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Onion Spacing to Reduce Bacterial Rot of Fresh Market Onions

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Small-scale diversified fresh market vegetable growers who grow onions intensively are constantly challenged by yield losses due to bacterial bulb rots, which greatly compromise the profitability of the crop.

Bacterial Rot of Onions

In New York, Sour Skin caused by *Burholderia cepacia*, is the most common cause of bacterial bulb rot, but *Pantoea ananatis* has also been identified, and several others are likely part of the complex. Bacterial diseases first appear as leaf blight symptoms on the center leaves of the plant, resulting in yellowing or bleaching and wilting of these leaves. The infection progresses down the leaves and the neck, and eventually into the bulb. Affected bulb scales eventually become soft and yellowish-brown in appearance. Additional losses can occur during storage when outwardly asymptomatic bulbs at harvest continue to breakdown. It is possible that a bacterial infection may be stopped in the leaves before it reaches the bulb, but once it is in the bulb, there is nothing that can be done.

Bacteria persist in soil, water, crop debris, weeds and other crops. Infection generally occurs through a wound (caused by pelting rain, hail, thrips, herbicide or mechanical injury) when free water from rain, irrigation or flooding, causes water congestion in the host tissue. Bacteria enter the plant via contaminated water during irrigation or splashing soil during heavy rainfall events, when it settles in the leaf axils, and directly through the green neck tissue when onions are topped during harvest.

Infection may occur at any time during the growing season, but, often plants do not show symptoms until after bulbing. Bacteria spread more rapidly in water-soaked tissue, and survive, infect, develop and spread over a wide temperature range (32 to 105 °F). Bacterial diseases are favored by excessive nitrogen fertilization.

Chemical tactics have failed to control bacterial diseases

Attempts have been made by several growers to control bacterial diseases in onions with copper bactericides and other chemicals such as Oxidate. However, in Pennsylvania, 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 plant spacing.

How does plant spacing affect bacterial rot?

Essentially, wider plant spacing produces larger plants with more leaves, thicker necks and 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 greener for a prolonged period of 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 of bacterial infections in the leaves to spread into the bulbs. It is possible for a bacterial infection that is in a leaf to be stopped before it makes its way into the bulb, if the neck tissue is no longer conducive to its spread (i.e. the tissue is dry and not green and succulent). Since narrow plant spacing produces smaller plants with thinner, tighter necks that mature on time, theoretically, these plants would have less bacterial disease and improved storability.

In an on-farm trial that we conducted in New Holland, PA in 2009, we found that compared to the grower's standard spacing (6" plant spacing, 4 rows/bed), plants grown on narrow spacing (4" with 4 rows/bed) had significantly 1 less leaf per plant, a thinner neck by 0.08" and twice as many lodged plants (narrow: 86% vs. std.: 44%) at harvest on July 16 (Table 1). Plants grown with wider plant spacing (10" with 3 rows per bed) had significantly thicker necks by 0.07" and only 7% lodged plants (Table 1).

Narrow plant spacing reduced incidence of bacterial rot to one third

In an on-farm trial that we conducted in Interlaken, NY in 2009, the grower's standard planting configuration (8" plant spacing with 4 rows/bed) resulted in 37% incidence of bacterial bulb rot at harvest compared to the narrow 4" plant spacings with 4 and 3 rows per bed, which had 13% and 14% disease incidence, respectively (Table 2). Consequently, these narrow plant spacings also had significantly higher marketable yields and economic return despite higher input costs, as a result of more marketable jumbo and colossal sized bulbs (Table 2). Although, wide plant spacings yielded more colossal weight, it was these large sized bulbs that tended to rot (data not shown).

The cost of transplants in the narrow plant spacings were 1.5 to 2 times more than for the standard planting configuration (Table 2 & 3). Despite

this, the net economic return was 1.4 and 1.5 times more than the standard ($277 per 100 ft bed) for the 4" plant spacing configurations with 3 ($384 per 100 ft bed) and 4 ($419 per 100 ft bed) rows/bed, respectively, when the price was $0.90 per lb, irregardless of bulb size. Even in markets where the jumbo and colossal sized bulbs yield higher prices, the economic return of the narrow plant spacings was still 1.4 times more than the grower's standard plant spacing (Table 3), because many of the colossal sized bulbs were rotten and unmarketable.

Table 1. Evaluation of plant spacing on small-scale fresh market sweet onions (cv. Candy) for plant size and lodging at maturity, New Holland, PA, July 16, 2009.

Planting Configuration					*Plant Size*[4]		*Maturity*
Planting Density (inch^2/bulb)	Number Rows per Bed[1]	Row Spacing (inch)	Plant Spacing (inch)	No. plants per 100 ft bed[1]	Number Leaves per Plant	Neck Diameter (inch)	% Lodging[3]
24 inch^2	4	6	4	1200	7.86 b[2]	0.66 d	86.4 a
32 inch^2	3	8	4	900	8.16 b	0.69 cd	68.3 ab
36 inch^2 Standard	4	6	6	800	8.83 a	0.74 bc	44.3 b
60 inch^2	4	6	10	480	9.16 a	0.78 ab	7.5 c
80 inch^2	3	8	10	360	9.18 a	0.81 a	7.0 c
				P value:	***0.0001***	***0.0001***	***0.0004***

[1] bed width = 3 feet.
[2] numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, p > 0.05.
[3] percent lodging was estimated visually.
[4] number of leaves per plant and neck diameter were counted and measured, respectively, from 10 randomly selected plants per replicate.

Table 2. Evaluation of planting configurations of small-scale pungent yellow fresh market onions (cv. Nebula) on marketable yield and grade, quality and economic return, Interlaken, NY 2009 (Hoepting 2009).

Planting Configuration					*Total Marketable Yield*	*Onion Grade (lb per 100 ft bed)*				*Bacterial Bulb Rot*		*Economic Return ($ per 100 ft bed)*		
Planting Density (in^2/bulb)	No. rows /bed[1]	Row spacing (inch)	Plant spacing (inch)	No. plants per 100 ft bed[1]	(lb per 100 ft bed[1])	Small <2.5"	Med 2.5-3"	Jumbo 3-4"	Colossal >4"	lb per 100 ft bed[1]	% by weight	GROSS[3]	Cost of transplants[4]	NET[5]
24 inch^2	4	6	4	1200	510 a[2]	10.0 a	36.0 a	330 a	130 b	70	13.3 b	$459	$40.50	$419
32 inch^2	3	8	4	900	460 a	2.00 b	10.0 b	190 b	270 a	70	13.8 b	$414	$30.38	$384
48 inch^2 standard	4	6	8	600	330 b	0.00 b	6.00 bc	50.0 c	270 a	180	37.3 a	$297	$20.25	$277
60 inch^2	4	6	10	480	220 bc	1.00 b	0.00 c	20.0 c	200 ab	170	41.5 a	$198	$16.20	$182
80 inch^2	3	8	10	360	160 c	0.00 b	1.00 c	10.0 c	130 b	190	53.6 a	$144	$12.15	$132
P Value:					***0.0001***	***0.0046***	***0.0000***	***0.0000***	***0.0352***	***NS[6]***	***0.0064***			

[1] Bed width = 3 ft.
[2] numbers in a column followed by the same letter are not significantly different, Fisher's Protected LSD test, p > 0.05.
[3] GROSS = marketable yield x $0.90 per pound.
[4] cost of transplants = $1.35 per 40 plants (=$0.03375 per plant).
[5] NET = GROSS minus cost of transplants, all other expenses equal.
[6] NS = not significant.

Recommendations

- If you are experiencing economic losses due to bacterial rots in your onions, consider experimenting on a small scale with narrow plant spacing (i.e. 4"). Please let us (Jud Reid, Christy Hoepting or Katie Klotzbach) know if you are interested in trying narrow plant spacing, as we would be very interested in seeing it on your farm.
- Practice good field sanitation by not leaving rotten cull onions in the field. Even if you practice good crop rotation, the bacteria will build up in your fields over time.
- Do not apply nitrogen after bulbing has begun, as this can increase bacterial problems.

Stay tuned! Plans are underway (funding pending) to continue this research in 2010 and 2011 in NY and PA.

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Table 3. Evaluation of planting configurations of small-scale pungent yellow fresh market onions (cv. Nebula) on economic return, using variable pricing of PA sweet onions, 2009 (Hoepting 2009).

Planting Configuration					*$ per size class[2] (per 100 ft bed[1])*				*Economic Return ($ per 100 ft bed)*		
Planting Density (in²/bulb)	No. rows /bed[1]	Row spacing (inch)	Jumbo 3-4"	No. plants per 100 ft bed[1]	Small $0.20/lb	Medium $0.40/lb	Jumbo $0.50/lb	Colossal $0.55/lb	GROSS[3]	Cost of transplants[4]	NET[5]
24 inch²	4	6	4	1200	$2.00	$14.40	$165.00	$71.50	$252.90	$24.00	$229
32 inch²	3	8	4	900	$0.40	$4.00	$95.00	$148.50	$247.90	$18.00	$230
48 inch² standard	4	6	8	600	$0.00	$2.40	$25.00	$148.50	$175.90	$12.00	$164
60 inch²	4	6	10	480	$0.20	$0.00	$10.00	$110.00	$120.20	$9.60	$111
80 inch²	3	8	10	360	$0.00	$0.40	$5.00	$71.50	$76.90	$7.20	$70

[1]Bed width = 3 ft.
[2]size class distribution from Table 1.
[3]GROSS = sum of $ per size
[4]cost of transplants = $0.02 per plant.
[5]NET = GROSS minus cost of transplants, all other costs equal.

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2008 Organic Production Survey

www.nass.usda.gov/ny

The 2008 Organic Production Survey counted 827 USDA-certified or exempt organic farms in the state of New York, according to Steve Ropel, Director of USDA's National Agricultural Statistics Service, New York Field Office. Nationally, New York ranks fourth in the number of organic farms, behind California, Wisconsin, and Washington. Total area devoted to organic production in New York was 168,428 acres. Value of sales of organically produced commodities in the state totaled $105.1 million, ranking seventh nationally and accounting for 3.3 percent of total U.S. organic sales. This survey, conducted as a follow-on to the 2007 Census of Agriculture, is USDA's first ever wide-scale survey of organic farming in the United States.

Complete results are available online at www.agcensus.usda.gov/Publications/2007/Online_Highlights/Organics.

For further information call the New York office at 800-821- 1276 or email: nass-ny@nass.usda.gov.

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