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The effect of LS203 (*Bacillus pumilus*) as an amendment for biological plant resistance activation in cantaloupe and watermelon transplant plugs and subsequent field performance.

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Introduction

In the state of FL, over 33,500 acres of watermelons and 7,000 acres of cantaloupes were grown in 1997-98 season. Florida growers, already faced with environmental and regulatory constraints and competition from Mexico, will soon have to face the loss of methyl bromide, the powerful soil fumigant used against soilborne diseases, insects, and weeds. This loss could swing the pendulum to the side of the competition.

Furthermore, the cry for food safety voiced by the American public has hastened the loss of other chemicals used in vegetable production as the agriculture industry declines to re-register older chemistry. This has placed the U.S. on the road to an agriculture of reduced chemical inputs and an increased reliance on biological control.

LS203 (Gustafson, Plano, TX) is a soil-amendment formulation of *Bacillus pumilus* GB-87, an organism billed as a biological plant resistance activator (i.e., promotes systemically acquired resistance.) It has been used in clinical trials in the southeastern United States, but little is known about its effects on watermelon or cantaloupe transplants either in the greenhouse or in the field. If effective, LS 203 may prove to be a useful tool in a systems approach to finding an alternative to methyl bromide.

Our spring 1998 objective was to apply LS203 according to company protocol to the soilless media used in the production of watermelon and cantaloupe transplants, and to assess the horticultural aspects of these crops both in the greenhouse and in a double-cropping field situation.

Methods

A trial was established at the Southwest Fl Research and Education Center of the University of Florida in Immokalee, FL to test the effect of LS203 biological plant resistance activator on cantaloupe and watermelon transplant growth, growth response in the field, and yield. On February 6, 1998 ninety-four grams/cu ft. of LS203 were mixed with sufficient Metro Mix 220 (Scott's Co., Marysville, OH) to fill four, 200-cell, flats which were then seeded with `SME 3118' cantaloupe or `Paladin' watermelon (both

Sakata Seed, Morgan Hill, CA). Four replications of either LS203-amended and control media (i.e., without LS203) were established for each crop.

Seedlings were grown for four weeks under standard FL transplant production procedures (Vavrina, 1996), and then five plants from each replication for each crop were sampled to determine the greenhouse growth parameters of leaf area, root dry weight (DW), shoot DW, root:shoot ratio, and number of true leaves.

On March 10, 1998, additional cantaloupe and watermelon transplants were taken to the field and planted in plastic-mulched beds that had been previously cropped with tomatoes (drip irrigated) or pepper (seep irrigated). Cantaloupe field spacing was 18" in-row on 6' centers and watermelon in-row spacing 36" on 12' centers. To approximate FL Extension Service recommendations of 120N-78P-200K, the crops were fertilized either by fertigation or granular fertilizer (punched in) depending on irrigation method. Twelve cantaloupe and 12 watermelon plants were set for each treatment by replication. Six replications were set out in a randomized complete block design, four replications taken directly from the greenhouse flats by rep. and two additional reps comprised of plants taken randomly from the greenhouse flats. Soil and air temperatures during that time ranged from the high 70s to low 80s. Manzate and Bravo fungicides were applied to prevent the advancement of fungal diseases. Various *Bacillus thuringiensiss* were also applied to reduce worm pressure

Field data were taken on plant DW (one plant per rep. by treatment) 30 days after planting (DAP), early female flowering (30 DAP), and yield (two harvests of each crop.) Data were analyzed by ANOVA (SAS) with mean separation via Fisher's Protected LSD at $p<0.05$.

Results

<u>Greenhouse Transplant Growth</u>

LS203 presence on transplant roots was verified by plating on trypticase soy agar. SME 3118' cantaloupe transplants when grown for four weeks in soilless medium amended with LS203 had a greater leaf area and slightly increased shoot DW compared to the control (Table 1). The increased shoot growth lead to a decrease in the root:shoot ratio, as was expected.

Table 1. The effect of LS203 biologically amended soilless media on watermelon and cantaloupe transplant growth four weeks after seeding.

Amendment	Leaf Area (cm^2)	Dry Top (g)	Dry Root (g)	Root Shoot Ratio	True Leaf (no)
			Cantaloupe		
LS203	26.01	0.1469	0.0352	0.246	2.35
Control	22.35	0.1282	0.0367	0.294	2.10
LSD 5%	3.33	NS	NS	NS	NS
LSD10%	--	0.0176	NS	0.042	NS
			Watermelon		
LS203	17.14	0.1146	0.0262	0.231	2.05
Control	13.38	0.0964	0.0244	0.262	1.70
LSD 5%	NS	NS	NS	NS	NS
LSD 10%	3.20	NS	NS	NS	0.30

`Paladin' watermelon transplants responded similarly to LS203 treatment with increased leaf area and a trend toward greater shoot DW (Table 1.) Additionally, LS203 appeared to advance watermelon seedling maturity as evidenced by a greater leaf number than the untreated control.

Field Establishment Parameters

Ridomil resistant *Phytophthora capsici,* driven by El Nino weather conditions (cold and wet) was identified early in the trial on both seepage- and drip-irrigated crops. Attempts to control the disease seemed futile until the weather conditions became warmer and drier. Resetting of affected transplants was carried out for approximately three weeks. A cataloguing of the plant loss (Table 2) revealed that the incidence of *P. capsici* was more severe in cantaloupes and in the drip-irrigated field. Problems stemming from a faulty fertilizer injector may have exacerbated *P. capsici* incidence in the drip-irrigate cantaloupe. Uneven distribution of disease incidence precluded statistical analysis of these data.

Table 2. Number of transplants contracting *Phytophthora capsici* 3/16 – 4/2/1998

Date/Field	No. Cantaloupe Control Plants	No. Cantaloupe LS203 Plants	No. Watermelon Control Plants	No. Watermelon LS203 Plants
3/16 Seep	1	1	0	1
3/16 Drip	0	1	0	0
3/24 Seep	9	8	0	1
3/24 Drip	15	10	2	6
4/2 Seep	6	4	0	1
4/2 Drip	9	7	3	2
Total	40	31	5	9

In field, seedling dry weight 30 DAP was unaffected by treatment (Table 3). The data did reflect the faulty fertigation problem showing greatly reduced DW's in the drip field compared to the plant DW accumulated in the seep field. Additionally, flower initiation was not influenced by LS203 treatment in watermelon or seep-irrigated cantaloupe (Table 3). However, the stress caused by the faulty fertilizer injector apparently impacted drip-irrigated cantaloupe to a greater extent as significantly more flower initiation occurred on the control cantaloupes.

Table 3. The effect of LS203 biological amendment on plant growth in the field.

Treatment	Watermelon Drip	Watermelon Seep	Cantaloupe Drip	Cantaloupe Seep
		Shoot DW (g)		
LS203	3.16	11.62	1.16	8.90
Control	2.33	8.17	1.60	11.21
LSD 5%	NS	NS	NS	NS
LSD 10%	NS	NS	NS	NS
		Flower Initiation (no.)		
LS203	3.5	4.5	6.5	54.7
Control	3.3	2.8	17.3	50.0
LSD 5%	NS	NS	10.8	NS
LSD 10%	NS	NS	--	NS

Yield Parameters

Plant losses to *P. capsici* following the reset period necessitated reassigning trial replications and the number of plants per replication for subsequent harvests. Eleven watermelon plants were harvested from six replications in the drip field and 11 watermelon plants from four replications in the seepage-irrigated field. Ten cantaloupe plants were harvested from three replications in the seepage-irrigated field and eight cantaloupe plants from six replications in the drip irrigation study.

Our missing a critical spray for melon worm (all plots) and the early fertilizer stress in the drip field further compromised cantaloupe yield. Cantaloupe fruit were harvested when exhibiting some degree of webbing, though these fruit were often immature. Full maturity in cantaloupe resulted in fruit losses to internal rot caused by melon worm infestation. Because of this only two harvests were feasible compared to the usual five for cantaloupe.

Cantaloupe. For drip-irrigated (fertilizer stressed) cantaloupe, production was slightly reduced at first harvest where LS203 was used in the transplant medium (Table 4.) This reduction was in fruit number only, as weight per plot and individual fruit weight were similar to the control. No differences were noted at second harvest or in total harvest fruit number or weight (either plot weight or individual fruit weight.)

Cantaloupes grown with LS203 transplant amended medium under seepage irrigation exhibited no differences in either fruit number, plot fruit weight, or individual fruit weight at either first or second harvest compared to the control (Table 5.) However, a tendency toward greater individual fruit weight by the controls was realized when first and second harvest data were combined ($p \leq 0.10$).

Watermelon. One watermelon harvest was managed in the drip-irrigated field (Table 6) and two harvests were taken in the seepage-irrigated field (Table 7.) Neither trial showed any effect of LS203 on watermelon fruit number or fruit weight per plot compared to the control. Yields were comparable between the two irrigation methods (at first harvest) indicating that watermelon compensated for early fertilizer inequities under drip irrigation, unlike cantaloupe. Individual fruit-weight differences recorded in LS203-amended cantaloupe were lacking in watermelon.

Discussion

The fact that LS203 advanced leaf development (both area and number), and subsequently shoot growth in the greenhouse indicated a growth promotion aspect to *Bacillus pumilus.* Transplant growers usually prefer root growth to shoot development; however, should this growth promotion continue in the field (i.e., enhanced stand establishment) transplant growers and receivers would be greatly pleased. Growth promotion was not apparent in the field with this trial, but should be evaluated in future trials.

We had hoped that the double-cropped land scenario would present some soilborne diseases with which to challenge LS203, but this did not occur. Significantly more flowers were initiated by the control cantaloupes compared to the LS203 cantaloupes in the drip field only. The fact that plants in the drip field were fertilizer stressed might indicate that under such stresses LS203 treated plants may not be as competitive. This phenomenon bears further investigation. It was also noted that drip-irrigated cantaloupe flower production was only 1/3 that of the seep-irrigated cantaloupes, (15 vs. 50). Additionally, cantaloupes flower more prolifically and sooner in the cycle than watermelon, hence the dramatic flowering response between species and irrigation methods.

Seepage-irrigated cantaloupe production was three times greater in this trial than drip irrigated production. This provided further evidence that drip-irrigated cantaloupe never compensated for the stresses undergone in early development. The seepage-irrigated control cantaloupe achieved a slightly greater overall average fruit weight than the LS203 treatment plants. This might suggest that the symbiotic nature of *B. pumilus* came at some energy expense or depletion of resources for the plant. Watermelon yield was unaffected by treatment with LS203.

The data from this study represent a single, spring trial with LS203. The presence of *P capsici* and complications from a faulty fertilizer injector affected the trial. Due to these factors, further testing is recommended. Additional research should target greenhouse and field performance across the varied environmental and cultural conditions found in FL. Once establishing the horticultural aspects impacted by LS203, testing under conditions of known pathogen pressure with and without the use of registered agricultural chemicals would be the next logical step.

Literature

Vavrina, C.S. 1995. An introduction to the production of containerized vegetable transplants. Univ. FL, Cooperative Extension Service, Bulletin No. 302.

Table 4. The effect of LS203 biologically amended medium on cantaloupe yield in a drip irrigated field (plot=12' on 6' centers with 8 plants/plot at 18" spacing).

Treatment	**Number per Plot**	**Weight per Plot**	**Average Fruit Weight**
	(no.)	(lbs.)	(lbs.)
		First Harvest	
LS203	12.8	16.7	1.30
Control	14.2	20.0	1.38
LSD 5%	NS	NS	NS
LSD 10%	1.2	NS	NS
		Second Harvest	
LS203	14.7	21.6	1.45
Control	13.8	19.6	1.41
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS
		Total Harvest	
LS203	27.5	38.3	1.37
Control	28.0	39.6	1.40
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS

Table 5. The effect LS203 biologically amended medium on cantaloupe yield in a semi-closed seepage irrigated field (plot=15' on 6' centers with 10 plants/plot at 18" spacing).

Treatment	Number per Plot	Weight per Plot	Average Fruit Weight
	(no.)	(lbs.)	(lbs.)
		First Harvest	
LS203	34.7	75.6	2.19
Control	33.3	92.6	2.77
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS
		Second Harvest	
LS203	18.0	38.3	2.13
Control	14.3	33.9	2.35
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS
		Total Harvest	
LS203	52.7	113.9	2.16
Control	47.7	126.5	2.66
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	0.42

Table 6. The effect of LS203 biologically amended medium on watermelon yield in a drip irrigated field (plot=33' on 12' centers with 11 plants/plot at 3' spacing).

Treatment	MKT Number	MKT Weight	Cull Number	Cull Weight	Total Number	Total Weight	MKT Ave. Melon Wt.
	(no.)	(lbs.)	(no.)	(lbs.)	(no.)	(lbs.)	(lbs.)
LS203	12.3	221.0	0.8	5.8	13.2	226.8	18.1
Control	12.5	227.8	0.8	5.8	13.3	233.7	18.3
LSD 5%	NS	NS	NS	NS	NS	NS	NS
LSD 10%	NS	NS	NS	NS	NS	NS	NS

Table 7. The effect of LS203 biologically amended medium on watermelon yield in a semi -closed seepage irrigated field (plot=33' on 12' centers with 11 plants/plot at 3'spacing)

Treatment	Number per Plot	Weight per Plot	Average Fruit Weight
	(no.)	(lbs.)	(lbs.)
		First Harvest	
LS203	10.8	222.6	20.6
Control	12.5	238.8	19.0
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS
		Second Harvest	
LS203	6.8	92.8	13.7
Control	7.5	110.0	14.5
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS
		Total Harvest	
LS203	17.5	315.4	17.9
Control	20.0	348.8	17.5
LSD 5%	NS	NS	NS
LSD 10%	NS	NS	NS