Section IV
Cereal Crop Pests

ECONOMIC IMPACT OF HESSIAN FLY ON SPRING WHEAT IN EASTERN OREGON, 2001 & 2002

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Damage caused by Hessian fly (*Mayetiola destructor*) was quantified in spring wheat variety trials near Pendleton, Oregon during 2001 and 2002. Grain yields for resistant genotypes were 69% higher than those for susceptible genotypes. Aldicarb (Temik) treatment led to a doubling of yields for susceptible genotypes at one location. Resistant varieties and aldicarb improved grain market quality by up to two grades during 2001 but not 2002. Hessian fly caused economic damage in excess of $70 per acre (20 bu/acre x $3.50/bu) during 2001 and $47 per acre (11 bu/acre x $4.25/bu) during 2002. These estimates exclude price discounts for reduced market quality.

Genetic Resistance

Experiments were performed to examine spring wheat cultivars and advanced breeding lines for response to Fusarium crown rot (*F. pseudograminearum*). Wheat entries were planted into conventionally-tilled (chisel plow and rod weeder) summer fallow following winter wheat that was harvested 14 months earlier at the OSU Columbia Basin Agricultural Research Center (CBARC) at Pendleton. Wheat entries were from Dr. Kidwell's breeding program, where resistance to Hessian fly is emphasized. Wheat was planted at 25 seeds/ft^2 into 5x20 ft replicated (4x) plots. Seed was treated with benomyl (Benlate®) and planted on March 20, 2001 and March 14, 2002. Each wheat entry was planted with and without inoculum of *F. pseudograminearum*, using a split-plot design. Since responses to Hessian fly are reported only for non-inoculated plots, data reported here were analyzed as a randomized complete block design. Hessian fly damage was first noted during June each year. During 2001, samples were collected and plants were scored positive if at least one puparium was detected per plant. Prematurely ripening (whiteheads) and total heads per row were counted in early July and grain was harvested during August. During 2002, data was collected similarly with the exception that individual tillers were also scored for presence of puparia and percentages of lodged tillers were estimated.

Reactions of wheat to Hessian fly ranged from no resistance to complete resistance (Tables 1 and 2). Grain yield was greatly reduced for many entries susceptible to Hessian fly. Yield was correlated with percentages of plants infested by Hessian fly (Fig. 1A). The regression during 2001 suggested an 0.26-bushel yield reduction for each percentage of infested plants but evaluation of plotted data indicated the possibility of a critical infestation level at which yield began to be depressed. This was examined by bracketing data into quadrants and moving vertical and horizontal lines to approximate the percentage of infested plants at which yield became unstable in some entries (Fig. 1B). Damage appeared to become acute when at least one puparium was present in more than 80 percent of the plants during 2001. The relationship between infestation and yield was less defined during 2002, when infestation levels were lower than in 2001.

Damage was also evaluated by comparing average yields for entries with either more or less than 50 percent infested plants during 2001, and more or less than 20 percent infested plants during 2002 (Fig. 2). Eleven entries with less than 50 percent infested plants yielded 69 percent more grain than eleven entries with more than 50 percent infested plants during 2001; 51 vs. 30 bu/acre. The same percentage difference in yield occurred when groups of 12 entries were compared at lower levels of infestation during 2002; 32 vs 19 bu/acre.

Test weight was evaluated in the same manner as grain yields. Test weight was correlated with percentages of plants infested by Hessian fly during 2001 ($y = 58.7 - 0.02x$, $R^2 = 0.23$, $p = 0.02$) but Hessian fly did not reduce test weight during 2002. Bracketed data during 2001 indicated that test weight for some wheat entries became unstable and declined when more than 80 percent of plants were infested. U.S. grain marketing requirements are strongly influenced by test weight. Minimum standards for hard red spring wheat and white club are 58 lb/bu for No. 1, 57 lb/bu for No, 2, 55 lb/bu for No. 3, 53 lb/bu for No. 4, and 50 lb/bu for No. 5. Hessian fly therefore reduced wheat marketing grade from No. 1 to No. 3 during 2001 (Fig. 2).

Variety x Temik Interaction

An experiment during 2001 was designed to examine damage by root-lesion nematodes. Spring wheat was planted into annually cropped no-till fields at CBARC 8 miles NE of Pendleton and the Hill Farm 8 miles SE of Pendleton. Spring wheat followed 2 years of winter wheat at CBARC and 1 year of canola after winter wheat at the Hill Farm. Four spring wheat varieties were susceptible and one ('Westbred 926') was resistant to Hessian fly. Each variety was planted into replicated plots with or without Temik® 15G in a split-plot design. Wheat was planted as described for the genetic resistance study. Temik was applied at 25 lb/acre with the seed. Starter fertilizer (16-20-0-14; at 10 lb N/acre) was banded 1-inch below the seed, and seed was treated with RTU Raxil-Thiram®. Hessian fly was detected during June and plants were scored positive if they contained one or more puparium per plant. Grain was destroyed after harvest because Temik is not registered for use on wheat.

High levels of Hessian fly were recorded at both sites. About 90 percent of mature plants for susceptible varieties contained at least one puparium under the leaf sheath of one or more tillers (Table 3). Up to 12 puparia per tiller were observed at CBARC, where the fly caused extensive lodging. 'Westbred 926' had no puparia in plants at the Hill Farm and in up to 13 percent plants at CBARC. Temik strongly improved foliar growth and tiller density for susceptible varieties at CBARC, and reduced lodging at both locations. Temik did not reduce final fly infestation rates, as assessed by puparia present on plants late in the growing season. Therefore, the insecticide did not greatly reduce over-summering or wintering populations capable of emerging for the autumn or spring flights.

During 2001, 'Westbred 926' had higher grain yields than the four other varieties. Yield improved 4 to 7 percent when Temik was applied to 'Westbred 926' (Table 3). Applying Temik to the group of susceptible varieties improved yields 44 and 105 percent at the Hill Farm and CBARC, respectively. The yield benefit from genetic resistance was far less when Temik was applied (26 to 22 percent) than when it was not applied (45 to 60 percent). Spring wheat yields were not improved when Temik was applied to a Hessian fly-resistant cultivar ('Zak') in fields with negligible lesion nematode populations at two locations (unpublished data, 2002).

Yields were weakly correlated with both Hessian fly (Fig. 3A: 27 percent of yield) and lesion nematode damage (Fig. 3B: 21 percent of yield). Both pests were considered important constraints to grain yield in annually cropped fields. Data were explained more fully by regressing yield against a combined damage rating function for Hessian fly plus lesion nematodes (Fig. 3C: 46 percent of yield explained).

Test weight also improved 2 to 3 lb/bu when Temik was applied to 'Westbred 926' (Table 2). For all except one susceptible variety, application of Temik improved grain quality by one or two grades at both locations. The benefit of genetic resistance was also clear; 'Westbred 926' produced grain two to three market grades higher than for susceptible varieties at CBARC. Benefits of resistance were less clear at the Hill Farm, where 'Westbred 926' and all other varieties graded U.S. No. 3 or lower in the absence of Temik, and all except one variety were improved one or two grades by application of Temik.

Acknowledgements

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Table 1. Influence of Hessian fly on grain yield and quality in spring wheat varieties and breeding lines at the Columbia Basin Agricultural Research Center at Pendleton during 2001.

Wheat entry	Plants with one puparium or more	Grain yield	Test weight	Market grade
	percent	*bu/acre*	*lb/bu*	*US No.*
Macon	0	50	58.3	1
WA 7894	0	43	59.1	1
WA 7877	3	57	58.7	1
Zak	5	58	57.5	2
WA 7892	20	42	57.9	2
WA 7906	23	51	58.3	1
WA 7893	23	49	58.9	1
Tara	23	43	58.6	1
WA 7905	35	54	58.9	1
WA 7887	35	52	58.9	1
WA 7890	48	56	57.4	2
WA 7904	73	42	56.7	3
WA 7902	85	18	59.4	1
WA 7910	90	39	58.8	1
WA 7886	90	31	56.0	3
Calorwa	90	19	52.7	5
Scarlet	93	34	58.3	1
WA 7900	95	19	57.1	2
WA 7883	98	31	56.3	3
WA 7901	100	36	54.8	3
WA 7907	100	33	57.4	2
WA 7914	100	26	58.3	1
LSD (p = 0.05)	37	9	2.7	-
CV (%)	47	16	3	-
P (>F)	<0.001	<0.001	0.001	-

Table 2. Influence of Hessian fly on grain yield and quality in spring wheat varieties and breeding lines at the Columbia Basin Agricultural Research Center at Pendleton during 2002.

Wheat entry	Tillers with one puparium or more	Plants with one puparium or more	Lodged tillers	Grain yield	Test weight	Market grade
	percent	*percent*	*percent*	*bu/acre*	*lb/bu*	*US No.*
Butte 86	0	0	5	27	61.4	1
Macon	0	0	tr	36	61.7	1
Tara	0	0	1	24	60.9	1
Westbred 926	0	0	tr	25	61.8	1
Zak	0	0	1	29	58.7	1
WA 7859	0	0	1	30	60.3	1
WA 7887	0	0	0	28	59.9	1
WA 7894	0	0	1	27	61.2	1
WA 7905	0	0	1	28	62.3	1
WA 7906	0	0	1	26	61.4	1
WA 7909	0	0	2	28	62.1	1
WA 7913	0	0	1	39	62.5	1
WA 7919	0	0	tr	35	60.3	1
WA 7921	0	0	tr	40	61.4	1
WA 7926	0	0	0	29	60.7	1
WA 7927	0	0	0	30	61.4	1
WA 7928	0	0	1	31	61.1	1
WA 7930	1	3	1	32	61.0	1
WA 7883	2	10	4	20	58.3	1
WA 7922	3	5	tr	34	61.0	1
WA 7931	4	10	1	34	62.3	1
WA 7914	8	23	6	27	60.0	1
Calorwa	9	25	8	12	60.8	1
Scarlet	9	33	8	17	58.8	1
WA 7907	11	25	10	17	60.3	1
WA 7929	12	33	13	21	60.0	1
WA 7904	16	45	4	15	58.7	1
WA 7920	17	28	8	25	62.6	1
WA 7902	18	35	5	10	62.2	1
WA 7923	21	38	6	25	62.2	1
WA 7924	22	38	5	23	61.3	1
WA 7925	27	50	11	26	60.8	1
WA 7900	28	45	20	12	61.8	1
LSD (p = 0.05)	14	27	3	7	1.2	-
CV (%)	165	144	66	22	2	-
P (>F)	<0.001	<0.001	<0.001	<0.001	<0.001	-

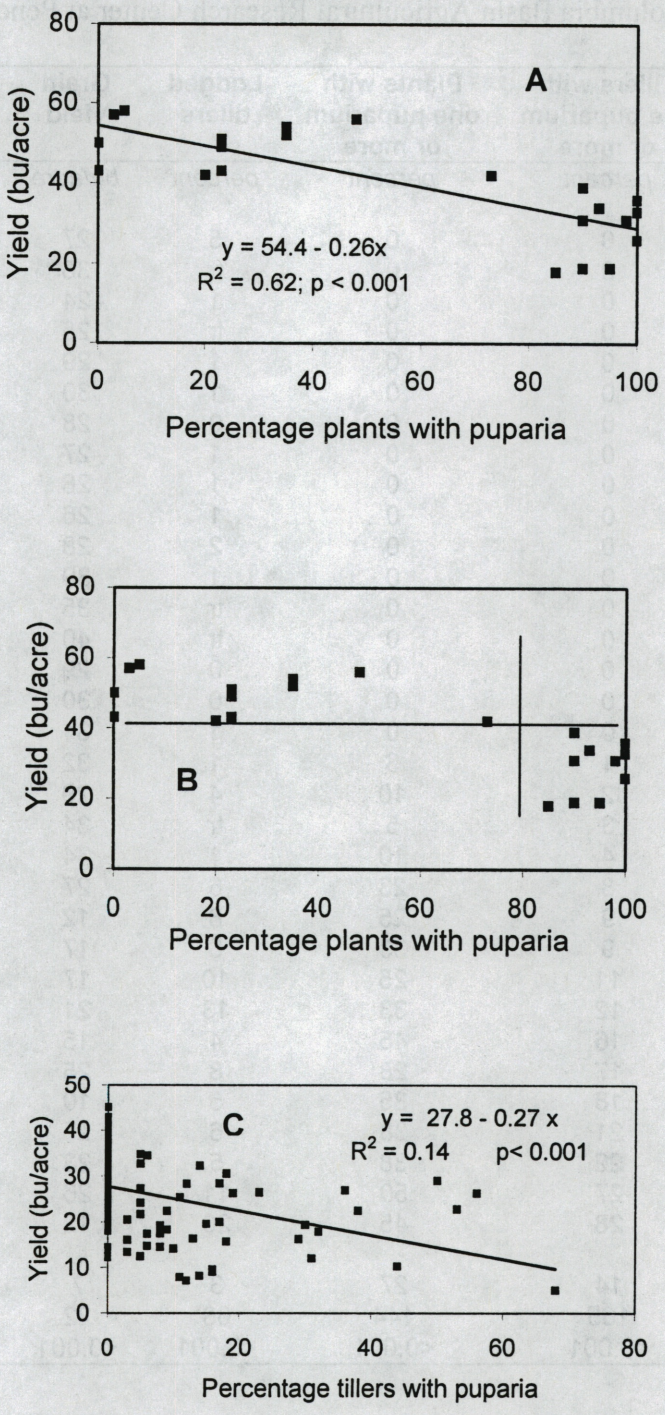
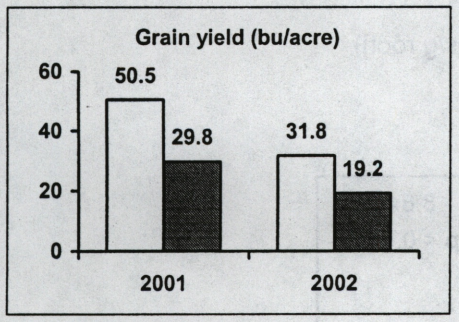


Figure 1. Relationship of Hessian fly infestation and yield of spring wheat varieties and lines at the Columbia Basin Agricultural Research Center; regression for 22 entries during 2001 (A) and the same data bracketed to illustrate threshold infestation rates causing declining yield (B), and regression for 24 entries during 2002.

Table 3. Influence of Temik®, applied with seed at the time of planting, on numbers of Hessian fly puparia, grain yield, and test weight for a resistant ('Westbred 926') and four susceptible varieties of spring wheat.

Location and varieties	Mature plants with one puparium or more		Grain yield			Grain test weight		
	Control	Temik	Control	Temik	benefit	Control	Temik	benefit
	percent	*percent*	*bu/acre*	*bu/acre*		*lb/bu*	*lb/bu*	*lb/bu*
Hill Farm								
Westbred 926	0	0	29	31	7%	55.5	58.3	2.8
Other 4 varieties	99	88	16	23	44%	55.3	57.4	2.1
Reduced yield and test weight			45%	26%	-	0.2	0.9	-
CBARC								
Westbred 926	7	13	48	50	4%	57.0	58.9	1.9
Other 4 varieties	91	92	19	39	105%	54.7	56.1	1.4
Reduced yield and test weight			60%	22%	-	2.3	2.8	-



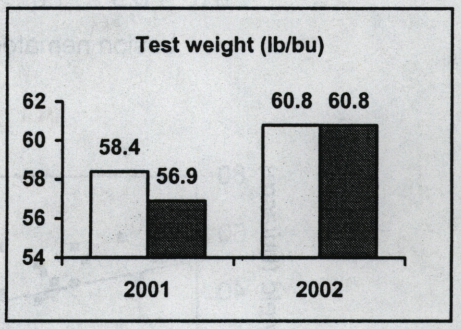


Figure 2. Comparison of grain yield and test weight for groups of Hessian fly 'resistant' and 'susceptible' sring wheat entries at the Columbia Basin Agricultural Research Center; groups of 11 wheat entries had one or more Hessian fly puparia in less than or more than 50 percent plants during 2001, and groups of 12 entries had one or more Hessian fly puparia in less than or more than 20 percent plants during 2002.

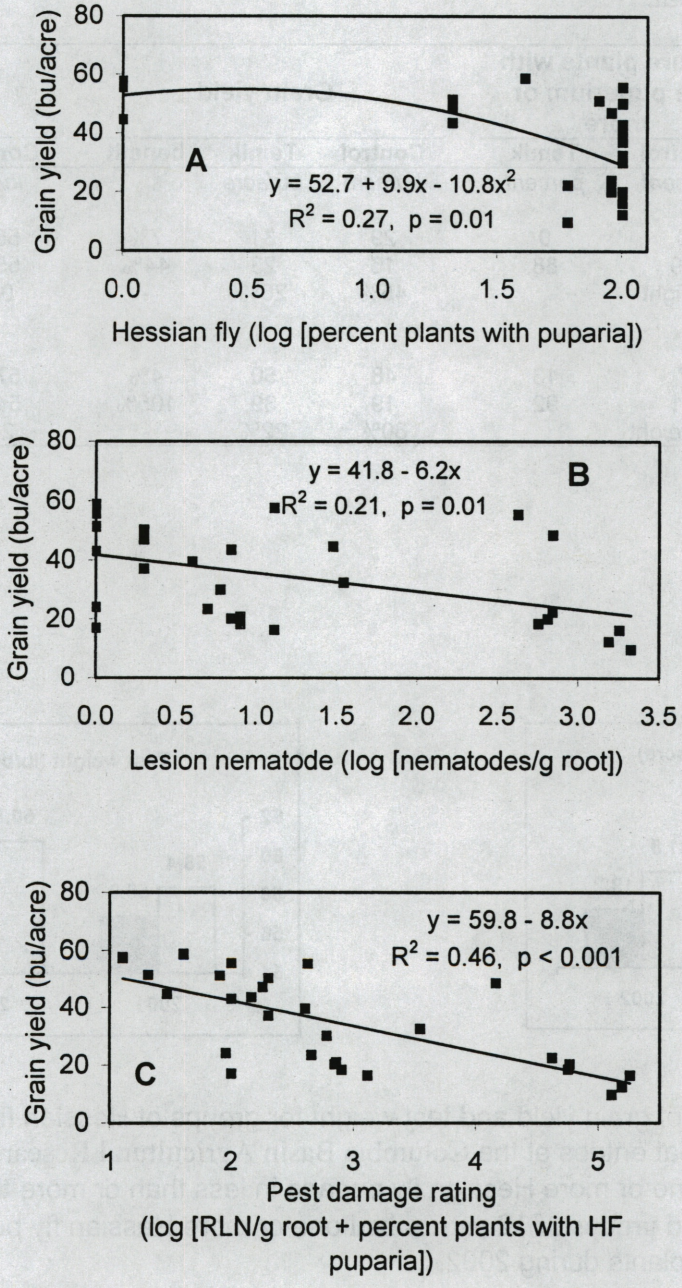


Figure 3. Relationship of spring wheat yield and Hessian fly infestation (A), root lesion nematode (B), and combined effects of damage from Hessian fly and lesion nematode (C) for five varieties planted with or without aldicarb insecticide at the Columbia Basin Agricultural Research Center, 2001.