USING CULTURAL PRACTICES TO MANAGE BACTERIAL DISEASES AND INCREASE PROFITABILITY OF FRESH MARKET ONIONS

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Introduction

Small-scale diversified fresh market growers who grow onions intensively in New York and Pennsylvania are constantly challenged by yield losses due to bacterial diseases, which greatly compromise profitability. If bacterial diseases cannot be managed, this onion industry will not be sustained or expanded.

In New York, Sour Skin caused by *Burholderia cepacia*, is the most common cause of bacterial bulb decay, but *Pantoea ananatis* has also been identified, and several others are likely part of the complex. In Pennsylvania, the most frequently isolated bacterial pathogens include soft rot pathogens, *Pseudomonas marginalis* and *Pectobacterium caratovora*; and center rot pathogens, *Pantoea ananatis* and *P. agglomerans*; *Xanthomonas axonopodis* and *Pseudomonas viridiflava*. Bulbs with bacterial decay are not marketable, although sometimes they are sold unknowingly to detriment, because, a single internal scale can be infected as the outer scales remain firm making the decay undetectable. Losses to bacterial bulb decay have increased steadily over the past decade where onions are grown intensively on plastic mulch. It has become common for the incidence of bacterial bulb decay to be 35 to over 50% in parts of both PA and NY, costing growers $100 to $300 per 100 feet of bed (3 feet wide). In 2008 in PA, 34 growers lost a total of $140,000 to bacterial bulb decay.

Attempts have been made by several growers to control bacterial diseases in onions with copper bactericides and other chemicals such as Oxidate. However, in PA, it has been reported that weekly sprays of various bactericides starting as early as when onion plants have just 5 leaves and continuing until the pre-harvest entry interval of the bactericide still resulted in unacceptably high incidence of bacterial disease (i.e. >30%). In order for bactericides to work, they need to be part of an Integrated Pest Management program that incorporates various cultural tactics such as different mulches and plant spacing.

Mulch Type: Growers' standard black plastic absorbs sunlight, thus increasing soil temperature, which in turn, promotes early crop development of onions. However, during the heat of June and July, the warmer soil temperatures provided by the black plastic may actually be creating a more favorable environment for bacterial diseases to develop and spread. In contrast, reflective silver mulch keeps soil temperatures cooler, and black biodegradable mulch provides early season added heat, which gives way to cooler soil temperatures as it degrades during the heat of summer. The lower temperatures provided by these alternative mulches could be the difference between optimum and below optimum temperatures for bacteria to grow. Similarly,

soil temperatures of bare ground would be cooler than under black plastic, but it may be at the expense of effective weed control that may compromise yield.

Plant Spacing: Essentially, wider plant spacing produces larger plants with more leaves, thicker necks with delayed maturity. Large bushy plants are more conducive to holding water in the leaf axils and whorls, which can favor bacteria entering into the plant. Thick necks take longer to dry and remain succulent and green for a longer time, which provides ideal conditions for bacterial diseases to spread from the leaves into the bulb. Delayed maturity interferes with proper lodging and curing of the neck and bulbs, allowing for increased risk for bacterial infections in the leaves to spread into the bulbs. Since narrow plant spacing produces smaller plants with thinner, tighter necks that mature earlier, theoretically, these plants would be less conducive to bacterial bulb decay.

The focus of this project was to evaluate the effects of cultural practices including plant spacing and mulch type on bacterial bulb decay, yield, bulb size and economic return in New York and Pennsylvania. **Funding** was provided by NESARE Partnership and NE IPM Partnership grants.

Methods:

Five on-farm small-plot field trials were conducted in NY and PA in 2009 and 2010. In Interlaken, NY (2009) and in New Holland, PA (2009 & 2010), two narrow (4") and two wide (10") plant spacing configurations (3 & 4 rows per bed) were compared to the growers' standards (NY: 8", 4 rows; PA: 6", 4 rows). In NY in 2010, four narrow (4" & 6") planting configurations (3 & 4 rows per bed) and one wider configuration (8", 3 rows) were compared to the grower's standard. The trials were arranged as a randomized complete block design with 4 replications. Each replicate consisted of 1 bed wide by 15 feet. The growers maintained the trials. At maturity, number of leaves per plant and neck diameter were counted and measured on 10 randomly selected plants per replicate, and percent lodging visually estimated. All of the onions were harvested and graded. Significant differences among treatments were determined by General Analysis of Variance and Fisher's Protected LSD test (α=0.05).

Results:

Mulch Type: *Bacterial bulb decay:* In PA in 2010, the grower's standard black plastic mulch had 57% bacterial bulb decay at harvest (Table 1). Reflective silver mulch, biodegradable black mulch and bare ground had 23% (= 59% control), 17% (= 71% control) and 14% (= 75% control) bacterial bulb decay at harvest. *Marketable yield:* All of the alternatives to black plastic had significantly 1.8 to 2.8 times higher marketable yield (Table 1). *Bulb size:* Silver and biodegradable mulch had significantly 3.7 and 3.6 times, respectively, higher jumbo weight than black plastic (Table 1). Bare ground had significantly higher small and medium weight than black plastic. *Economic return:* Silver mulch had the highest economic return at $166 to $279 per 100 feet of row, which was closely followed by biodegradable black plastic at $160 to $262 per 100 feet of row, which were 1.9 to 2.9 times higher than black plastic, which net only $64 to $90 per 100 feet of bed (Table 1).

Recommendation: Black plastic should eventually be abandoned and alternative mulches, especially reflective silver mulch and biodegradable black plastic, be studied further to elucidate which most consistently performs the best during different growing seasons.

Table 1. Evaluation of different mulch types for reducing incidence of bacterial bulb decay and improving profitability in onion (cv. Candy), New Holland, PA, 2010: marketable yield and grade, incidence of bacterial bulb rot at harvest and net return.

At harvest (Jul-20-2010) per 100 feet of bed:

Treatment	Total Market-able Yield (lb)	Onion Grade (lb)				% bacterial bulb decay by weight	Net Economic Return[6]		
		Colossal (>4")	Jumbo (3-4")	Med. (2.25-3")	Small (<2.25")		Cost of Mulch/ herbi-cides[3]	Variable Price[4]	Uniform Price[5]
Black plastic (std)	119.5 c[1]	13	65 a	24 c	16 b	57 %	$2.38	$64	$90
Silver Plastic	331 a	27	242 b	46 bc	16 b	23 %	$4.20	$166	$279
Biodegradable Black Plastic	321 a	14	231 b	54 b	22 b	17 %	$7.00	$160	$262
Bare ground	213 b	0	85 a	82 a	46 a	14 %	$0.11	$121	$150
P Value (α=0.05)	***0.0008***	***NS[2]***	***0.0011***	***0.0026***	***0.0063***	***NS***			

[1]Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, p <0.05. [2]**NS:** Not significant, Fisher's Protected LSD test, p > 0.05. [3]**cost of herbicides:** Prowl H2O @ 8 fl oz + Goal Tender @ 24 fl oz = $16.67 per acre. [4]**Variable Price:** According to PA Simply Sweet marketing program: Colossal - $0.55/lb; Jumbo - $0.50/lb; Medium - $0.40/lb; Small - $0.20/lb; no more than 30% total marketable weight can be sold as small + medium. [5]**Uniform Price:** According to Interlaken road side stand prices: all grades except small (<2.25" not marketable) - $0.90/lb. [6]**Net Economic return:** gross (data not shown) minus cost of mulch/herbicides.

Onion Spacing: *Plant size:* In all of our trials, there was a general trend that as plant spacing decreased and plant density increased, plants had fewer leaves and thinner neck diameters at harvest, and matured earlier (data not shown). *Bacterial bulb rot:* In all trials, there was a general trend that as plant spacing decreased and planting density increased, incidence of bacterial bulb decay at harvest decreased (Table 2). Incidence of bacterial bulb decay in the growers' standard spacing was 37%, negligible, 6.4% and 63% in NY 2009, PA 2009 (data not shown), NY 2010 and PA 2010, respectively (Table 2). Percent control of bacterial bulb decay provided by the narrow plant spacing configurations (4", 3 & 4 rows) ranged from 53 – 64%. *Marketable yield:* There was a general trend in all trials that as plant spacing increased and planting density decreased, marketable yield increased (Table 2). Marketable yield in the narrow plant spacing (4") configurations (3 & 4 rows) was significantly 1.4 to 2.4 times higher than the growers' standards (Table 2). *Bulb size:* There was a general trend that as plant spacing decreased and plant density increased, jumbo weight increased, medium and small weight increased, and colossal weight was either the same or less than the growers' standards (Table 2). Jumbo weight was significantly 1.5 to 6.6 times higher in the narrow spacing (4") configurations (3 & 4 rows) compared to the growers' standards. Narrow spacing (4") had significantly higher small and medium weight than the growers' standards in all trials (Table 2). *Economic return:* Narrow plant spacing (4") with 4 rows net 1.4 to 5.5 times more with a value of $43 to $258 per 100 feet of bed than the growers' standards. Narrow plant spacing (4") with 3 rows net 1.1 to 1.9 times more with a value of $45 to $107 per 100 ft of bed than the growers' standards.

Recommendation: To manage bacterial disease of fresh market onions, we recommend that growers increase planting density to less than 36 inch^2 per bulb. For growers marketing jumbo and colossal onions, we recommend not using 4" plant spacing with 4 rows per bed, because there is risk of too much small and medium weight, especially in a hot dry year; rather, use 4" and 3 rows instead.

Table 2. Evaluation of onion spacing for reducing incidence of bacterial bulb decay and improving profitability in onion, Interlaken, NY 2009 & 2010 and New Holland, PA, 2010: marketable yield and grade, incidence of bacterial bulb decay at harvest and net return.

At harvest, per 100 feet of bed:

	Onion Spacing			Total	Onion Grade (lb)					Net Economic Return[5]		
Planting Density (inch²/bulb)	**No. rows /bed**	**Plant Spacing (inch)**	**No. plants /100 ft of bed**	**Market-able Yield (lb)**	**Colossal (>4")**	**Jumbo (3-4")**	**Medium (2.25-3")**	**Small (<2.5")**	**% bacterial bulb decay by weight**	**Cost of transplants[2]**	**Variable Price[3]**	**Uniform Price[4]**
Interlaken, NY: 2009 (cv. Nebula) on silver plastic												
24 inch²	4	4	1200	510 a[1]	130 b	330 a	36 a	10 a	13.3 % b	$40.50	$229	$410
32 inch²	3	4	900	460 a	270 a	190 b	10 b	2.0 b	13.8 % b	$30.38	$230	$384
48 inch² standard	4	8	600	330 b	270 a	50 c	6.0 bc	0.0 b	37.3 % a	$20.25	$160	$277
60 inch²	4	10	480	220 bc	200 ab	20 c	0.0 c	1.0 b	41.5 % a	$16.20	$111	$181
80 inch²	3	10	360	160 c	130 b	10 c	1.0 c	0.0 b	53.6 % a	$12.15	$70	$132
		P Value (α=0.05):		***0.0001***	***0.0352***	***0.0000***	***0.0000***	***0.0046***	***0.0064***	--	--	--
Interlaken, NY: 2010 (cv. Candy) on silver plastic												
24 inch²	4	4	1200	873 a	399	434 a	39 a	0	3.1 %	$40.50	$412	$745
32 inch²	3	4	900	716 b	447	253 b	16 b	0	6.0 %	$30.38	$348	$614
36 inch²	4	6	800	697 bc	510	182 b	4.7 c	0	3.6 %	$27.00	$346	$600
48 inch²	3	6	600	559 c	497	59 c	1.3 c	0	7.3 %	$20.25	$283	$483
48 inch² standard	4	8	600	595 bc	525	67 c	4.0 c	0	6.4 %	$20.25	$303	$516
64 inch²	3	8	360	369 d	349	20 c	0.7 c	0	23.3 %	$15.19	$202	$317
		P Value (α=0.05):		***0.0001***	***NS***	***0.0000***	***0.0001***	***--***	***NS***	--	--	--
New Holland, PA: 2010 (cv. Candy) on black plastic												
24 inch²	4	4	1200	339 a	0.0	187	108 a	43 a	29.5 %	$24.00	$315*	$242
32 inch²	3	4	900	277 ab	8.7	197	54 b	17 b	29.4 %	$18.00	$110*	$216
36 inch² standard	4	6	800	151 bc	6.7	122	21 b	1.3 b	63.1 %	$16.00	$57	$118
60 inch²	4	10	480	90 c	8.7	65	15 b	0.7 b	70.8 %	$9.60	$34	$71
80 inch²	3	10	360	77 c	25	43	6.7 b	2.0 b	70.1 %	$7.20	$31	$60
		P Value (α=0.05):		***0.0178***	***NS***	***NS***	***0.0012***	***0.0002***	***NS***	--	--	--

[1]Numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, p <0.05. [2]**cost of transplants:** NY - $1.35 for 40 plants or $0.03375 per plant (plugs); PA - $0.02 per plant (bare roots from Texas). [3]**Variable Price:** According to PA Simply Sweet prices: Colossal - $0.55/lb; Jumbo - $0.50/lb; Medium - $0.40/lb; Small - $0.20/lb; no more than 30% total marketable weight can be sold as small + medium. [4]**Uniform Price:** According to Interlaken road side stand prices: all grades except small (<2.25" not marketable) - $0.90/lb. [5]**Net return:** gross (data not shown) minus cost of transplants.