NOTE

Effects of Tillage, Irrigation and Fertilization on Infestation of Corn Ears by Lepidopteran Larvae and Fungi in Northeastern Mexico[1]

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J. Entomol. Sci. 43(2): 254-256 (April 2008)

Key Words *Helicoverpa zea*, *Spodoptera frugiperda*, *Fusarium*, *Aspergillus*, *Ustilago*

Impacts of tillage on insects in crop production have mainly focused on those living in the soil because of the direct effects (mechanical damage) caused by tillage implements (Stinner and House 1990, Annu. Rev. Entomol. 35: 299-318). Indirect effects of tillage on insects and pathogenic diseases attacking the aerial parts of plants have been poorly studied, particularly when tillage is combined with other cultural practices (Piñango et al. 2001, Entomotropica 16: 173-179). These indirect effects include changes in natural enemies, soil temperature and moisture, and plant characteristics (Funderburk et al. 1990, Crop Sci. 30: 686-690). The objective of this study was to determine the impact of tillage, irrigation, and fertilization on the infestation of corn, *Zea mays* L., ears by lepidopteran and fungal pests in northeastern Mexico.

This investigation was conducted at the INIFAP Experiment Station near Río Bravo in northern Tamaulipas, Mexico (25°57N, 98°01W), from 2005-2007. The experiment was a randomized complete block design with split-split plot arrangement and 3 replications. The whole plot (A) included 4 tillage systems: (A_1) Moldboard plough (disking stalks after harvest, followed by moldboard plough and disking, then building the rows); (A_2) subsoil-bedding (shredding stalks after harvest, followed by subsoiling on row centers and forming beds in the same operation); (A_3) shred-bedding (shredding stalks after harvest, followed by bedding on the old rows); and (A_4) no tillage (shredding stalks after harvest and spraying 0.6 kg/ha of glyphosate and 0.72 kg/ha of 2-4 D amine twice for weed control). Treatment A_1 represents conventional tillage in this area; whereas treatments A_2 and A_3 are reduced tillage systems. Subplot (B) included 2 levels of irrigation: (B_1) 10 cm each at 10-14 leaves, silking, and milk stages; and (B_2) dryland (no supplemental irrigation). Subsubplot (C) included 2 levels of fertilization (N-P-K): (C_1) 140-40-0; and (C_2) none. Subsubplots measured 5.5 m (6 rows) wide × 52 m long. Corn (cv. Pioneer 3025W) was planted during early February and harvested during late June each year. No insecticides were applied.

[1]Received 21 August 2007; accepted for publication 18 December 2007.

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Table 1. Mean (± SEM) percent incidence of corn ear lepidopteran larvae and fungi in Río Bravo, Tam., México. 2005-2007

Year	Ear worms*	*Fusarium* spp.	*A. flavus*	*U. maydis*
2005	69.1 ± 2.0 b	24.4 ± 2.0 a	3.3 ± 0.6 a	1.5 ± 0.6 b
2006	91.5 ± 1.1 a	10.7 ± 2.0 b	1.7 ± 0.6 b	3.0 ± 0.6 a
2007	49.3 ± 2.2 c	9.8 ± 1.9 b	1.5 ± 0.4 b	0.6 ± 0.2 c

* *Helicoverpa zea* (86%) and *Spodoptera frugiperda* (14%).
Values in columns, followed by the same letter, do not differ significantly ($P < 0.05$) as determined by the LSD test.

Twenty-five plants per plot in the 4 central rows were randomly sampled each at milk stage and harvest. At milk stage, ears were inspected for lepidopteran larvae. At harvest, damage to the ears by insects fungi (*Fusarium* spp., *Aspergillus flavus* Link:Fr., and *Ustilago maydis* [DC.] Corda) was determined by visual inspection. Percent incidence (plants attacked/total plants × 100) was calculated for insects and fungi. Raw data were subjected to a 3-way analysis of variance (ANOVA) with tillage, irrigation, and fertilization as factors A, B, and C, respectively; means were compared using the LSD test ($P < 0.05$) (SAS Institute 1999, STAT/SAS User's Guide, Cary, NC).

Regardless of year and treatment, the most abundant lepidopteran species was *Helicoverpa zea* (Boddie) with an overall 86% of all larvae observed; the remaining 14% were *Spodoptera frugiperda* (J. E. Smith). Incidence of these insects was highest in 2006 (91.5%) and lowest in 2007 (49.3%). The most common fungus observed was *Fusarium* spp., with the highest incidence occurring in 2005 (24.4%). Incidence of *A. flavus* and *U. maydis* was <4% regardless of year (Table 1).

Table 2 shows ANOVA results for main effects and interactions among tillage,

Table 2. ANOVA testing effect of tillage, irrigation, and fertilization on incidence of corn ear lepidopteran larvae and fungi. Río Bravo, Tam., México. 2005-2007

		Ear worms*		*Fusarium* spp.		*A. flavus*		*U. maydis*	
Source	df	*F*	*P*	*F*	*P*	*F*	*P*	*F*	*P*
Tillage (A)	3	2.89	0.06	4.94	0.01	6.18	0.01	0.27	0.85
Irrigation (B)	1	6.33	0.02	8.35	0.01	0.18	0.67	7.24	0.01
Fertilization (C)	1	2.79	0.10	1.76	0.19	2.20	0.14	0.87	0.64
A x B	3	0.97	0.58	0.44	0.73	0.29	0.84	1.49	0.24
A x C	3	1.39	0.26	0.81	0.50	0.14	0.93	0.32	0.81
B x C	1	0.49	0.50	0.98	0.67	2.43	0.15	0.02	0.90
A x B x C	3	0.03	0.99	0.45	0.72	0.59	0.63	1.01	0.40
Error	30								

* *Helicoverpa zea* (86%) and *Spodoptera frugiperda* (14%).

Table 3. Mean incidence (%) of corn ear lepidopteran larvae and fungi as affected by tillage, irrigation, and fertilization. Río Bravo, Tam., México. 2005-2007

	Ear worms*	*Fusarium* spp.	*A. flavus*	*U. maydis*
		Tillage (A)		
Mouldboard	66.3 a	10.7 b	1.2 b	1.7 a
Subsoil-bedding	68.1 a	10.7 b	1.4 b	1.6 a
Shred-bedding	73.6 a	10.8 b	2.1 b	1.5 a
No tillage	71.9 a	18.3 a	4.0 a	2.1 a
		Irrigation (B)		
Irrigated	67.5 b	15.1 a	2.1 a	1.0 b
Dryland	72.5 a	10.1 b	2.3 a	2.5 a
		Fertilization (C)		
140-40-0	71.6 a	11.5 a	1.8 a	2.0 a
None	68.3 a	13.8 a	2.6 a	1.5 a

* *Helicoverpa zea* (86%) and *Spodoptera frugiperda* (14%).
Values in columns by factor (A, B, C), followed by the same letter, do not differ significantly ($P < 0.05$) as determined by the LSD test.

irrigation, and fertilization on incidence of lepidopteran larvae and fungi. Significance ($P < 0.05$) was only observed in main effects of tillage and irrigation. Neither main effect for fertilization nor interactions among factors were detected. For lepidopterans, only levels of irrigation were significantly different ($P < 0.05$) with higher incidence occurring in dryland corn (Table 3). The higher incidence of insect damage in dryland corn might be attributed to a differential moth preference for drought-stressed plants (Smith and Riley 1992, J. Econ. Entomol. 85: 998-1106; Rodríguez-del-Bosque 1996, Plant Dis. 80: 988-993).

Both *Fusarium* spp. and *A. flavus* occurred more frequently in no tillage, as compared with the other tillage practices (Table 3). Apparently, crop residues left in no tillage increases or enhances fungal inoculum, as observed elsewhere (Flett et al. 1998, Plant Dis. 82: 781-784). Incidence of *Fusarium* spp. was higher in irrigated than dryland corn (Table 3), contrary to other reports (Reid and Hamilton 1996, Can. J. Plant Pathol. 18: 279-285). Incidence of *U. maydis* was higher in dryland than irrigated corn (Table 3), similar to findings in Texas, USA (Machado et al. 2002, Crop Sci. 42: 1564-1575).

In conclusion, tillage and irrigation affected infestation of corn ear lepidopteran larvae and fungi in northeastern Mexico. Interactions among tillage, irrigation, and fertilization were not detected. No tillage favored incidence of *Fusarium* spp. and *A. flavus*, two of the fungi causing mycotoxin contamination of corn.

AUTHOR GUIDELINES

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