Damage by the European Corn Borer (Lepidoptera: Pyralidae) to Winter Wheat[1]

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J. Entomol. Sci. 27(4):361-365 (October 1992)

ABSTRACT The effect of European corn borer, *Ostrinia nubilalis* (Hübner), injury during the spring on yield and yield components of winter wheat, *Triticum aestivum* L. em Thell, was studied. Spike and grain characteristics of infested and uninfested culms were compared in three fields of 'Florida 302' winter wheat in eastern Georgia. Feeding on inner stem tissue by larvae killed the grain spike producing a "white head" symptom in wheat. Most larvae (95.2%) tunnelled in the peduncle which caused an average of 3.4% of spikes to be barren. Larval injury did not reduce spike length but did reduce grain weight per spike by 44.6% and grain weight per kernel by 41.9%. Kernel number per spike was reduced by 11.7% mostly because of a 9.9% reduction in kernel number per spikelet. Spikelet number per spike was reduced by 1.8%. Tunnelling by *O. nubilalis* larvae also reduced grain test weight and quality. These results indicated that a culm infestation of 10% or more would be necessary before control measures would be justified in winter wheat.

KEY WORDS Insecta, *Ostrinia nubilalis,* damage, white-head.

The European corn borer, *Ostrinia nubilalis* (Hübner), has been reported from many herbaceous host plants (Hodgson 1928) and is an important pest of corn and other crops. Wheat, *Triticum aestivum* L. em Thell, has been reported as an occasional host of ECB (Hodgson 1928, Caffrey and Worthley 1927). Wilson (1980) reported on economic infestations of ECB in winter wheat in New York with infestations of 5 to 10% infested stalks. European corn borer has expanded its range into the southeastern United States (Sparks and Showers 1975) and infestations have been observed in winter wheat in eastern Georgia. First generation larvae are present in wheat in the spring after anthesis where they tunnel and feed on the inner stem. This injury often severes the stem conductive tissue producing a "white head" syndrome characterized by bleaching of the spike (grain head) (Wilson 1980). The white head syndrome can be produced by other stem boring insects in wheat such as the wheat stem maggot, *Meromyza americana* Fitch, and the common stalk borer, *Papaipema nebris* Guenee (Kieckhefer and Morrill 1970, Hatchett et al. 1987). When ECB larvae are full-grown, they produce an exit hole which weakens the stalk, often causing it to lodge or break before harvest. European corn borer injury was believed to prevent seed development in infested culms, but inspection of infested culms revealed that seeds often were present in infested culms with white head symptoms. This study quantifies the effect of ECB injury on grain yield, yield components and grain quality of winter wheat.

[1] Accepted for publication 12 June 1992.

Materials and Methods

The effect of ECB injury on seed production of winter wheat was studied by comparing infested and uninfested stalks in three fields of soft red winter wheat. 'Florida 302' wheat was grown in all fields which were located at the Southeast Branch Experiment Station near Midville, GA. Field 1 was sampled 1990, and fields 2 and 3 were sampled in 1991. Fields were inspected two weeks before harvest (10 to 15 May in each year) for culms with white head symptoms and evidence of ECB feeding. Infested culms (53 to 122 culms/field) were collected only if a larva, pupa, pupal case or exit hole plus frass were evident. The node above which feeding occurred was recorded for each infested culm. A similar number of uninfested culms were collected in each field and dissected to confirm the absence of infestation.

Spike (grain head) length and number of spikelets per spike were recorded for each spike. Spikes were threshed using a single-head thresher. Kernels were counted and weighed after being dried at 60°C for 72 h. Kernels per spike, kernels per spikelet, grain weight per spike and kernel weight were calculated for each spike. Seed were pooled among infested and uninfested culms in each field and grain test weight was measured.

Wheat yield components and spike length measurements of infested and uninfested were analyzed within fields using Student's t-test for unequal replication (SAS Institute 1985). Grain test weight was analyzed using a t-test with fields as replicates. The percentage change in each parameter also was averaged between fields.

Results and Discussion

Most larvae occurred in main culms rather than in lateral secondary culms. An average ($\bar{x} \pm$ SD) of 95.2 ± 0.8% of larvae occurred in the peduncle between the spike and the upper node. Virtually all of the 4.5% of larvae occurring below the uppermost node were between the first and second nodes below the spike. Nodal position of larval injury within the stalk did not significantly ($P = 0.21 - 0.97$) affect plant parameters in any field. 'Florida 302' is a full season cultivar with a culm diameter larger than most other cultivars currently grown. Cultivar preference was not examined in this study, but ECB infestations seemed to be greater in cultivars similar to Florida 302 with large culms than in cultivars with smaller culms.

Spikes of most infested culms had kernels present in the spike with only 3.4 ± 2.8% of spikes being barren. Larval injury did not reduce spike length (Table 1). Infested spikes actually were significantly longer than uninfested spikes in field 2, but this difference was small. Table 1 shows the effect of ECB larval injury on the yield and yield components of wheat in each field. Larval injury significantly reduced kernel number per spike in all fields and reduced kernel number per spikelet in two of three fields. Spikelet number per spike were slightly lower in infested than uninfested spikes in all fields, but this difference was significant only in field 2. Grain test weight averaged 723 kg/m^3 in uninfested culms and 627 kg/m^3 in infested culms and was significantly different at the 10% level ($t = 3.50$; $df = 2$).

Table 1. Effect of European corn borer injury on yield and yield components of winter wheat.

Infestation	N	Spike length (cm)	Spikelets per spike	Kernels per spike	Kernels per spikelet	Kernels weight (mg)	Grain weight (mg) per spike
Field 1							
Uninfested	121	10.46	21.55	59.57	2.77	25.92	1557
Infested	122	10.49	21.23	48.79	2.27	14.83	827
t-value		-0.19	1.06	4.75**	4.90**	12.50**	10.45**
Field 2		9.70	21.94	51.41	2.34	30.97	1600
Uninfested	100	10.06	21.36	47.62	2.26	17.38	872
Infested	98	-2.29*	2.19*	2.05*	0.87	14.98**	11.24**
t-value							
Field 3							
Uninfested	59	10.26	23.54	57.93	2.46	31.19	1803
Infested	53	10.17	23.09	52.32	2.26	19.00	1057
t-value		0.37	1.87	2.21*	1.99*	9.74**	7.20**

* and ** indicate a significant t-value for comparison of means within fields at $P = 0.05$ and $P = 0.01$, respectively (t-test).

Larval damage caused large reductions in kernel weight and grain weight per spike in all fields. Kernel weight was reduced an average of 41.9% and grain weight per spike was reduced by 44.6%. Larval damage reduced kernel number per spike by an average of 11.7% and kernel number per spikelet by 9.9%. Spikelets per spike were reduced by only 1.8%. Therefore, grain yield per spike was lowered primarily by a reduction in kernel weight and a small reduction in kernel number. Furthermore, kernel number per spike was most influenced by a reduction in kernels per spikelet instead of fewer spikelets per spike.

These results are consistent with stress effects that occur during grain filling, with kernel weight being much more adversely affected than other yield components. Larval injury probably did not affect spike size and spikelet number because these parameters are determined in wheat before spike emergence (Simmons 1987). Larval feeding did not occur until after spike emergence. Likewise, potential kernel number is determined before anthesis, consequently the reduction in kernel number by larval injury probably is a result of kernel abortion in response to larval induced stress.

Wilson (1980) reported ECB infestations of 5 to 10% of culms in fields in New York and considered these infestations as being economic. It is not known whether ECB infestations could be effectively controlled in wheat using insecticides, consequently it is not possible to calculate a gain threshold as defined by Stone and Pedigo (1972). However, ECB injury reduced grain yield of infested culms by about 50%, therefore an infestation of 10% infested culms would reduce grain yield by 5%. This assumes no yield compensation by uninfested culms which probably does not occur because damage occurs too late in the season for uninfested culms to have time to compensate. If wheat market price was $0.11/kg ($3.00/bu) and yield potential was 4000 kg/ha (59.2 bu/acre), then a 5% yield loss caused by a 10% infestation of culms would equal 200 kg/ha or $22.00/ha ($8.91/acre). It is unlikely that ECB could be controlled in wheat using insecticides for less than $22.00/ha. Therefore, control measures would be economically justified only when infestations exceed 10% infested culms although this value would vary with wheat yield potential and price. These numbers may underestimate the impact of ECB damage because many of the seed of infested culms are small and probably would be lost during combining thereby magnifying the realized yield loss. Furthermore, premature senesance of infested culms probably would reduce garin quality. Nevertheless, infestations in Georgia typically have been well below 5% infested culms in winter wheat and would not justify control measures.

Despite the minor economic importance of ECB in wheat, winter wheat probably has an important role in the populations dynamics of ECB in the southeastern United States. Sparks and Showers (1975) found that first generation adults occurred during the end of March and first two weeks in April at a time when summer hosts generally are not yet available. Wheat serves as an interim host for the first generation and probably permits ECB populations to increase in wheat before moving to corn, cotton, and other summer hosts later in the season.

Acknowledgments

I thank W. Slaughter, Jr., L. Sisk and P. Singleton for technical assistance. I also thank C. J. Eckenrode (NY Agric. Exp. Stn., Geneva, NY) and J. J. Roberts (USDA-ARS, Griffin, GA) for valuable assistance with this project.

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