SPINACH (*Spinacia oleracea* 'Seven R', 'Coho', 'Fall Green')
White rust; *Albugo occidentalis*

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EFFICACY OF GENETIC CONTROL AND CHEMICAL CONTROL FOR MANAGING WHITE RUST IN SPINACH, 1996: A field experiment was conducted at the Long Island Horticultural Research Laboratory in Riverhead, NY, on Riverhead sandy loam soil. White rust was established in the field before the experiment was started. Rows of spinach were planted on 23 May and 5 Jul along two sides and through the center of the field. Infected leaves obtained from commercial spinach plantings were placed randomly on plants throughout these rows while it was raining. Fertilizer (1000 lb/A of 10-10-10) was broadcast and incorporated on 22 Aug. The experimental plots were planted on 28 Aug. Weeds were controlled by disking before planting, applying Ro-Neet 6E (1.5 qt/A) on 26 Aug, and hand weeding. Ridomil 2E (1.5 qt/A) was applied with Ro-Neet to control damping-off. Average monthly high and low temperatures (F) were 75/58 in Sep and 65/45 in Oct. Rainfall (in.) was 4.74 and 9.12 for these months, respectively. The field was overhead irrigated (approx. 1.0 in.) on 29-30 Aug and 5 Sep. Beet armyworm was managed by applying Larvin 3.2 (30 oz/A) on 26 Sep and 4 Oct. The 18 treatments consisted of three varieties and six fungicide programs arranged in a factorial design with four replications. Varieties were Seven R (Asgrow Seed Co.) which is susceptible to white rust, Coho (Alf Christianson Seed Co.) which is moderately susceptible, and Fall Green (Alf Christianson Seed Co.) which is moderately resistant. Plots were three 25-ft rows spaced 12 in. apart on raised beds. Fungicides were applied on 24 Sep; 1, 8, 15, 23 Oct; and 1 Nov with a CO_2-pressurized backpack sprayer and hand-held boom equipped with three Blue XR TeeJet (8003VS) nozzles spaced 17 in. apart that delivered 40 gpa at 50 psi. Rain began about 1 hr after the applications were completed on 8 Oct and 1 Nov, which may have compromised the fungicide control. Disease severity (0-100 severity) was assessed on 30 Sep, 22-23 Oct and 29-31 Oct. Number of lesions or severity was recorded for each expanded leaf on each of four plants at four locations (16 plants total). Harvesting was done from 5 - 11 Nov. Two methods were used to simulate fresh market and processing spinach harvest. Plants were cut at the soil line from three 3-ft sections in the center row of each plot. Plants with white rust were counted. Leaves with white rust or chlorotic/necrotic tissue were removed, categorized, counted and weighed. The categories were: B Grade due to white rust (total lesion size of at least 0.75 in. diam), A Grade with white rust (total lesion size less than 0.75 in.), and B Grade other (25% of tissue not green for reasons other than disease). Leaf tissue with no white rust also was weighed. For processing spinach harvest, leaves were cut with hand-held clippers two in. above the soil line, which is the height used by commercial harvesters, from three 3-ft sections. Leaves were separated into three categories (A Grade, B Grade due to disease and B Grade other), then weighed. The overall quality of the cut leaves for each plot was rated A, B, or substandard if the weight of B Grade leaves was less than 5% of the total yield, greater than 5%, or greater than 12%, respectively. Economic benefit of each fungicide program was calculated by subtracting the value of the nontreated crop from the net return for the treated crop (net return = crop value minus treatment cost). Prices used to calculate crop value were $7.16 for a 25-lb crate of fresh market spinach, $175/T for A grade processing spinach, and $145/T for B grade processing spinach. Substandard spinach was priced the same as B grade; a processor could choose to reject it. Fungicide costs/A were $3.30 for Kocide, $18.90 for Aliette, $6.38 for Maneb, and $4.75 for Syllit. Treatment cost included $6.60/A to make an application. In addition to conducting a standard analysis of variance, planned comparisons were conducted between each nontreated resistant variety and Seven R treated with Kocide + Aliette.

Disease pressure was high. White rust was first observed in some plots on 23 Sep when most plants were at the two-leaf stage. It became quite severe, especially on nontreated Seven R. Both chemical control (fungicides) and genetic control (host plant resistance) were effective. Both significantly reduced white rust severity, incidence and % B Grade yield. Impact of control practices on severity was often greater than on Grade A yield because leaves severely affected by white rust and leaves with just one large lesion were both considered Grade B. For example, rust severity on 29 Oct was four times greater on non-treated Seven R than on Kocide-treated Seven R whereas percent of fresh market yield that was B Grade due to rust was only 1.6 times greater. Varieties differed significantly in total yield (T/A), with susceptible Seven R producing the most. Syllit was the most effective fungicide and one of the least expensive ($68/A for 6 applications). Economic benefit of the fungicide programs for fresh market spinach was $1218 to $2860 for Seven R while there was no benefit to applying fungicides to Fall Green. The percent B grade processing spinach for all treatments was greater than 12% and resulted in substandard rating. Chemical control and genetic control were equally effective. Susceptible Seven R treated with Kocide + Aliette produced a similar amount of A grade fresh market spinach as nontreated Fall Green ($p=0.33$) and nontreated Coho ($p=0.46$).

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Variety	Treatment & rate/A	Rust Severity[1]	Rust incidence[2]	Fresh market spinach yield: Total (T/A)	B Grade rust (%)[3]	A Grade (crate/A)	Fungicide Benefit ($)	Processing spinach yield: Total (T/A)	B Grade (%)	A Grade (T/A)	Fungicide Benefit ($)
	Control	4.8	93	10.7	15	560		4.0	40	3.4	
	Kocide LF 1qt	1.4	63	10.0	8	580	84	4.8	28	3.6	53
	Aliette 80WDG 3 lb	1.5	83	11.6	12	619	269	4.6	32	3.5	-69
	Kocide 1 qt + Aliette 2 lb	1.0	63	12.1	6	700	830	5.2	27	3.3	4
	Maneb 75DF 2.1 lb	1.7	67	11.5	11	677	760	5.5	27	3.2	138
	Syllit 65W 0.5 lb	0.3	20	10.5	1	645	540	4.8	18	3.2	48
Seven R		3.0	84	12.0	15	609		5.9	42	3.4	
Coho		1.6	64	11.3	7	667		4.5	27	2.8	
Fall Green		0.8	46	9.9	4	615		4.1	16	3.9	
Seven R	Control	7.8	100	10.0	22	380		4.4	63	2.8	
Seven R	Kocide	1.9	93	11.4	14	634	1,759	5.7	40	3.1	134
Seven R	Aliette	2.4	98	13.7	20	651	1,787	6.4	49	4.4	138
Seven R	Kocide+Aliette	2.0	89	12.2	11	636	1,660	6.2	39	3.6	100
Seven R	Maneb	3.4	85	11.6	21	561	1,218	6.5	44	2.7	228
Seven R	Syllit	0.7	42	13.2	2	789	2,860	6.5	19	3.9	246
Coho	Control	4.9	97	10.1	15	551		3.7	42	2.7	
Coho	Kocide	1.4	66	10.3	5	578	134	4.8	25	2.2	99
Coho	Aliette	1.2	82	12.7	9	731	1,136	3.9	30	2.7	-116
Coho	Kocide/Aliette	0.5	49	11.8	3	741	1,188	4.7	26	3.1	-24
Coho	Maneb	1.4	78	13.2	8	813	1,798	5.5	20	3.0	193
Coho	Syllit	0.2	15	9.6	1	588	197	4.3	18	3.2	23
Fall Green	Control	1.9	81	11.9	7	750		4.0	15	4.9	
Fall Green	Kocide	1.1	30	8.4	4	528	-1,649	3.9	18	5.6	-75
Fall Green	Aliette	0.8	70	8.4	7	474	-2,129	3.5	17	3.3	-229
Fall Green	Kocide/Aliette	0.6	52	12.4	4	724	-359	4.8	14	3.3	-65
Fall Green	Maneb	0.3	39	9.8	2	656	-751	4.5	17	4.0	-6
Fall Green	Syllit	0.0	2	8.7	0	559	-1436	3.6	17	2.5	-124
ANOVA analyses (p-values)											
Replication		0.0066	0.0647	0.0001	0.1997	0.0001		0.0064	0.0049	0.0161	
Variety		0.0007	0.0001	0.0176	0.0001	0.4014		0.0002	0.0001	0.9524	
Fungicide		0.0001	0.0001	0.3021	0.0001	0.2593		0.2240	0.0003	0.0038	
Variety X Fungicide		0.3714	0.2758	0.1004	0.1220	0.0150		0.8668	0.0267	0.0998	

[1] White rust severity (0-100) on 29 Oct.
[2] Incidence of plants with white rust at harvest.
[3] Percentage of leaves that were B grade because of white rust.