatures in spring.**
- **In three out of four years, this translated also into a significant yield increase of 17,6 % on average-**

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