TECHNICAL NOTES

Effects of a Nematode on Biomass and Density of Silverleaf Nightshade

F.E. NORTHAM AND C.C. ORR

Abstract

Infective fourth stage larvae of the silverleaf nightshade (*Nothanguina phyllobia* Thorne) were broadcast on rangeland populations of silverleaf nightshade (*Solanum elaeagnifolium* Cav.) as a biological control for the weed. Plots were inoculated with nematode-infested dried leaves in April and August of 1977 at two southern High Plains shortgrass prairie locations. One site had been denuded of vegetation 2 years previously. While the August inoculation failed, the April inoculation was successful at both locations: 41% of the plants at the denuded site and 20% of the plants at the shortgrass site became infected with nematodes. At the disturbed site, a difference from the control of 23% in the foliar biomass and a 42% in the plant density of silverleaf nightshade were attributable to nematode injury. Nematode infection was not observed on any other plant species.

Silverleaf nightshade (*Solanum elaeagnifolium* Cav.) is an aggressive perennial invader plant for disturbed land in the southwestern U.S., including Texas (Orr et al. 1975), Arizona (Parker 1972), and California (Goeden 1971). Since its accidental introduction in Australia around 1900, it has threatened to become a serious problem in Australian wheat and grazing industries (Leys and Cuthbertson 1977). Abundant seed production and a spreading woody rootstock with large food reserves and high reproductive capability promote the effectiveness of silverleaf nightshade as a colonizer. Areas where vegetation is periodically denuded—fire guards, ranch roads, pipeline cuts, roadside ditches, construction sites, livestock feeding/watering areas and cultivated fields—become habitats for extensive silverleaf nightshade populations. The economic impact of silverleaf nightshade is increased by the presence of glycoalkaloids toxic to cattle and sheep. Buck et al. (1960) reported that concentrations of silverleaf nightshade in livestock rations as low as 0.01% of body weight can be lethal.

Orr et al. (1975) suggested a foliar nematode parasite, (*Nothanguina phyllobia* Thorne), for the biological control of silverleaf nightshade. The nematode causes hypertrophy and hyperplasia of leaf and stem tissues, resulting in large galls (Orr et al. 1975); each gall contains thousands of infective nematode larvae. As galls dry, larvae become quiescent and survive anhydrobiotically until moisture revives them (Robinson et al. 1978). When free moisture is available, larvae climb silverleaf nightshade plants, initiate new galls in young tissue, mature, and reproduce. Nematodes overwinter in both the soil and galled plant material. The host range of the nematode is restricted to silverleaf nightshade with limited infections observed in closely related nightshade species.

Authors are former graduate student, Department of Range and Wildlife Management, Texas Tech University, Lubbock, Texas, now range conservationist, U.S. Dep. Agr. Soil Conserv. Serv., P.O. Box 660, Silverton, Tex. 79257; and zoologist, U.S. Dep. Agr. Rt. 3, Lubbock, Tex. 79401.

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The effect on density and biomass from inoculating rangeland populations of silverleaf nightshade artificially with dried nematode-infested plant material are reported.

Materials and Methods

Nematode inoculum was prepared from galled silverleaf nightshade leaves collected from naturally infected plants in August of 1976. Leaves were air-dried, crushed, passed through a 2.4-mm sieve, and stored at room temperature. Extraction of nematode from this inoculum with water showed it to contain 24,000 infective larvae/g.

Plots were established in a 2.2-ha (5-acre) area in Lubbock County, Texas, containing two contrasting habitats. One habitat was southern High Plains shortgrass prairie in which the brush had been mechanically removed 20 years previously; grasses and perennial forbs covered more than 60% of the soil surface. This area will be referred to as the shortgrass site. The second habitat was shortgrass prairie which had been bladed bare of vegetation in 1975, and by May of 1977 less than 25% of the soil surface was revegetated. This area will be referred to as the disturbed site. The soil of both habitats was an Amarillo fine sandy loam. Eight 3 × 3-m (10-ft) plots were selected randomly at each site. Four plots (two at each site) were inoculated in April of 1977 by hand-broadcasting each plot with 32 g inoculum (8 larvae/cm²); four more plots were inoculated in August of 1977 at the same rate. Each inoculated plot was paired with an untreated control.

Plant density and the number of galled plants were recorded monthly from May to September during 1977 and 1978. In August of each year, the volume (calculated from the height × width) of all silverleaf nightshade in each plot was measured; the heights and widths of 178 plants in 1977 and 200 plants in 1978 growing outside the test plots were also measured. These plants were clipped at ground level, dried for 24 h at 105° C, and weighed. Linear regression analyses (Snedecor and Cochran 1967) of various plant height and width combinations, with oven-dry weight yielded a relationship (at $P < 0.01$) for each year. The foliar biomass (dry weight) of test plants was estimated by this procedure.

Results

Establishment of Infection

Foliar galls on silverleaf nightshade were first observed in the April-inoculated plots 40 days after inoculation; 41% of the plants in the disturbed area and 20% of the plants in the shortgrass area were infected by nematodes (Table 1). The August inoculation produced no galls in either area. In 1978, 47% of the inoculated plants in the disturbed area and 9% of the inoculated plants in the shortgrass area still had nematode galls. No galls were observed either year in the control plots.

Foliar Biomass

In 1978, foliar biomass at the disturbed site was greatly reduced due, in part, to less favorable rainfall. Biomass decreased by 90% in the inoculated plots and by 67% in the controls. The 23% difference

Table 1. Density, foliar biomass and galled plants of *Solanum elaeagnifolium* at two prairie sites in 1977 and 1978 as influenced by inoculation in April 1977 with *Nothanguina phyllobia*.

Location	Plant density (plants/m ²)			Foliar biomass (g/m ²)			% of plants galled	
	1977	1978	Reduction	1977	1978	Reduction	1977	1978
D.S. ¹								
Inoculated	5.6	1.9	66%	54.5	5.6	90%	41	47
D.S.								
Control	3.4	2.6	24%	14.9	4.9	67%	0	0
S.S. ²								
Inoculated	1.7	6.4	none	4.0	11.2	none	20	9
S.S.								
Control	1.7	2.9	none	7.1	8.3	none	0	0

¹D.S. = Disturbed Site

²S.S. = Shortgrass Site

in biomass reduction was attributed to nematodes and was significant at $P = 0.05$. Foliar biomass in the shortgrass area increased in 1978 (Table 1).

Plant Density

The number of silverleaf nightshade plants in the inoculated plots of the disturbed area was noticeably reduced the second season after inoculation. The number of plants in the inoculated plots was reduced from 5.6/m² in 1977 to 1.9/m² in 1978, a reduction of 66%. Plant density in the control plots was reduced from 3.4/m² in 1977 to 2.6 in 1978, a reduction of 24%. The 42% difference between inoculated and control plots was attributable to nematodes (significant at $P = 0.05$) (Table 1).

Discussion

The establishment of *N. phyllobia* infections in rangeland populations of silverleaf nightshade was influenced by season and habitat. The August inoculations were applied while the upper 15 cm (6 in.) of soil were dry and little dew or effective rainfall occurred. Since nematode larvae required a film of moisture for movement on foliar surfaces (Robinson et al. 1978), the aridity of the environment at that time is probably responsible for the failure of nematode infection. The successful April inoculations were applied when spring rainfall and heavy dews created moisture conditions favorable for the nematodes to invade silverleaf nightshade tissue.

In the shortgrass site only 20% of plants became galled compared to the 41% at the disturbed site. This result may be explainable in terms of plant surface area. Robinson et al. (1979) reported that *N. phyllobia* larvae will climb numerous plant species indiscriminately. At the shortgrass site, silverleaf nightshade constituted <50% of the total foliar biomass, while at the disturbed site it comprised more than 80%. The probability then, of nematodes

ascending non-host species should have been greater in the shortgrass plots, thereby diluting the number of larvae effectively available for infecting silverleaf nightshade.

The success of colonization by the nematode and the deleterious effects on the density and foliar biomass of silverleaf nightshade agree with the results obtained on cropland by Orr et al. (1975) and Robinson et al. (1978). They reported successful infestation of silverleaf nightshade after hand-broadcasting of nematode infested plant material. The reductions in plant density (ca. 50%) and foliar biomass (20–80%) were similar to the observed results on disturbed rangeland. These results show *N. phyllobia* to be valuable biological control for silverleaf nightshade in disturbed rangeland.

Literature Cited

- Buck, W.B., J.W. Dollahite, and T.J. Allen. 1960. *Solanum elaeagnifolium* silverleaf nightshade poisoning in livestock. J. Amer. Vet. Med. Ass. 137: 348-351.
- Goeden, R.D. 1971. Insect ecology of silverleaf nightshade. Weed Sci. 19:45-51.
- Leys, A.R., and E.G. Guthbertson. 1977. *Solanum elaeagnifolium* Cav. (silverleaf nightshade) in Australia. Proc. So. Weed Sci. Soc. 137-141.
- Orr, C.C., J.R. Abernathy, and E.B. Hudspeth. 1975. *Nothanguina phyllobia*, a nematode parasite of silverleaf nightshade. Plant Dis. Rep. 59:416-418.
- Parker, K.F. 1972. An illustrated guide to Arizona weed. Univ. Arizona Press, Tucson, 338 p.
- Robinson, A.F., C.C. Orr, and J.R. Abernathy. 1978. Distribution of *Nothanguina phyllobia* and its potential as a biological control agent for silverleaf nightshade. J. Nematol. 10:362-366.
- Robinson, A.R., C.C. Orr, and J.R. Abernathy. 1979. Behavior response of *Nothanguina phyllobia* to selected plant species. J. Nematol. 11:73-77.
- Snedecor, G.W., and W.G. Cochran. 1967. Statistical methods. Iowa State Univ. Press, Ames. 593 p.