ONION (*Allium cepa*)
Onion stunting; *Rhizoctonia* spp.

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Yield responses of three onion cultivars to stunting caused by *Rhizoctonia* spp. in the Columbia Basin of Oregon and Washington, 2012.

Rhizoctonia spp. cause patches of stunted onion plants in onion bulbs crop in the Columbia Basin of Washington and Oregon when onion crops are planted in sandy soils of this semi-arid region following winter cereal cover crops. A herbicide application is used to kill the cereal cover crop, usually just prior to planting onion seed, to avoid the cover crop competing with the onion crop. Plants in the stunted patches do not resume the normal growth and development compared to adjacent healthy plants, resulting in reduced bulb size in the patches. Field surveys were carried out to assess the effects of onion stunting caused by *Rhizoctonia* spp. on the yield of each of three onion cultivars grown in the semi-arid Columbia Basin of Oregon and Washington in grower-cooperator, center-pivot irrigated fields. Onion cultivars evaluated were: Mercury, a red cv. seeded in four rows per 44 in. wide bed on 13 Mar in a field near Paterson, WA; Tamara, a yellow cv. planted in two double-rows per 40 in. wide bed on 16 Mar in a field near Boardman, OR; and Cometa, a white cv. planted in two double-rows per 34 in. wide bed on 8 Apr in a field near Pasco, WA. Each field was maintained by a different grower-cooperator. Patches of onion plants with different severity of stunting were selected in each field at the five to seven true-leaf growth stages. The severity of stunting was rated using a 1 to 3 scale where: 1 = a majority of the plants in the patch were stunted < 33% relative to adjacent, healthy plants outside the patch; 2 = a majority of plants were stunted 33 to 66%; and 3 = a majority of plants were stunted > 66%. Five patches were selected per field for each of the three severity ratings. Each patch was > 5 ft. long and at least two beds wide. Manual harvest of each cultivar was done at maturity: 1 Aug for Mercury, 27 Aug for Tamara, and 21 Aug for Cometa, by harvesting bulbs from 5 ft. of each of two double rows per patch. Bulbs also were harvested from an equivalent area of healthy plants adjacent to each patch. Bulbs from each patch and adjacent healthy area were bagged separately and graded by size: colossal (> 4.00 in. diameter), jumbo (3.00-4.00 in.), medium (2.25-3.00 in.), prepack (< 2.25 in.), and culled (non-marketable). The total number of bulbs in each size category was counted, and the total bulb weight per size category measured. All sizes, except culled bulbs, were considered marketable. The number and weight of bulbs in each size category was calculated as a percentage of the bulbs harvested in a plot. The reduction in number and weight of bulbs in each size category was then computed as a percentage of the number and weight of bulbs of each size harvested from healthy plants adjacent to the patch. The relationship between severity of onion stunting and percentage reduction in yield for each cultivar was calculated using correlation and regression analyses in SigmaPlot (Version 10; Systat Software Inc., San Jose, CA).

The number of bulbs harvested within stunted patches did not differ significantly from the number of bulbs harvested from adjacent, healthy plants in each of the three fields evaluated (*data not shown*), i.e., stunting caused by *Rhizoctonia* did not affect plant stands. However, bulb size was affected by onion stunting, with a greater impact on bulb size the more severely the plants were stunted (Table 1). Colossal bulbs were present only in healthy areas sampled from the fields planted with Mercury or Tamara, but not in healthy areas in the Cometa field or in any of the patches for any of the cultivars (Table 1). In the healthy areas sampled from the Mercury and Tamara fields, a majority of the bulbs were jumbo size, followed by medium size bulbs, with few or no prepack and culled bulbs. In healthy areas of the Cometa field, a majority of bulbs were medium and jumbo. As the stunting severity increased, the number of prepack bulbs increased as a result of fewer jumbo and medium bulbs. For all three cultivars, the distribution of bulb number and weight among the size categories for bulbs harvested in the patches shifted to a greater number and weight of smaller bulbs as the stunting severity increased (Table 1). Total weight of Mercury bulbs was reduced by 49, 54, and 77% in patches with severity ratings of 1, 2, and 3, respectively, compared to adjacent, healthy plants. Similarly, the number of total marketable bulbs (colossal + jumbo + medium + prepack) compared to healthy areas of the field was reduced 49, 54, and 79% in patches with mean severity ratings of 1, 2, and 3, respectively. Correlation analyses revealed significant associations between severity of stunting in the Mercury field and percent reduction in jumbo bulbs ($r = 0.61$, $P = 0.012$ for number of bulbs, and $r = 0.60$, $P = 0.014$ for weight of bulbs), total bulbs ($r = 0.63$, $P = 0.009$ for number of bulbs, and $r = 0.70$, $P = 0.003$ for weight of bulbs), and total marketable bulbs ($r = 0.64$, $P = 0.007$ for number of bulbs, and $r = 0.69$, $P = 0.003$ for total weight). Onion stunting resulted in similar reductions in bulb yield for Tamara. The total weight of Tamara bulbs harvested from patches with a severity of 1 was 25% less than in healthy areas of the field, and patches with a stunting severity of 2 and 3 produced 58 and 61% less total bulb weight, respectively. Significant positive correlations for Tamara were found between the severity of stunting and percentage reduction in number ($r = 0.93$, $P = 0.0001$) and weight ($r = 0.93$, $P = 0.0001$) of jumbo bulbs, total bulb weight ($r = 0.73$, $P = 0.002$), and total marketable bulb weight ($r = 0.73$, $P = 0.002$), but not for total and marketable bulb number. For Cometa, stunting reduced the total number of bulbs and number of marketable bulbs, as well as total weight of bulbs and weight of marketable bulbs. Patches in the Cometa field with severity ratings of 1, 2, and 3 had a reduction in total bulb weight of 34, 47, and 66%, respectively; and a reduction in marketable bulb weight of 35, 48, and 68%, respectively. The number of medium bulbs ($r = 0.61$, $P = 0.017$) and weight of medium bulbs ($r = 0.64$, $P = 0.01$), total number of bulbs ($r = 0.56$, $P = 0.02$) and total bulb weight ($r = 0.70$, $P = 0.003$), and number ($r = 0.75$, $P = 0.001$) and weight of marketable bulbs ($r = 0.73$, $P = 0.002$) of Cometa were also positively correlated with severity of stunting. Significant regression equations calculated for total bulb weight and marketable bulb weight for Mercury, Tamara, and Cometa enabled estimation of the potential yield loss associated with each severity of stunting for each of the three cultivars (Table 2). These regression equations may be useful for cost-benefit analyses in experiments evaluating the impact of potential management practices on stunting caused by *Rhizoctonia* spp. In conclusion, onion stunting caused by *Rhizoctonia* spp. reduced bulb yields significantly for all three cultivars, and the greater the severity of stunting, the greater the decrease in total and marketable bulb weight as a result of smaller bulbs.

Table 1.

Cultivar	Onion stunting severity (0-3)	Number of onion bulbs in each size category (% of bulbs harvested)[z]					Total onion bulb weight by size category (% of bulbs harvested)[y]				
		Colo-ssal	Jumbo	Medium	Pre-pack	Culled	Colo-ssal	Jumbo	Medium	Pre-pack	Culled
Cometa	0	0[x]	32	54	12	2	0	50	46	4	0
	1	0	10	59	25	6	0	23	66	10	1
	2	0	3	56	30	11	0	8	74	15	3
	3	0	1	35	36	28	0	5	62	27	6
Mercury	0	1	65	31	3	0	2	77	20	1	0
	1	0	26	46	18	10	0	47	45	6	2
	2	0	9	61	24	6	0	20	68	11	1
	3	0	8	38	24	30	0	26	50	16	8
Tamara	0	2	85	11	2	0	6	89	5	0	0
	1	0	55	43	2	0	0	69	29	2	0
	2	0	20	62	17	1	0	37	55	7	1
	3	0	3	64	32	1	0	8	77	14	1

z The number of bulbs in each size category was converted to a percentage of all bulbs harvested from a plot (total = 100% for all size categories).

y The weight of all onion bulbs in a particular size category was calculated as a percentage of the total weight of onion bulbs harvested from that patch.

x Each data point is the mean of five replicate patches for that severity rating.

Table 2.

Cultivar	Regression equation for the reduction in number or total weight of onion bulbs in a stunted patch as a percentage of bulbs harvested from adjacent, healthy plants	*P*-value [z]	R^2 (%)[y]
Cometa	Total bulb number = -16.2 + 12.7X[x]	0.0284	32
	Total bulb weight = 16.1 + 16.4X	0.0034	50
	Marketable bulb number = -20.3 + 20.8X	0.0013	56
	Marketable bulb weight = 16.2 + 17.1X	0.0020	54
Mercury	Total bulb number = -16.9 + 11X	0.0089	40
	Total bulb weight = 27.7 + 15.1X	0.0027	49
	Marketable bulb number = -17.8 + 17.5X	0.0071	41
	Marketable bulb weight = 27.8 + 15.5X	0.0029	48
Tamara	Total bulb number = -9.1 - 0.54X	0.9460	0
	Total bulb weight = 12.8 + 17.1X	0.0021	53
	Marketable bulb number = -11.6 + 0.44X	0.9570	0
	Marketable bulb weight = 12.4 + 17.3X	0.0020	53

z *P* value = probability that the regression equation is significant.

y R^2 = Coefficient of determination for the regression equation that best fit the data.

x X = Mean severity of stunting of a majority of the onion plants in a patch, rated on a scale of 1 to 3, compared to adjacent, healthy plants (refer to the scale description in the main text).