Co-Application of Calcified Algae and MicroEssentials-S10 Affects Phosphorus Availability and Productivity of Maize

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Objective: ***To evaluate grain yield responses of maize to different combinations and rates of calcified algae and MicroEssentials-S10.***

Introduction:

Various seaweed, kelp, algae, and marine derived products have shown promise in increasing stress tolerance, crop health, and yield of maize (*Zea mays.* L).

A product made from calcified algae (*Lithothamnium* spp.), Algen (Oceana Minerals, Sao Paulo, Brazil), is a dry granular material containing many organic compounds and is high in calcium carbonate (Figure 1).

These organic compounds may stimulate microbial activity and promote phosphorus mineralization when soil applied. In addition, calcium carbonate raises soil pH which tends to favor microbial activity, but calcium (Ca) has the potential to bind with phosphorus (P) at raised soil pH, making P unavailable for plant uptake.

It was unknown how Algen would affect P availability for maize when applied with an acidifying P fertilizer like MicroEssentials-S10 (12-40-0-10S; MES10), which contains elemental sulfur, and that was the basis of this research.

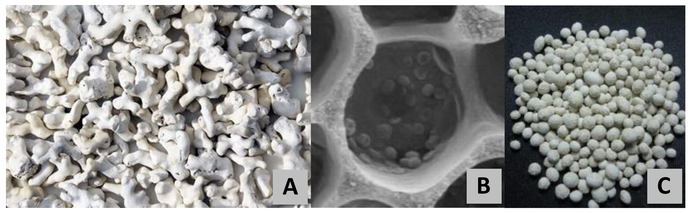

Figure 1. A) Dried *Lithothamnium* spp. B) Porous structure of *Lithothamnium* spp. C) Final granular form of Algen.

Research Approach:

The experiment was conducted at Champaign, IL in 2020 and 2021 on fields that had different levels of inherent soil fertility (Table 1). Soybean (*Glycine max*) was the previous crop and a management-responsive hybrid, DKC59-81 RIB, was planted at 89,000 plants ha^{-1}.

Table 1. Soil test results from trial locations in 2020 and 2021.

Year	OM†	CEC	pH	P‡	K	Ca	Mg	S
	%	meq/100g	units	ppm				
2020	3.8	18	6.7	18	107	2348	582	6
2021	4.9	26	6.2	30	133	3346	636	9

† OM, organic matter; CEC, cation exchange capacity. ‡ Mehlich-3 extraction.

Algen and MES10 were co-applied in a band 10-15 cm directly beneath the crop row. Algen was applied at 0, 100 and 150 kg ha^{-1}, corresponding to none, low, and high rates, and combined with two rates of MES10 (67 and 90 kg P_2O_5 ha^{-1}) providing a reduced (low) and a full (high) rate of P_2O_5 in 2020. In 2021, two 0 kg P_2O_5 ha^{-1} MES10 (Algen only) treatments were included to balance the design to a 3 x 3 factorial. Plots were four rows wide and planted at 0.76 m row spacing and 12 m in length. Trial design was a RCBD with treatments replicated six times.

Results:

In 2020, increasing the MES10 rate slightly increased grain yield over the untreated control (Figure 2). The high rate of Algen with the low (75%) rate of MES10 yielded similarly to the high rate of MES10 alone. However, the high rate of Algen paired with the high rate of MES10 significantly increased yield by 797 kg ha^{-1} (Figure 2).

In 2021, Algen applied alone nominally decreased grain yield, but there was a synergistic response when increasing amounts of Algen were paired with the low rate of MES10 compared to the low MES10 rate alone (Figure 3). The high rate of MES10 alone increased grain yield by 498 kg ha^{-1}, even though the soil test values (Table 1) were above the threshold predictive of a response to added phosphorus.

When averaged across the 2020 and 2021 growing seasons, the greatest overall yield came from pairing the high rate of Algen with the high rate of MES10 (Table 2). Additionally, the high MES10 and the low MES10 + high Algen treatments increased yield by 420 and 361 kg ha^{-1}, respectively (Table 2).

Grain yield increases were largely driven by modestly increasing kernel number without a compensatory decrease in average kernel weight (Table 2).

Table 2. Interaction of MicroEssentials-S10 (MES10) and Algen rates on grain yield and yield components of maize grown at Champaign, Illinois averaged over 2020 and 2021.

MES10 Rate	Algen Rate	Grain Yield†	Δ Yield from Control	Kernel Weight	Kernel Number
		Mg ha^{-1}	kg ha^{-1}	mg kernel^{-1}	kernel m^{-2}
Untreated Control		11.3	-	254	4386
Low	None	11.4	+107	259	4378
	Low	11.4	+164	258	4433
	High	11.6*	+361	255	4557
High	None	11.7*	+420	259	4506
	Low	11.5	+221	260	4423
	High	11.8*	+533	262	4513
LSD ($P \leq 0.05$)		0.3	-	NS ($P = 0.35$)	NS ($P = 0.14$)

† Grain yield expressed at 0% moisture.
* Significantly different from the untreated control.

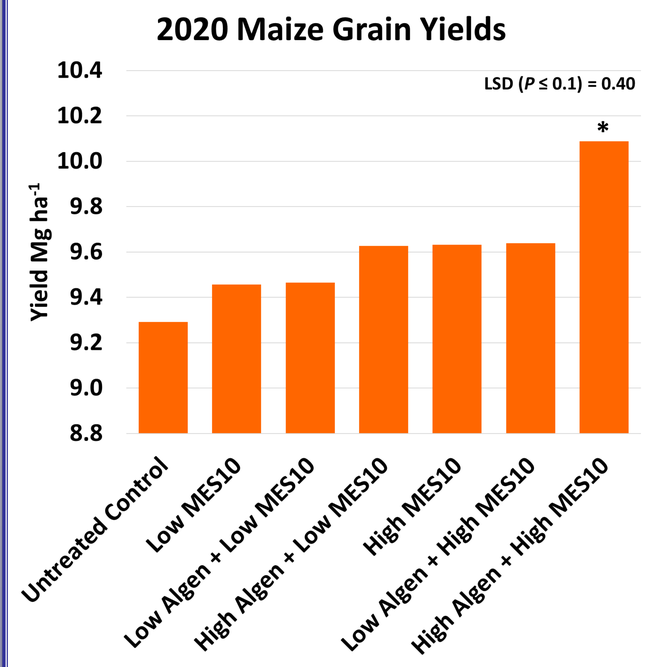

Figure 2. Maize grain yields as influenced by Algen and MicroEssentials-S10 treatments in 2020. (* = significance)

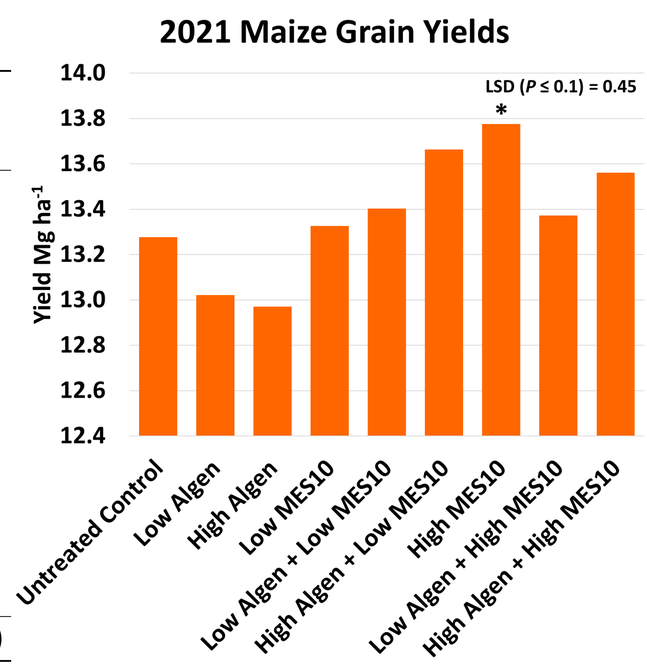

Figure 3. Maize grain yields as influenced by Algen and MicroEssentials-S10 treatments in 2021. (* = significance)

Conclusions:

Applications of phosphorus fertilizer (MES10) were critical in setting a higher maize grain yield potential across both years of the study, with the highest grain yields resulting from the high MES10 rate.

Algen (calcified algae) alone had no effect on yield, but pairing Algen with MES10 showed that Algen was able to increase the yield response to phosphorus fertilizer, therefore it was not a replacement for fertility.

On average, the low rate of MES10 paired with the high rate of Algen provided similar grain yields to the high rate of MES10 alone, indicating that Algen may be capable of reducing phosphorus fertilizer needs.

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