Cucumber Plant Growth and Fruit Yield as Affected by 6-Benzyladenine and Magnesium Sulfate

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Introduction

Cucumber is an important vegetable crop in Georgia, with a surface of 1,700 ha and a farmgate value of $41 million. It is exposed to heat stress conditions that affect fruit quality and yield. Crop biostimulants may increase crop yield and quality under adverse environmental conditions. Biostimulant 6-benzyladenine (6-BA) is used for fruit thinning in apples and other fruit trees.

Objective

To determine effects of 6-BA alone or in combination with magnesium sulfate ($MgSO_4$) on plant growth and function and fruit yield in cucumber.

Materials and Methods

- Experiment conducted in Tifton, GA, in fall of 2010. Soil is loamy sand, with a pH of about 6.5.
- Cucumber ('Dasher II') direct-seeded on 23 Aug. on raised beds (on 1.8 m centers); two rows per bed (36 cm apart), 30 cm between plants, white plastic mulch, and one drip tape line in center of bed.
- *Experimental design* was a randomized complete block with six replications and six treatments [3 BA levels (0, 20 and 60 ppm) x 2 $MgSO_4$ levels (0 and 136 kg/ha)].
- *Biostimulant* 6-BA (*MaxCel*®; Valent BioSciences) applied with backpack sprayer at either 20 ppm 6-BA or 60 ppm 6-BA.
- *Magnesium sulfate* (10% Mg and 12.9% S) applied through drip tape at 0 or 136 kg/ha.
- *Weather* data (air temperature and ETo) obtained from a nearby Univ. of Georgia weather station. Plants irrigated at to 100% crop evapotranspiration (ETc).
- *Leaf chlorophyll* SPAD values measured with a chlorophyll meter (SPAD-502, Minolta).
- *Leaf gas exchange and fluorescence* measured with a gas exchange system (LI-1600, LI-COR). Water use efficiency calculated as ratio between net photosynthesis and transpiration.
- *Yield*. Fruit harvested 11 times and graded as marketable and culls, according to U.S. Grading Standards.
- *Vegetative top fresh weight*. After last harvest, plants in each plot excised at the base of the stem and weight of the vines (vegetative top fresh weight) immediately determined.
- *Statistical analysis.* Data analyzed using the GLM Procedure of SAS (SAS 9.1, SAS Inst. Inc., Cary, N.C.).

Results

- *Weather.* Mean air temperature 23.5 °C; cumulative rainfall 114 mm.
- *Leaf chlorophyll* SPAD values lowest in plants treated with 60 ppm 6-BA (Table 1); unaffected by magnesium sulfate.
- *Top vegetative fresh weight.* Top vegetative FW increased with increasing 6-BA rate (Table 1); it was unaffected by magnesium sulfate.
- *Soil water content.* Soil water content unaffected by 6-BA or magnesium sulfate (Table 1).
- *Gas exchange and fluorescence*. Net photosynthesis, stomatal conductance, water use efficiency, and leaf fluorescence (Photosystem II efficiency) were unaffected by 6-BA (Table 2). Stomatal conductance increased with magnesium sulfate application.
- Y*ields.* Marketable and total fruit number decreased while individual fruit weight increased with increasing 6-BA (Table 3). Marketable and total fruit yields unaffected by 6-BA and $MgSO_4$.

Conclusions

- Biostimulant 6-BA associated with increased vegetative growth and reduced chlorophyll SPAD values; reduced fruit number and increased fruit size; delayed fruit production.
- Yield differences probably due to effect of 6-BA in promoting vegetative growth at expense of reproductive growth.
- Magnesium sulfate had no effects on plant growth or fruit yields.

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Table 1. Chlorophyll (SPAD) values, vegetative top fresh weight, and soil water content.

Treatment [z]	Chlorophyll (SPAD)	Vegetative FW (kg/plant)	Soil water content (%)
6-BA			
0 ppm	49.8 a	282 c	8.1
20 ppm	49.7 a	373 b	8.0
60 ppm	48.3 b	464 a	8.0
P	0.001	<0.0001	0.632
$MgSO_4$			
0 kg/ha	49.2	365	8.0
136 kg/ha	49.3	382	8.0
P	0.882	0.252	0.831
Interaction			
P	0.058	0.655	0.667

[z] 6-BA: 6-benzyladenine; $MgSO_4$: magnesium sulfate at 136 kg/ha.

[y] Means followed by the same letter are not significantly different based on Fisher's protected least significant test at 95% confidence.

Table 2. Gas exchange and fluorescence.

Treatment [z]	Net Photosynthesis ($\mu mol\ m^{-2}\ s^{-1}$)	Stomatal conductance ($mol\ m^{-2}\ s^{-1}$)	Water use efficiency ($\mu mol/mmol$)	PSII efficiency [y]
6-BA				
0 ppm	23.9	0.288	0.165	4.14
20 ppm	25.0	0.294	0.172	4.20
60 ppm	24.3	0.291	0.168	4.10
P	0.525	0.923	0.149	0.549
$MgSO_4$				
0 kg/ha	24.1	0.278 b	0.167	4.18
136 kg/ha	24.7	0.303 a	0.170	4.11
P	0.427	0.047	0.399	0.342
Interaction				
P	0.945	0.462	0.250	0.242

[z] 6-BA: 6-benzyladenine; $MgSO_4$: magnesium sulfate at 136 kg/ha.

[y] Means followed by the same letter are not significantly different based on Fisher's protected least significant test at 95% confidence.

[y] Photosystem II (PSII) efficiency. Fraction of absorbed PSII photons that are used in photochemistry.

Table 3. Cumulative fruit yields.

Treatment [z]	Marketable		Cull		Total		Fruit wt.
	1000/ha	t/ha	1000/ha	t/ha	1000/ha	t/ha	g/fruit
6-BA							
0 ppm	172 a	26.8	61.5	5.9	233 a	32.7	157 b
20 ppm	150 ab	24.9	50.6	5.5	201 b	30.4	165 ab
60 ppm	137 b	23.0	55.8	5.6	192 b	28.6	168 a
P	0.001	0.217	0.169	0.801	0.012	0.197	0.069
$MgSO_4$							
0 kg/ha	145	23.6	53.6	5.5	199	29.1	163.4
136 kg/ha	160	26.1	57.9	5.8	218	31.9	163.6
P	0.092	0.152	0.229	0.352	0.070	0.116	0.857
Interaction							
P	0.564	0.543	0.785	0.622	0.770	0.654	0.093