Using silicon, Stimplex and plant resistance in pumpkin production systems to reduce plant disease loss

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Objective: Evaluate silicon alone and in combination with Stimplex (a nutrient supplement) and powdery mildew resistance on foliar and soil borne diseases and yield of pumpkin.

Material and Methods: There were two studies conducted at the Upper Marlboro Research and Education Center. The first study examined foliar disease problems. Treatments were: Calcium silicate, Stimplex and a powdery mildew resistant (tolerant) pumpkin variety (*Charisma*) vs. a similar non resistant variety (*New Rocket*, same days to harvest and same wt per pumpkin as *Charisma*). Calcium silicate was applied at a rate of 4,000 lbs/a before bed formation to 4 rows in a plot (25x50 ft area). Lime was applied to the other 4 rows in a plot to bring soil pH up to 6.8-7.0. Within each split plot a 2x2 experiment was run with the two varieties of pumpkin at two 'rates' of Stimplex (applied or not applied). This created a 2x2x2=8 treatment factorial study. There were 8 rows of plastic (2 pumpkin varieties, two rates of silicon (applied or not) and two rates of Stimplex (applied or not)) 50 feet long on 6 ft row middles with drip irrigation. There were 4 reps. Pumpkin seeds were planted 8 June at a 3 ft spacing, 16 plants/row. Stimplex was applied at the rate of 1.5 qts/a via drip irrigation on 22 June, 14 July, 28 July, 18 August and 6 September. Foliar diseases (powdery and downy mildew) were evaluated in late June, and in mid-July, August and September by examining the percentage of leaf area infected by a pathogen. A rating system of 1-5 was used with 1=1-10%; 2=11-25%; 3=26-50%; 4=51-75%; 5= >76% of foliage infected. No fungicides were used in this study. Pumpkins were harvested and weighed on 15 September. Data were analyzed using 2x2x2 factorial ANOVA and means were separated using Orthogonal Contrasts (SAS, 2009).

The second study examined soil disease problems. Calcium Silicon and Stimplex were used in a 2x2 study. Both were applied as described above into 4-row plots with four reps. *Gladiator* pumpkin seed was planted 3 ft apart in 50 ft long rows on 6 ft centers on 8 June. A field was selected in which *Fusarium spp* and *Phytophthora spp* had been found infecting squash plants three years prior to the 2010 trial with pumpkin. This field had a corn-soybean-corn rotation for the last three years. Foliar applications of Bravo (3 apps), Curzate (2 apps) and Ranman (1 app) were applied to control foliar disease. The percentage of plants killed by soil borne pathogens was recorded on 18 August and 15 September. Pumpkins were harvested and weighed 22 September. Data were analyzed using a 2x2 factorial ANOVA and means were separated using Orthogonal Contrasts (SAS, 2009).

Results/discussion: Throughout May and June we had record rainfall, with May setting a new record and June coming in second. From 1 April 2010 through the end of June we recorded 25.2 inches of rain at Upper Marlboro, which is 11.6 inches above average for this time period.

Foliar disease study: **Powdery Mildew.** The main factors of powdery mildew (PM) resistance vs not and the presence of silicon vs not were both significant ($P \leq 0.05$, presence of either was significantly better than not present). Any treatment in which Silicon was applied had reduced powdery mildew foliar problems (Table 1). Adding silicon to a PM resistant pumpkin variety significantly increased the tolerance of plants to powdery mildew infection (Table 1) compared to PM resistance alone. Stimplex did not increase the tolerance of the varieties to PM.

Table 1. Interaction of PM resistance, silicon and Stimplex on powdery mildew infection in pumpkin. "+" sign means treatment was applied, "-" sign means treatment was not applied

PM Resistant	Silicon	Stimplex	June	July	August
+	-	-	1.8a	2.7a	3.3bc
+	+	-	1.2ab	1.4b	1.7a
+	-	+	1.4a	1.7ab	2.2ab
+	+	+	0.8b	1.3b	1.5a
-	+	-	1.6a	2.0ab	2.1ab
-	-	+	1.9a	2.3a	2.6bc
-	+	+	1.3ab	1.8ab	2.0ab
-	-	-	2.1a	3.1a	4.5c

Ratings are 1-5, with 1=1-10%; 2=11-25%; 3=26-50%; 4=51-75%; 5= >76% of foliage infected
Means with different letters are significantly different at the $p \leq 0.05$ level; orthogonal contrasts

Downy Mildew. None of the main effects of PM resistance, silicon or Stimplex were significant for downy mildew (DM). However, the interaction of silicon and Stimplex significantly increased plant resistance to DM infection (Table 2).

Table 2. Interaction of PM resistance, silicon and Stimplex on downy mildew infection in pumpkin. . "+" sign means treatment was applied, "-" sign means treatment was not applied

PM Resistant	Silicon	Stimplex	July	August	September
+	-	-	0.6a	3.7a	4.2a
+	+	-	0.5a	3.4a	4.1a
+	-	+	0.6a	2.9ab	3.9a
+	+	+	0.2a	1.3b	3.2b
-	+	-	0.6a	3.1a	4.0a
-	-	+	0.4a	2.3ab	4.2a
-	+	+	0.2a	1.8ab	3.5ab
-	-	-	0.7a	3.9a	4.6a

Ratings are 1-5, with 1=1-10%; 2=11-25%; 3=26-50%; 4=51-75%; 5= >76% of foliage infected
Means with different letters are significantly different at the $p \leq 0.05$ level; orthogonal contrasts

Yields. Using PM resistant pumpkins increased yields compared with not using PM resistance. Using silicon or Stimplex alone did not significantly increase yields, except vs the control - no PM resistance, no silicon and no Stimplex, but having both present did increase yields compared with using only PM resistance or no resistance. While silicon reduced infection of PM it did not reduce DM infection and DM was particularly virulent this season. Therefore, while yields were better with silicon they were not significantly different than the control or using PM resistance. Only when silicon and Stimplex were applied together was there a yield boost in pumpkin which could be due to Stimplex increasing the nutrient content of pumpkin or interacting with silicon to reduce foliar diseases or both.

Table 3. Interaction of PM resistance, silicon and Stimplex on pumpkin yields.
"+" sign means treatment was applied, "-" sign means treatment was not applied

PM Resistant	Silicon	Stimplex	Pumpkin yield (lbs)
+	-	-	368.3 b
+	+	-	404.4 ab
+	-	+	389.8 ab
+	+	+	441.5 a
-	+	-	372.2 ab
-	-	+	381.6 ab
-	+	+	424.8 a
-	-	-	315.2 c

Soil borne pathogen study. *Fusarium solani* f. sp. *cucurbitae* was the overwhelming pathogen recovered from wilted pumpkin plants. Plants began to wilt approximately 4 weeks after emerging. Silicon did little to reduce soil borne pathogen infection and death. Stimplex alone significantly reduced disease problems and the interaction of silicon and Stimplex was significant (Table 4).

Table 4. Interaction of silicon with Stimplex in reducing soil disease problems in pumpkin. . "+" sign means treatment was applied, "-" sign means treatment was not applied

		% dead plants	
Silicon	Stimplex	August	Sept.
-	-	18.3a	24.6a
+	-	15.6ab	19.2ab
-	+	9.5bc	13.6b
+	+	4.2c	6.1c

Yields. Using silicon did not increase yields. Using Stimplex did increase yields and using silicon and Stimplex together significantly increased yields compared with not using silicon or Stimplex or using either by itself (Table 5). How silicon and Stimplex interacted to reduce soil-born pathogen problems is not known at this time. Each may stimulate a separate systemic acquired resistance (SAR) pathway or the same pathway, in which they stimulate it beyond what one can normally do. Stimplex may increase root growth and nutrient uptake as well as increase an SAR pathway and silicon helps to facilitate this increase.

Table 5. Interaction of silicon and Stimplex on yield of pumpkins with soil borne disease problems. . "+" sign means treatment was applied, "-" sign means treatment was not applied

Silicon	Stimplex	Pumpkin yield (lbs)
-	-	265.8 a
+	-	291.6 ab
-	+	357.7 b
+	+	485.4 c

Means with different letters are significantly different at the $P \leq 0.05$ level; orthogonal contrasts