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Effects of the Subterranean Aphid [*Geoica utricularia* (Passerini)] on Forage Yield and Quality of Sand Lovegrass

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Abstract

In 1977 at Mead, Nebraska, replicated plots in two sand lovegrass (*Eragrostis trichodes*) nurseries naturally infested with root aphids (*Geoica utricularia* Passerini) were treated with soil drenches of carbofuran and disulfoton (2.24 kg/ha AI) to quantify the economic importance of these aphids. In a nursery of 'Nebraska 27' sand lovegrass, the carbofuran and disulfoton treated plots produced 45% and 16% more forage, respectively, than the untreated plots. In a nursery of another Nebraska experimental strain, the treated plots produced more forage than the untreated plots but the differences were not significant. There were no differences among treated and control plots in either nursery for dry matter, protein, and in vitro dry matter digestibility percentages.

Sand lovegrass is a warm-season, perennial bunchgrass that is native to the Nebraska Sandhills where it is an important and abundant grass. It is often included in mixtures for reseeding warm-season pastures and rangelands in Nebraska (Vallentine 1967).

Information on the effects of root aphids on yield and quality of forage grasses is not available even though several species of subterranean aphids have been reported on the roots of annual and perennial grasses for over 80 years. A summary of published reports of root aphids on annual and perennial grasses in North America is listed in Table 1. Numerous papers have been published on the effects of subterranean aphids on agronomic and horticultural crops (Smith 1972).

Geoica utricularia (Passerini) is white, pear-shaped with body, head, and appendages armed with broad, slightly curved squamae (Cutright 1925). In Nebraska, the aphids are almost always attended by one of two species of ants, *Lasius alienus* (Foerster) or *L. neoniger* (Emery). Figure 1 shows the root aphid, *Geoica utricularia* (det. by M.B. Stoetzel, Systematic Entomology Laboratory, USDA-SEA-AR, Beltsville, Maryland) and a field ant, *Lasius neoniger* (det. by D.R. Smith, Systematic Entomology Laboratory) on soil and sand lovegrass, *Eragrostic trichodes* (Nutt.) Wood, roots.

Many root aphids have a primary overwintering host plant. Some species, like *G. utricularia*, have become modified to an entirely subterranean life so that the aerial form has become extinct, at least in some geographical areas (Hottes and Frison 1931). Swenk (1913) and Cutright (1925) have reported winged forms of *G. utricularia* but their part in the life cycle is unknown. Palmer (1952) reported that according to Mordvilko (1935), the primary or winter host of *G. utricularia* in Asia Minor is *Pistacia* sp. on which it causes leaf galls. *Pistacia* does not occur in North America and the aphid remains on the secondary host plant throughout the year (Hottes and Frison 1931; Palmer 1952). Geological evidence shows that *Pistacia* was native to North America but was eliminated during the glacial periods (Cutright 1925).

We first observed *G. utricularia* on sand lovegrass plants in June 1975 at the Mead Field Laboratory of the Nebraska Agricultural Experiment Station when we were digging and moving selected plants from a selection nursery to a crossing block. The Mead Field Laboratory is located about 35 km west of Omaha, Nebraska. We subsequently found *G. utricularia* in all our sand lovegrass nurseries at Mead. Although no precise counts were made, *G. utricularia* appeared to be present in numbers sufficient to cause economic damage. Single plants often had over 50 aphids on their roots.

The purpose of this study was to quantify the economic importance of these aphids by determining the effect of soil drenches of insecticides on forage yield and quality of sand lovegrass in fields naturally infested with *G. utricularia.*

Materials and Methods

Two sand lovegrass seed increase nurseries located on the Agronomy Section of the Mead Field Laboratory were used in this study. Both nurseries were seeded in 1970 in rows spaced 1 m apart. One nursery was seeded with the cultivar 'Nebraska 27' while the other nursery was seeded with a strain collected in Knox County, Nebraska. The latter strain will be referred to as the "Knox" strain. Both nurseries were managed for seed production, which included spring burning or mowing, N fertilization, and cultivation for weed control.

In both nurseries, a plot consisted of a single row 9 m in length. Contiguous plots were separated by 3-m alleys. A completely randomized experimental design was used with 7 and 6 replications, respectively, in the Nebraska 27 and Knox nurseries. The three treatments were an untreated control, and two different insecticides. Carbofuran[1] (2,3-dihydro-2,2-dimethyl-7-

[1]This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended.

Fig. 1. *Root aphids,* Geoica utricularia, *and an associated ant,* Lasius neoniger, *on roots and surrounding soil of a sand lovegrass plant. Magnification is approximately 10 x.*

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benzofuranyl methylcarbamate) and disulfoton[1] (0, 0-diethyl S-[2-ethylthio) ethyl] phosphorodithioate) were applied as soil drenches at the rate of 2.24 kg/ha of active ingredient (AI) with 7.5 liters of insecticide solution applied per plot. Drenches were applied to the treated plots on May 21 and August 6, 1976 and on April 28, 1977.

The nurseries were not harvested for yield in 1976 because of a heavy infestation of annual grasses. In 1977 both nurseries were sprayed with 8.96 kg/ha (AI) of DCPA (dimethyl tetrachloroterephthalate) and with 2.24 kg/ha (AI) of atrazine (2-chloro-4-ethylamino)-6-(isoprophylamino)-s-triazine) to control annual grasses.

The Knox and Nebraska 27 nurseries werr harvest for yield, respectively, on August 19 and 23, 1977. They were cut at a 8 cm height with a flail-type forage harvester. Bare soil areas within a plot were measured and the total length of a plot covered by vegetation was determined. Yields were converted to dry matter yield per meter of plot by dividing dry matter yield per plot by the length of plot covered by vegetation to adjust for differences among plots for vegetation that was unrelated to the treatments. Each plot was sampled for dry matter percentage, in vitro dry matter digestibility (IVDMD) percentage, and protein percentage. The Kjeldahl procedure (A.O.A.C. 1960) was used to determine percent N. Protein values are Kjeldahl N × 6.25. The Tilley and Terry (1963) procedure was used to determine the IVDMD percentage.

Results and Discussion

Forage yields were not measured in 1976 in either nursery because of a severe infestation of weedy grasses. However, visual observations indicated increased growth of sand lovegrass in the treated plots in both nurseries. In 1977 the plots treated with carbofuran and disulfoton in the Nebraska 27 nursery produced 45 and 17%, respectively, more forage than the untreated control plots (Table 2).

Table 1. A summary of published reports of root aphids on annual and perennial grasses in North America.

Source	Geographic area	Aphid	Host grasses
Osborn and Sirrine (1895)	Iowa	*Anoecia corni* (Fabricius)	Big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), *Spartina cynosuroides, Muhlenbergia racemosa,* switchgrass (*Panicum virgatum*), timothy (*Phleum pratense*)
		Anoecia cornicola (Walsh)	Foxtails (*Setaria glauca* and *S. viridis*), barnyardgrass (*Echinochloa crusgalli*), corn (*Zea mays*), *Eragrostis major*
Sandborn (1906)	North America	*Macrosiphum avenae* (Fabricius)	Orchardgrass (*Dactylis glomerata*), *Bromus secalinus* foxtail barley (*Hordeum jubatum*), *Phalaris canariensis*
		Geoica utricularia (Passerini)	Timothy, barnyardgrass
		Anoecia corni (Fabricius)	Big bluestem, foxtail barley, *Eragrostis pectinaceae, E. major, Muhlenbergia racemosa*
		Colopha ulmicola (Fitch)	*Eragrostis purshii, E. frankii*
Swenk (1913)	Nebraska	*Geoica utricularia* (Passerini)	Corn, wheat (*Triticum aestivum*), unspecified weedy grasses.
		Forda formicaria (von Heyden)	Wheat, bluegrass (*Poa pratensis*)
Cutright (1925)	Ohio	*Anoecia corni* (Fabricius)	Orchardgrass, redtop (*Agrostis alba*)
		A. querci (Fitch)	Crabgrass (*Digitaria sanguinalis*) *Setaria* spp., *Panicum capillare,* switchgrass, bluegrass, little bluestem, corn, timothy, sorghum (*Sorghum bicolor*), *Muhlenbergia mexicana*
		Geoica uticularia (Passerini)	Oats (*Avena sativa*), wheat, corn, bluegrass, timothy, barnyard grass, *Setaria viridis, Agrostis perennans, Danthonia spicata, Muhlenbergia mexicana*
		Pemphigus bursarius (L.)	Redtop, *Andropogon virginicus, Aristida dichotoma,* rye (*Secale cereale*), wheat
Palmer (1952)	Colorado	*Tetraneura ulmi* (L.)	*Agropyron* spp., other unspecified grasses
		Forda marginata Koch	*Agropyron* spp., smooth bromegrass (*Bromus inermis*) *B. tectorum,* barnyardgrass, *Elymus* sp., *Hordeum* sp., bluegrass, *Setaria* spp., barley (*Hordeum vulgare*), wheat, oats
		F. formicaria von Heyden	Bluegrass, *Phleum alpinum, Elymus* sp., *Melica bulbosa*
		Geoica utricularia (Passerini)	barnyardgrass, unspecified other grasses
Knowlton and Fronk (1943)	Utah	Numerous species including *Geoica utricularia* (Passerini)	Unspecified grasses
		Forda marginata Koch	Unspecified *Agropyron, Bromus tectorum,* bluegrass, bermudagrass (*Cynodon dactylon*)
Hottes and Frison (1931)	Illinois	*Geoica utricularia* (Passerini)	Corn, unspecified grasses
		Forda formicaria von Heyden	Corn, bluegrass
Robinson (1965)	Manitoba	*Forda marginata* Koch	Quackgrass (*Agropyron repens*), *Poa* sp.
		Forda formicaria von Heyden	Quackgrass, *Poa* sp.

Table 2. Means, coefficients of variation *(C. V.)*, *'F'* ratios and *L.S.D.* values for forage dry matter percentages, dry matter yields (g/m) of row), protein and in vitro dry matter digestibility (IVDMD) percentages of control and treated plots of two sand lovegrass nurseries infested with root aphids at Mead, Nebraska.

	Treatment Means			C.V.	'F' ratio for	
	Control	Carbofuran	Disulfoton	%	treatments	$L.S.D._{.05}$
			Nebr. 27			
% Dry Matter	38.0	36.7	37.6	4.4	0.95	ns
Yield	278.3	404.3	325.3g	12.0	12.83**	28.7
% IVDMD	40.7	40.8	40.6	4.8	0.02	ns
% Protein	9.6	9.6	9.6	5.6	0.03	ns
			Knox			
% Dry Matter	37.4	35.8	38.2	4.8	2.55	ns
Yield I+	306.6	325.0	310.3	26.3	0.08	ns
Yield II+	263.7	325.0	310.3	19.1	1.65	ns
% IVDMD	40.6	40.2	39.5	4.2	0.61	ns
% Protein	10.4	10.8	10.7	5.8	0.67	ns

**Indicates significance at the .01 level of probability. ns = non-significant.

+ Yield I includes the control plot 7-3, Yield II excludes it. Plot 7-3 yielded 29% more forage than the next highest yielding plot and 71% more than the next highest-yielding control plot.

These differences were statistically significant. In the Knox nursery in 1977, the treated plots produced more forage than the untreated plots but the differences were not significant (Table 2). One of the control plots (7-3) in the Knox nursery yielded 29% more forage than the next highest plot in the nursery and 71% more than the next highest control plot. With plot 7-3 excluded, the carbofuran and disulfoton plots produced 23 and 17%, respectively, more forage than the untreated control plots. These differences were not statistically significant because of a large experimental error as indicated by the large coefficient of variation for yield. There was considerable variation for yield in the nursery that could not be attributed to the treatments even after plot 7-3 was excluded from the analyses of variance.

The variation that existed in the Knox nursery for forage yield illustrates some of the problems that are encountered while studying root aphids. Cutright (1925) pointed out that their subterranean habitat precludes detailed observations and that they are sensitive to light, disturbance, changes of soil humidity, and are so dependent on ants that they cannot be successfully handled in their absence. Non-uniform distributions of aphids within the experimental area can easily occur and large experimental errors may be expected. There is some movement of aphids by ants among plant species during the active growing season. For example, *G. utricularia* were found on tall fescue (*Festuca arundinacea*) plants in roadways adjacent to both nurseries only in the late fall after the warm-season sand lovegrass had become dormant.

There were no significant differences among treated plots in either nursery for dry matter. IVDMD or protein percentages. There were small coefficients of variation for these traits, indicating small experimental errors. In retrospect, differences in forage quality should not have been expected since there were no visual differences among treated and untreated plots other than the amount of vegetation produced. It would not have been possible to visually detect any insect damage on the untreated plots by observing the above-ground biomass without being able to compare them to treated plots.

The differences in forage yield among the treated and untreated plots indicate that the root aphid (*G. utricularia* (Passerini)) reduces forage yields of sand lovegrass. The effect of root aphids on forage yield may be greater than our results indicate because there was probably some reinfestation of treated plots after the insecticides dissipated.

We have not made a survey to determine how widespread the root aphids are on sand lovegrass but we have found root aphids on sand lovegrass plants in seeded plots at the DeSota Bend National Wildlife Refuge, Blair, Nebraska, which is located at the Missouri River in western Iowa, 35 km north of Omaha. We have found *G. utricularia* on tall fescue, foxtail barley, downy bromegrass, barnyardgrass, and yellow foxtail. In addition, we have found Forda marginata Koch (det. by M.B. Stoetzel, Systematic Entomology Laboratory) on tall fescue and on a single plant of crested wheatgrass.

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