Wireworm (Coleoptera: Elateridae) survey in wheat-growing areas of northcentral and northeastern Oregon[1]

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ABSTRACT

A wireworm survey was conducted at 34 sites in wheat-growing areas of northcentral and northeastern Oregon using a baiting technique. The highest mean number of wireworms found at any site was 4.4 per bait of corn-wheat mixture. When wireworm numbers at each site were used to estimate the population density, some sites had densities high enough to cause yield reduction in spring wheat but not winter wheat. The species were predominantly *Ctenicera pruinina* (Horn), *Limonius californicus* (Mannerheim), and *Melanotus longulus oregonensis* (LeConte), with lesser numbers of *Limonius infuscatus* Motschulsky, *Ctenicera glauca* (Germar), *Aeolus mellillus* (Say), and *Dalopius* sp. False wireworms (Tenebrionidae) were also found at 10 sites, but their influence is uncertain.

INTRODUCTION

Wireworms, the larvae of click beetles, are destructive pests of cereal grain crops, feeding on seeds, roots, and underground stems. In the Pacific Northwest, they include members of the genera *Aeolus*, *Agriotes*, *Ctenicera*, *Dalopius*, *Limonius, and Melanotus* (Hyslop 1915, Lane 1935). Much research has gone into developing treatment of seeds with pesticides for protecting the crops and determining the short-term benefits derived from its use, such as reduction in stand loss and increase in yield. Yet, because no long-term study has been conducted, one can only assume that continued use of treated seeds suppresses wireworm populations.

Many of the pesticides used for seed treatment in the past are no longer available, and the availability of safe, effective and economical products in the future is uncertain. The necessity of using treated seeds to control wireworms depends upon whether or not damaging populations are present, for which the data are limited (Toba et al. 1985, 1988). Soil sampling can be used to estimate wireworm densities (Jones and Shirck 1942, Onsager 1969). However, such sampling is laborious and time consuming, whereas baiting is less demanding. Ward and Keaster (1977) developed a method of baiting by covering a buried mixture of corn and wheat with a polyethylene sheet, resulting in significantly higher attractancy to corn-infesting wireworms than did uncovered baits. Because such a baiting technique merely indicates the absence or presence and relative abundance of wireworms, Toba and Turner (1983) developed a method whereby a population density could be estimated from the number of wireworms found at the baits.

This report documents the density of wireworm populations in various wheat-growing areas of nine counties in northcentral and northeastern Oregon using a baiting technique.

MATERIALS AND METHODS

The survey was conducted in July and August 1981 at 34 sites. Each site was selected with the advice and consent of individual ranchers who all practiced dryland farming, primarily of wheat. The number of sites selected in each county was generally based on 1980 wheat acreage as compiled by the Extension Economic Information Office, Oregon State University. Ranchers were also asked about the field history, particularly in regards to the use of

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treated seeds for wireworm control. In several cases, the test sites were located in zones believed to be affected by wireworms within the recent past. Fallow fields were favored over planted fields. In the latter, an area of the field was left unplanted for the test sites.

Each study plot usually consisted of 16 bait spots in a 4-by-4 array, 15.2 m apart, except at three locations in Union County; 2 m apart at location 39E,1S,9 and 4 m apart at the other two locations. The baiting technique was similar to that of Toba and Turner (1983). At each spot, a 20-cm-deep hole was dug with a 5-cm-diameter steel pipe driven into the ground with a heavy hammer. Soil temperature readings were made about 5 cm below the bottom of each of four holes with a YSI Model 42SC Tele-Thermometer (Yellow Springs Instrument Co., Yellow Springs, Ohio) fitted with a soil probe. About 50 ml of a 1:1 mixture of presoaked whole wheat and corn was placed in each hole and covered with the same soil that had been removed. The seeds were untreated except for a fungicide (Vitavax) applied to wheat. The spot was then covered with a 0.6-m^2 polyethylene sheet (4 mil thick) centered over the spot, and the edges of the sheet were covered with soil.

About 21 d later, the baits, along with surrounding soil, were recovered with a 16-cm-diam posthole digger to a depth of about 25 cm. The soil was sieved through two screens (8 and 10 mesh per 2.5 cm), and the wireworms discovered were counted and placed in bottles. The bottles, along with the baits, were brought back to the laboratory for further examination, counts and identification of wireworms. Soil below 25 cm (usually as deep as 50-60 cm) was also removed and cursorily examined for wireworms. The total number of wireworms found at each site included the field counts plus any additional wireworms found in the baits during laboratory examination. The mean number of wireworms per bait per site was calculated based on the total number of baits recovered because some baits were not recoverable. Wireworm species were determined based on keys and descriptions in Glen et al. (1943) and Wilkinson (1963).

RESULTS AND DISCUSSION

The mean number of wireworms per bait per site varied from 0 to 4.4 (Table 1). The wireworm species, number of sites they were found at, and percentage of the total were as follows:

Species	**No. sites**	**%**
Ctenicera pruinina (Horn)	16	38.6
Melanotus longulus oregonensis (LeConte)	10	19.1
Limonius californicus (Mannerheim)	5	25.5
Limonius infuscatus Motschulsky	2	9.6
Dalopius sp.	1	5.6
Ctenicera glauca (Germar)	1	1.2
Aeolus mellillus (Say)	1	0.4

Umatilla County was represented by three species and had the highest mean number of wireworms per bait per site (2.23), followed by Union County with 1.19 wireworms, predominately *L. californicus*. The wireworms (0.67/bait/site) in Gilliam County were comprised of a mixture of four species, although only *C. pruinina* was present in three of the four sites with wireworms, whereas all of the wireworms (0.40/bait/site) in Morrow County were *C. pruinina*. Sherman County had 0.30 wireworms per bait per site (a mixture of four species), Baker County had 0.31 wireworms (all *M. longulus oregonensis*), Wasco County had 0.20 wireworms, and Wallowa and Jefferson Counties had none. No wireworms were found in soil below the baits.

A baiting technique indicates whether or not wireworms are actively present, and their relative abundance. It does not, however, give a measure of wireworm density as soil sampling does. Because no soil samples were taken in this study, the wireworm density at each site was estimated based on results of Toba and Turner (1983). They found that after 3 wk exposure of baits in June, the ratio of wireworms per bait:wireworms per 929 cm^2 (1 ft^2)

of soil sample was 0.59:1. Although climate and soil type were similar in both studies, we considered that room for error existed in using their data because of differences in time of study (June vs. July and August), location, and other factors. However, no other published reports could be found regarding the relationship between bait and soil sample, and soil temperatures recorded at our study sites (mean of 20.9°C) corresponded to that for June (22°C) in Toba and Turner's study. Thus, after calculating the estimated number of wireworms/929 cm^2 of soil at each site (Table 1), the highest density was found at location 28E,3N,24 with 7.45 wireworms.

Information is also lacking on damaging threshold populations of wireworms in wheat. However, Toba et al. (1985) have presented data that may be helpful in providing such information. When winter wheat was planted in plots treated with 4.5 kg a.i./ha fonofos and incorporated 10-15 cm deep, to provide the best possible treatment as an indication of potential yield in the absence of wireworms, yields in treated plots did not differ from those in untreated control plots even when the population density was as high as 6.87 wireworms/929 cm^2 of soil. With spring wheat, a density as low as 4.84 wireworms/929 cm^2 was capable of significantly reducing yields in the control plots compared to the fonofos-treated plots. Similar results were obtained by Toba et al. (1988) in which spring wheat yields in plots of untreated seeds were significantly lower than those in plots having seeds treated with carbosulfan, lindane or fonofos. In the present study, only one site had more than 6.87 wireworms/929 cm^2 (Table 1), but it would be questionable whether even this density would cause a yield reduction in winter wheat. However, there were three sites with densities greater than 4.84 wireworms/929 cm^2. Therefore, it appears that damaging populations can be found in wheat-growing areas of northcentral and northeastern Oregon, at least to spring wheat.

False wireworms, the larvae of certain genera of Tenebrionidae, are also important because they cause damage similar to that of wireworms in wheat crops (Calkins and Kirk 1975). We found false wireworms, primarily *Eleodus*, as follows:

Site location (County)	No./site
28E,3N,33a (Umatilla)	11
20E,2N,32 (Gilliam)	10
26E,1N,20 (Morrow)	7
27E,3N,25 (Umatilla)	5
16E,8S,28 (Wasco)	3
28E,3N,33b (Umatilla); 17E,3S,7 (Sherman); 21E,1N,24 (Gilliam)	2
13E,1S,9 (Wasco); 17E,7S,27 (Wasco)	1

When they were included in calculations for estimating density of wireworms and false wireworms per 929 cm^2 of soil, they did not add materially to the density of wireworms shown in Table 1; i.e., no additional sites had densities higher than 4.48 larvae/929 cm^2. However, no information is available on the attractancy of false wireworms to the bait we used or on the relationship between the number found at baits and the density per 929 cm^2 of soil.

Despite the apparent lack of damaging populations, it is possible that our estimates were conservative. Toba and Turner (1983) showed that the number of wireworms found at baits decreased from April to June, which in all likelihood was directly related to decrease in soil moisture. Because our study was conducted in July and August, one would expect soil moisture, and consequently the number of wireworms at the baits, to be lower than they would have been in June.

There appears to be no correlation between wireworm density and ranchers' practice of using seeds treated for wireworm control. Even if a damaging population was found in a field where treated seeds had been in use, one would expect such a treatment to exert pressure on the population, thereby preventing the development of an even higher population. On the

Table 1

Results of baiting for wireworms in wheat-growing areas of northcentral and northeastern Oregon.

Site location[a]	Soil name[b]	Seed treated[c]	No. baits[d]	No. wireworm	$\overline{X}$ No. wireworm/ bait	Est. $\overline{X}$ No. wireworm/ ft^2[e]	Wireworm species (%)[f]
UMATILLA COUNTY (323,000 Acres)							
28E,3N,24	Sagehill FSL	Yes	5/16	22	4.40	7.45	Lc(10), Cp(90)
27E,2N,25	Burke SL	Yes	2/16	6	3.00	5.08	Mo(67), Cp(33)
28E,3N,33a	Sagehill FSL	No[g]	16/16	27	1.69	2.86	Mo(83), Cp(17)
28E,3N,33b	Adkins FSL	Yes	13/16	22	1.69	2.86	Lc(100)
27E,3N,25	Shano SL	Yes	16/16	6	0.38	0.64	Mo(17), Cp(83)
GILLIAM COUNTY (135,000 Acres)							
21E,6S,5	Morrow SL	Yes	16/16	52	3.25	5.51	Mo(32), Cg(8), Li(60)
20E,3S,21	Condon & Valby SL	No	16/16	6	0.38	0.64	Cp(100)
20E,2N,32	Ritzville SL	Yes	16/16	4	0.25	0.42	Cp(100)
21E,3S,12	Condon & Valby SL	Yes	16/16	2	0.12	0.20	Cp(100)
21E,1N,24	Warden SL	Yes	16/16	0	0.00	0.00	
19E,2S,28	Mikkalo SL	Yes	16/16	0	0.00	0.00	
UNION COUNTY (52,000 Acres)							
39E,1S,9	Palouse SL	No[g]	16/16	32	2.00	3.39	Lc(100)
39E,3S,8	La Grande SCL	No	16/16	24	1.50	2.54	Lc(36), Da(64)
40E,3S,18	Hot Lake SL	No	16/16	1	0.06	0.10	Lc(100)
MORROW COUNTY (213,000 Acres)							
27E,2N,19	Ritzville SL	No	16/16	15	0.94	1.59	Cp(100)
26E,1N,20	Willis SL	Yes	16/16	12	0.75	1.27	Cp(100)
25E,1S,15	Ritzville SL	No	12/16	8	0.67	1.14	Cp(100)
26E,1N,4	Warden SL	Yes	16/16	4	0.25	0.42	Cp(100)
27E,2N,30	Ritzville SL	No	24/24	4	0.17	0.29	Cp(100)
24E,2S,30	Rhea SL	Yes	16/16	0	0.00	0.00	
23E,1N,28	Ritzville SL	Yes	16/16	0	0.00	0.00	
SHERMAN COUNTY (142,000 Acres)							
16E,4S,23	Condon SL	No	16/16	11	0.69	1.17	Mo(90), Cp(10)

Table 1 continued

Site location[a]	Soil name[b]	Seed treated[c]	No. baits[d]	No. wireworm	$\overline{X}$ No. wireworm/ bait	Est. $\overline{X}$ No. wireworm/ ft^{2}[e]	Wireworm species (%)[f]
18E,1S,7	Walla Walla SL	No	16/16	9	0.56	0.95	Cp(100)
17E,3S,7	Condon SL	No	16/16	2	0.12	0.20	Cp(100)
16E,2N,26	Walla Walla SL	Yes	16/16	0	0.00	0.00	
WASCO COUNTY (86,700 Acres)							
16E,8S,28	McMeen SL	No	16/16	8	0.50	0.85	Mo(43), Cp(43), Am(14)
13E,1S,9	Dufur SL	Yes	16/16	2	0.12	0.20	Mo(50), Li(50)
17E,7S,27	Tub GSCL	Yes	16/16	2	0.12	0.20	Mo(100)
13E,1S,13	Duart SL	No	16/16	1	0.06	0.10	Mo(100)
BAKER COUNTY (12,000 Acres)							
43E,8S,26	Brownscombe SL	No	16/16	5	0.31	0.52	Mo(100)
WALLOWA COUNTY (20,700 Acres)							
44E,5N,16	Cowsly SL	Yes	16/16	0	0.00	0.00	
43E,1S,15	Redmount GSL	Yes	16/16	0	0.00	0.00	
43E,1N,7	Snow SL	Yes	16/16	0	0.00	0.00	
JEFFERSON COUNTY (28,000 Acres)							
14E,10S,9	Cullius loam	No	2/2	0	0.00	0.00	

[a] Range, Township, Section of Public Land Survey System.
[b] GSL = gravelly silt loam, GSCL = gravelly silty clay loam, FSL = fine sandy loam, SL = silt loam, SCL = silty clay loam.
[c] Ranchers' response as to whether or not seeds were treated with pesticides for wireworm control (includes sometimes).
[d] Number recovered/number set.
[e] Calculations based on ratio of 0.59 wireworms/bait:1 wireworm/929 cm^2 (1 ft^2) of soil sample (Toba and Turner 1983).
[f] Abbreviations used: Am = *Aeolus mellillus*, Cg = *Ctenicera glauca*, Cp = *C. pruinina*, Da = *Dalopius* sp., Lc = *Limonius californicus*, Li = *L. infuscatus*, Mo = *Melanotus longulus oregonensis*.
[g] Sites have never been farmed.

other hand, lack of damaging populations in fields where no treated seeds had been in use is no assurance that damaging populations will not develop in the future.

Our results, along with those of Toba and Turner (1983) and Toba et al. (1985, 1988), indicated that the population densities of wireworms found in the wheat-growing areas studied apparently were not high enough to cause yield reduction in winter wheat, although they could cause stand reduction. The reason for this is that yield may not be affected despite a 20% reduction in plant stand (Harwood et al. 1957), whereby stand reduction is compensated by increased tillering by the remaining plants. On the other hand, population densities do exist that can reduce yields in spring wheat.

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