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NEMATODE STUDIES AT THE COTTONWOOD SITE

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ABSTRACT

In an attempt to determine the role of soil inhabiting nematodes in a grassland ecosystem, nematode number, biomass and taxa data was obtained over a three year period from heavily grazed and ungrazed treatments at the Cottonwood, South Dakota, Grassland Biome site. Substantial numbers of plant feeding forms occurred in both treatments with populations varying from 2 to 6 million/m² to a depth of 60 cm. Biomass of plant feeding nematodes was significantly greater in the ungrazed treatment due primarily to high numbers of dagger nematode, Xiphinema americanum. Biomass of predaceous forms nearly equaled that of plant feeders in both treatments, indicating their potential as agents of biological control. The saprophagous forms constituted a relatively small proportion of the biomass in both treatments and also showed little treatment response.

An inverse relationship between numbers of Tylenchorhynchus spp. and Helicotylenchus spp. was observed in the grazed treatment. Tylenchorhynchus spp. appeared nearly limited to the upper 10 cm of soil with Helicotylenchus spp. predominating with increasing depth, indicating a possible antagonistic relationship between these taxa.

Approximately 80 species of nematodes were identified from the grazed and ungrazed treatments. Grazing intensity did not influence taxa diversity, however, diversity rapidly decreased with an increase in sampling depth, a response attributed to a decrease in variety of food sources. Total number of nematodes also decreased with increasing sampling depth and approximately 70% of the nematodes occurred above 20 cm.

Nematicide treatments were used in field and greenhouse studies to further evaluate the role of nematodes. The nematicide significantly reduced nematode populations, increased aboveground herbage weight by as much as 59%, and further, provided a demonstration of the importance of nematodes as controllers of productivity in range.

A method for calculating intake of plant material for insects was modified to estimate nematode intake at the Cottonwood site and, surprisingly, plant feeding nematodes were found to consume more range vegetation than cattle. In addition, comparisons of nematode intake with that of several other consumer populations indicated that nematodes are major consumers at the Cottonwood site. The large biomass, high metabolic rate and indigenous nature of the nematode populations were suggested as probable reasons for the high intake.

Overall, it is apparent that soil inhabiting nematodes constitute a significant pathway of energy flow at the Cottonwood site.

INTRODUCTION

Range and pasture constitute a considerable portion of the land area in the Great Plains states. Range and pasture alone occupy 60% of the land in South Dakota, and thus are two of the states most important natural resources. Much of western South Dakota is used primarily for grazing and, due to climatic, topographic and edaphic factors rendering it unsuitable for cultivation, will continue to be so used for the foreseeable future. Currently the livestock industry of western South Dakota is a \$500 million business annually and research devoted to improving range productivity is amply justified.

The role of soil inhabiting nematodes in grasslands of the Northern Great Plains has received comparatively little investigation. A taxonomic study by Thorne and Malek (31) revealed the presence of many known and other potentially important species of plant parasitic nematodes in grasslands of this region. In addition, Smolik (23) has shown growth increases of 35 to 67% of Agropyron smithii Rydb. and Bouteloua gracilis (H.B.K.) Lag. ex. Steud. following fumigation of naturally infested range soil.

Much of the present study was conducted in cooperation with the Grassland Biome portion of the U.S. International Biological Program. A primary objective of the Grassland Biome Program is improvement of management recommendations through an improved understanding of grassland ecosystems.

The objective of the present study was to determine the role of nematodes in a grassland ecosystem, in particular the Grassland Biome

site located at Cottonwood, South Dakota. Concurrent with this objective nematode taxa, numbers and biomass were determined. The effects of sampling depth and grazing intensity on the above were also studied. Nematicide treatment of range grasses in field and greenhouse studies was used to further evaluate the role of nematodes. In addition, using biomass data, an attempt was made to calculate the amount of plant material consumed by plant feeding nematodes.

MATERIALS AND METHODS

A major portion of this study was conducted at the Cottonwood Range Experiment Station in west central South Dakota. A thorough description of the Cottonwood site has been given by Lewis (13). Nematodes were extracted from soil by the method of Christie and Perry (4). With the exception of nematocide experiments, all nematode numbers were corrected for extraction efficiency in an attempt to estimate the actual population. The efficiency of the wet screening portion of the method using a 325 mesh screen was approximately 73%. Ambient temperature influences the efficiency of the Baermann funnels and this efficiency will vary with sampling date, generally from 70 to 95%. Dorylaeids tended to remain in the screen residues more frequently than other taxa and consequently their numbers were corrected independently.

The number of nematodes in each of nine taxa groups was determined by counting the number present in each of three 1 ml aliquots of a 50 ml suspension in a Scott slide hookworm larvae counter. Specific identification and values for biomass determinations were obtained from permanent mounts (28) of individuals selected at random from among samples massed by treatment, depth and date. Approximately 1,000 mounts containing from two to twelve nemas per slide were prepared. Biomass was calculated by the formula of Andrassy (1). Lyophilization was used to determine a nematode moisture content of 75%. Trophic levels for the various forms were based on published reports (7, 8, 9, 10, 12, 21, 27, 28, 29, 30, 32) and, for certain of the dorylaeids, on the work of J. Ferris (personal communication).

Soil samples were obtained on dates selected by the biome personnel in 1970, 1971 and 1972. Soil cores, 4.2 cm diameter, were removed to a depth of 60 cm from grazed and ungrazed treatments. The cores were subdivided into 0-5, 5-10, 10-20, 20-30, 30-40, 40-50 and 50-60 cm depth increments, placed in plastic bags, and stored at 4°C until processed. Six to eight cores were taken from each treatment on each of three sampling dates in 1970 and 1971 and on four dates in 1972. Generally the sampling dates corresponded to initiation of growth in the spring, period of peak vegetative standing crop (July) and just prior to frost in the fall.

The grazed treatment areas were fenced from a pasture in the spring of each sampling year. This pasture has been heavily grazed since 1942 and is now dominated by Buchloe dactyloides (Nutt.) Engelm. and Bouteloua gracilis (H.B.K.) Lag. ex. Steud. The ungrazed treatment area is located in a pasture that has been fenced to exclude large herbivores since 1963. Prior to this time it had been lightly grazed and vegetation, dominated by Agropyron smithii Rydb., appears to have reached stability. Both treatment areas are located on gentle northeasterly slopes with silty clay soils (13).

The effects of nematicide treatment were evaluated in field and greenhouse experiments. Vydate®[®], S-methyl 1-(dimethylcarbamoyl)-N-[[methylcarbamoyl) oxy] thioformimidate, a systemic nematicide, was applied as a foliar spray at 20 kg active ingredient/ha four times at two week intervals in all experiments. Nematicide treatments were initiated in 0.5 m² field plots in heavily grazed range at the Cottonwood site in June, 1971. Ten replications each of nematicide treated

and non-treated plots were arranged in a randomized complete block design. At the same time, twelve 15 cm diameter soil cores were removed from an area adjacent to the field plots and placed in 15 cm clay pots. The pots were placed in an air-conditioned greenhouse ($25 \pm 3^{\circ}\text{C}$) and half were treated with nematicide to determine the effect on nematode populations. The experiment was terminated seven months later and effect of nematicide treatment determined. An additional twelve cores were removed in a similar manner June, 1972, for further evaluation of the effect of nematicide treatment on nematode populations and on growth of range grasses in a second greenhouse experiment. Clipping was initiated one month after the final nematicide application and the grass was clipped at three week intervals to a height of 5 cm until conclusion of the experiment 6 months later.

Evaluation of field plots was initiated 7 July, 1972. One-half of the plots within each treatment were clipped to soil level with hand-operated clippers and a 4.2 cm diameter soil core was removed to a depth of 10 cm and subdivided into 0-5 and 5-10 cm increments. The remaining plots were clipped 21 July, 1972, with an electrically-powered clipper and a 4.2 cm diameter core was removed to a depth of 60 cm and subdivided as previously described. Nematode species present in the treated and non-treated plots were determined by preparing permanent mounts of randomly selected individuals from massed samples. In addition, aboveground arthropods¹ were extracted with Berlese funnels from

¹Arthropod identification provided by Dr. Burruss McDaniel, Entomology Department, South Dakota State University, Brookings, South Dakota.

herbage obtained on 21 July. Regrowth in all plots was clipped 28 September, 1972. On 5 April, 1973, blocks of soil 6 x 6 cm to a depth of 10 cm were removed from all plots for final evaluation of nematode populations.

All pots in greenhouse experiments received regular applications of water and fertilizer, and insecticide was applied when necessary. Clippings obtained in all experiments were oven dried at 60°C for five days prior to weighing.

RESULTS AND DISCUSSION

Taxa, number and biomass studies

The following nematodes were identified from samples obtained from the Cottonwood Grassland Biome site: Acrobeles complexus Thorne, 1925; A. ctenocephalus Thorne, 1925; Acrobeloides minor (Thorne, 1925) Thorne, 1937; Akrotonus vigor Thorne, 1973; Aphelenchoides centralis Thorne and Malek, 1968; Aphelenchus avenae Bastian, 1865; Aporcelaimellus clamus Thorne, 1973; A. conoides Thorne, 1973; A. obscuroides Altheer, 1967; A. obscurus (T and S, 1953) Heyns, 1965; A. porcus Thorne, 1973; Axonchium micans Thorne, 1939; A. solitare Thorne, 1939; Basiria graminophila Siddiqi, 1959; Basiroides conurus Thorne and Malek, 1968; Bastiania sp.; Belondira apitica Thorne, 1939; Boleodorus acutus Thorne and Malek, 1968; B. thylactus Thorne, 1941; Cephalobus persegnis Bastian, 1865; Cervidellus serricephalus (Thorne 1925) Thorne, 1937; Chiloplacus contractus Thorne, 1937; Discolaimus texanus Cobb, 1913; Ditylenchus caudatus Thorne and Malek, 1968; D. microdens Thorne and Malek, 1968; Dorylaimellus nodochordus Thorne, 1939; D. tenuidens Thorne, 1939; Dorylaimoides teres Thorne and Swanger, 1936; Ecumenicus monohystera (deMan, 1880, And. 1959) Thorne, 1973; Eucephalobus oxyuroides (deMan, 1876) Steiner, 1936; Eudorylaimus acuticauda (deMan, 1880) Andrassy, 1959; E. conicaudatus Thorne, 1973; E. dubius Thorne, 1973; E. longicardius Thorne, 1973; E. miser (T and S, 1936) Andrassy, 1959; E. modestus (Altheer, 1952) Andrassy, 1959; E. sodakus Thorne, 1973; Helicotylenchus glissus Thorne and Malek, 1968; H. leiocephalus Sher, 1966; Heterodera

sp.; Labronema rapax Thorne, 1973; Laimydorus flexus (T and S, 1936) Andrassy, 1959; Leptonchus obtusus Thorne, 1939; Longidorus crassus Thorne, 1973; Mesodorylaimus pseudobastiani Loof, 1969; Monhystera sp.; Mononchus papillatus Bastian, 1865; Nothotylenchus sp.; Nygolaimus macrobrachyurus Heyns, 1968; N. papilloides Thorne, 1973; N. parabrachyurus Heyns, 1968; N. paratenuis, Thorne, 1973; Paratylenchus brevihastatus Wu, 1962; P. pesticus Thorne and Malek, 1968; P. vexans Thorne and Malek, 1968; Plectus parietinus Bastian, 1865; Pratylenchus scribneri Steiner, 1943; P. tenuis Thorne and Malek, 1968; Prismatolaimus sp.; Psilenchus elegans Thorne and Malek, 1968; P. hilarulus deMan, 1921; Pungentus monohystera Thorne and Swanger, 1936; Solidens vulgaris (Thorne 1930) Thorne, 1973; Subanquina radiculicola (Greeff, 1872) Paramonov, 1967; Thonus major Thorne, 1973; T. nothus (T and S, 1936) Thorne, 1973; Tripyla arenicola deMan, 1880; Trophurus minnesotensis (Caveness, 1958) Caveness, 1959; Tylencholaimellus grandis Thorne, 1973; T. striatus Thorne, 1939; Tylencholaimus proximus Thorne, 1939; Tylenchorhynchus acutus Allen, 1955; T. maximus Allen, 1955; T. nudus Allen, 1955, T. robustoides Thorne and Malek, 1968; Tylenchus exiguus deMan, 1876; T. fusiformis Thorne and Malek, 1968; T. parvissimus Thorne and Malek, 1968; Wilsonema sp.; Xiphinema americanum Cobb, 1913; X. vuittenezi Luc et. al., 1964.

The large variety of nematodes in the above list is apparently due to the mixed prairie nature of the sampling area and the large number of samples collected. Species encountered by treatment and depth for indicated sampling dates are presented in the appendix in Table A1. Appendix tables are designated by the letter A. Figure 1 compares the effects of grazing intensity and sampling depth on species diversity.

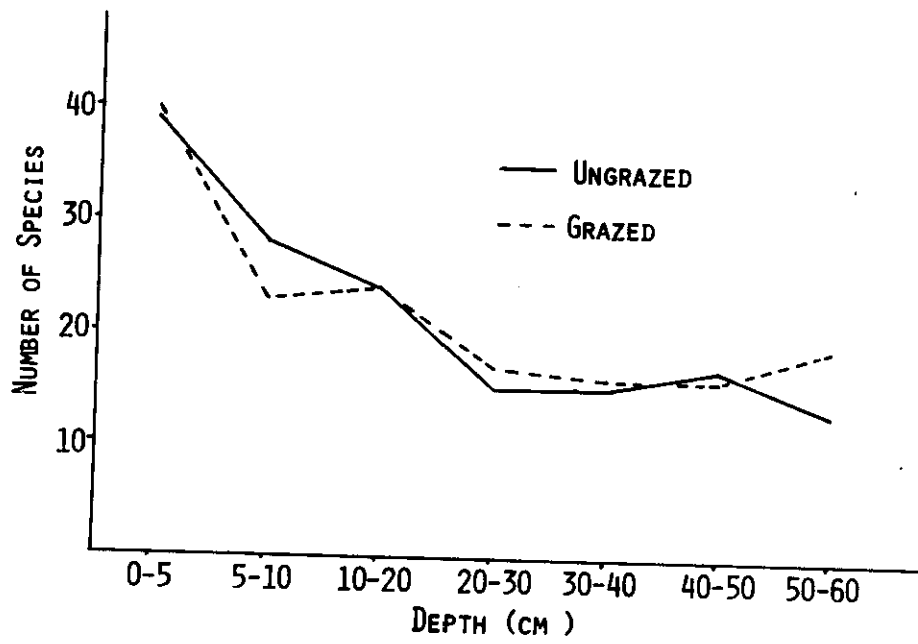


Fig. 1. Effect of grazing intensity and sampling depth on number of species encountered at the Cottonwood site.

Grazing intensity had little effect on species diversity whereas the reverse is true for sampling depth. The 0-5 cm samples had more than twice the number of species encountered in the 50-60 cm samples (Fig. 1). This greater diversity apparently reflects the greater variety of food sources available in the upper soil layers.

Figures 2 and 3 compare the effects of grazing intensity and sampling date on the number and biomass, respectively, of plant feeding nematodes per m^2 to 60 cm depth at the Cottonwood site. As indicated (Fig. 2), sampling date had a greater influence on nematode numbers than grazing intensity. The summary of the analyses of variances (Table 1) revealed significant grazing effects only for certain 1972 samples. In terms of nematode biomass, however, (Fig. 3) both grazing intensity and sampling date frequently resulted in statistically significant differences (Table 1). Nematode populations are usually expressed in terms of numbers; it would appear however, that biomass is also a useful means for judging populations and in the case of ecological studies is probably superior.

Effects of grazing intensity and sampling depth on number and biomass of plant feeding nematodes for the July, 1970 sampling are shown in Figs. 4, 5. The same general trends are again apparent, i.e., little difference in terms of numbers and greater differences in biomass between grazed and ungrazed treatments. The reason for the highly significant effects of depth (Table 1) are obvious in both Figs. 4 and 5 since well over half of the nematodes occurred above the 20 cm sampling depth. The majority of roots also occur above 20 cm (15) which would

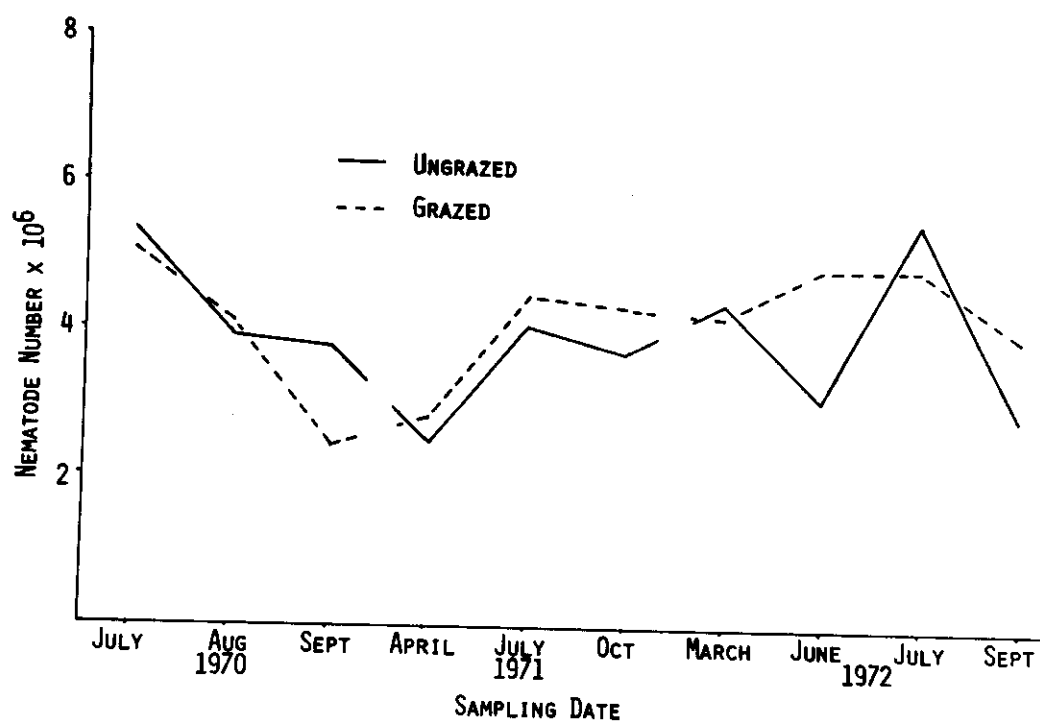


Fig. 2. Effect of grazing intensity and sampling date on number of plant feeding nematodes/m² to 60 cm depth at the Cottonwood site.

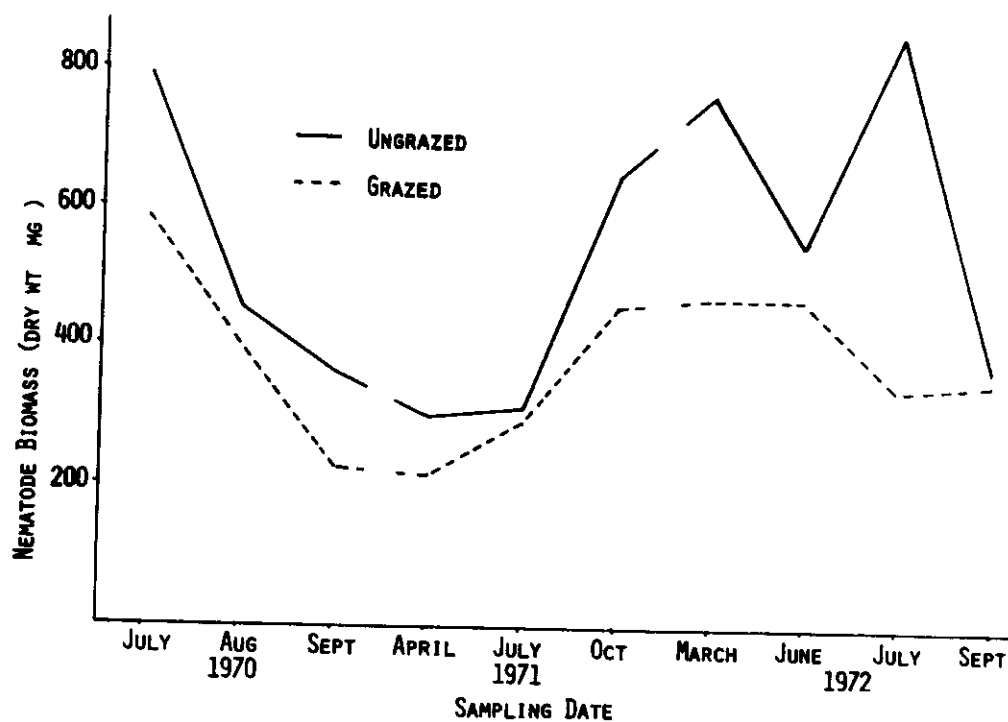


Fig. 3. Effect of grazing intensity and sampling date on biomass of plant feeding nematodes/m² to 60 cm depth at the Cottonwood site.

Table 1. Summaries of significance in the analyses of variances of numbers and biomass of nematodes.

	1970, Numbers	1970, Biomass	1971, Numbers	1971, Biomass	1972, Numbers	1972, Biomass
Treatment (Trt)	NS	*	NS	***	***	***
Date (Da)	***	***	***	***	***	***
Depth (De)	***	***	***	***	***	***
Trophic (Trp)	***	***	***	***	***	***
Trt x Da	NS	NS	NS	*	***	***
Trt x De	**	***	***	**	***	***
Da x De	***	***	***	***	***	***
Trt x Trp	NS	NS	**	**	***	***
Da x Trp	***	***	***	***	***	***
De x Trp	***	***	***	***	***	***
Trt x Da x De	NS	NS	NS	**	***	***
Trt x Da x Trp	NS	NS	NS	NS	*	***
Trt x De x Trp	NS	**	***	*	***	***
Da x De x Trp	**	***	***	***	NS	NS
Trt x Da x De x Trp	NS	NS	NS	NS	NS	**

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

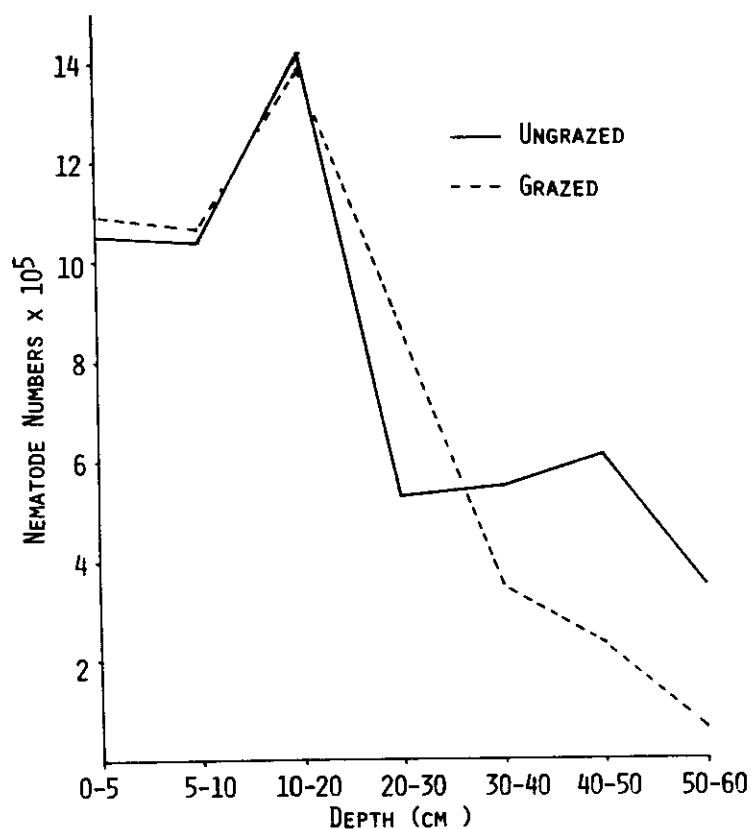


Fig. 4. Effect of grazing intensity and sampling depth on numbers of plant feeding nematodes/m² at the Cottonwood site, July, 1970.

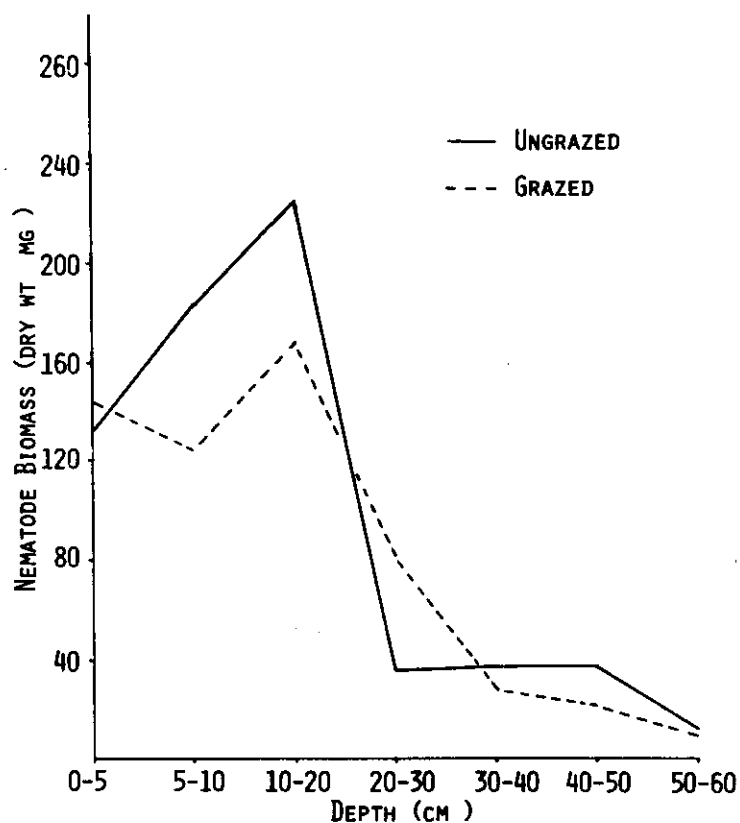


Fig. 5. Effect of grazing intensity and sampling depth on biomass of plant feeding nematodes/m² at the Cottonwood site, July, 1970.

account for the concentration of plant feeding nematodes in the upper soil layers. The tendency for nematode populations to remain higher as depth increased in the ungrazed treatment (Fig. 4) appeared to be consistent over most of the sampling dates (Table A2). A logical means to explain this difference is to compare the root biomass in the grazed versus ungrazed treatments. Upon so doing however, one finds that the root biomass is nearly always higher in the grazed treatment (15). It would thus appear that the higher populations are due to a greater proportion of suitable feeding sites at lower depths in the ungrazed treatment, that, in turn, are due to the shift in dominant vegetation that occurs from the grazed to ungrazed condition. The observed population differences also aid in explaining the significant treatment by depth interactions that frequently occurred. The analyses of variance for trophic level data in Table A2 are shown in Tables A3-A5.

Due to the large amount of data generated in this study it was not feasible to conduct a separate analysis of variance for each of the nine taxa groupings counted. Consequently three taxa, Tylenchorhynchus spp., Helicotylenchus spp. and Xiphinema spp. which constitute the greatest proportion of biomass, were selected to represent the plant feeding forms. The species included in these three and all other taxa groupings are shown in Table 2.

Certain of the taxa groupings (Table 2) contain genera that do not agree with the taxa title. These genera were of similar size and food habits to others in the taxa grouping and also occurred infrequently and in low numbers. The values for the predaceous forms were based on

Table 2. Taxa groupings used in comparisons of nematode number, biomass and trophic level data obtained at the Cottonwood site.

<u>Taxa grouping</u>	<u>Trophic level</u>	<u>Taxa contained within grouping</u>
<u>Tylenchorhynchus</u>	Plant feeding	<u>Tylenchorhynchus robustoides</u> (90) ^a ; <u>T. nudus</u> (6); <u>T. maximus</u> (2); <u>T. acutus</u> (1); <u>Trophurus minnesotensis</u> (1).
<u>Helicotylenchus</u>	Plant feeding	<u>Helicotylenchus leiocephalus</u> (87); <u>H. glissus</u> (12); <u>Heterodera</u> larvae (2).
<u>Xiphinema</u>	Plant feeding	<u>Xiphinema americanum</u> (97); <u>X. vuittenzezi</u> (2); <u>Longidorus crassus</u> (1).
<u>Paratylenchus</u>	Plant feeding	<u>Paratylenchus vexans</u> (64); <u>P. brevihastatus</u> (33); <u>P. pesticus</u> (2).
<u>Tylenchinae-</u> <u>Psilenchinae</u>	Plant feeding	<u>Tylenchus exiguus</u> (49); <u>T. parvissimus</u> (6); <u>T. plattensis</u> (1); <u>Ditylenchus caudatus</u> (6); <u>D. microdens</u> (2); <u>Basiroides conurus</u> (13); <u>Basiria graminophila</u> (2); <u>Psilenchus elegans</u> (2); <u>P. hilarulus</u> (1).
<u>Pratylenchus</u>	Plant feeding	<u>Pratylenchus tenuis</u> (85); <u>P. scribneri</u> (15).
<u>Dorylaim</u>	Plant feeding (40)	<u>Pungentus</u> (23); <u>Dorylaimellus</u> (19); <u>Tylencholaimellus</u> (19); <u>Axonchium</u> (16); <u>Belondira</u> (10); <u>Dorylaimoides</u> (6); <u>Tylencholaimus</u> (4); <u>Leptonchus</u> (2).
<u>Dorylaim</u>	Predacious (60)	<u>Eudorylaimus</u> (45); <u>Aporcelaimellus</u> (41); <u>Nygolaimus</u> (10); <u>Akrotonus</u> (1); <u>Mesodorylaimus</u> (1); <u>Laimydorus</u> (1) <u>Solidens</u> (1); <u>Discolaimium</u> (1).
<u>Mononchus</u>	Predacious	<u>Mononchus papillatus</u> (80); <u>Tripyla arenicola</u> (20).
<u>Rhabditida</u>	Saprophagous	<u>Acrobeles</u> (39); <u>Cephalobus</u> (27); <u>Chiloplacus</u> (15); <u>Eucephalobus</u> (10); <u>Plectus</u> (3); <u>Cervidellus</u> (3); <u>Acrobeles</u> (2); <u>Aphelenchus</u> (2); <u>Wilsonema</u> (1).

^aFigure in parenthesis indicates the percentage composition of each based on occurrences in permanent mounts of randomly selected individuals.

two taxa groupings and the saprophagous on one (Table 2). Thus, the analyses of variance (Tables A3-A5) are directly applicable to the saprophagous forms and, since the predaceous dorylaims comprised about 90% of the predaceous taxa, are also applicable to these forms.

Effects of grazing intensity, sampling depth and sampling date on numbers of all taxa groupings are shown in Table A6. Effects of grazing intensity and sampling date on the number of Tylenchorhynchus spp., Helicotylenchus spp. and Xiphinema spp. are compared in Figs. 6, 7 and 8 respectively. Analyses of variance for these taxa groupings are presented in Tables A7-A9. The number of Tylenchorhynchus spp. was significantly higher in the grazed treatment on nearly all sampling dates (Fig. 6), indicating a preference for grasses dominant in the treatment or a shift in other environmental conditions favorable to this group. There was little obvious correlation between grazing intensity and number of Helicotylenchus spp. (Fig. 7), although significant treatment differences existed for some dates. It appears that this group is well adapted to both grazing treatments.

Xiphinema spp. displayed a definite preference for the ungrazed treatment (Fig. 8). Members of this group are much larger than the preceding two and it is probable that they find the coarser-rooted A. smithii easier to feed upon than the finer-rooted grasses dominant in the grazed treatment. Xiphinema spp., particularly X. americanum, are sensitive to perturbations in the environment (20) and thus, environmental changes, beyond those of host that occur under heavy grazing, may also account for the population differences. Two obvious changes

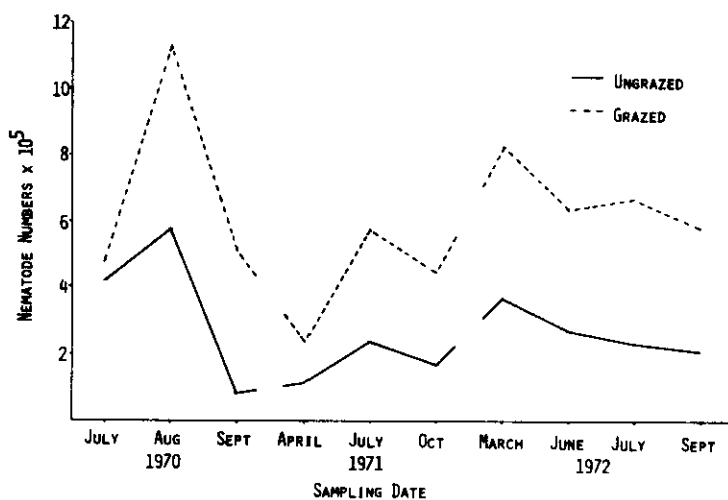


Fig. 6. Effect of grazing intensity and sampling date on number of *Tylenchorhynchus* spp./m² to 60 cm depth at the Cottonwood site.

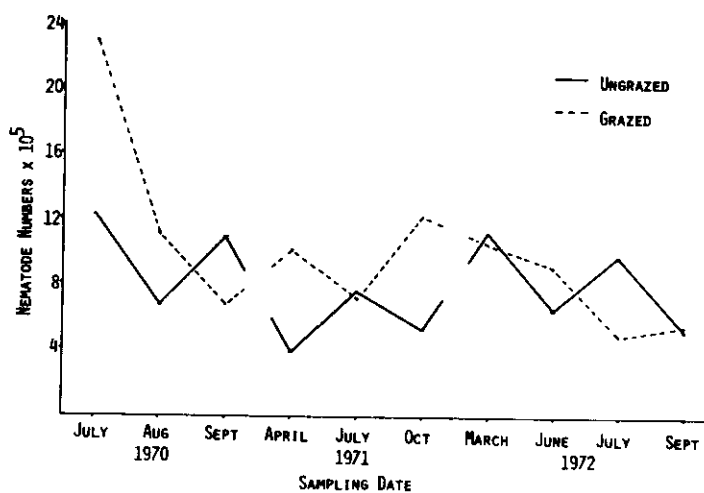


Fig. 7. Effect of grazing intensity and sampling date on number of *Helicotylenchus* spp./m² to 60 cm depth at the Cottonwood site.

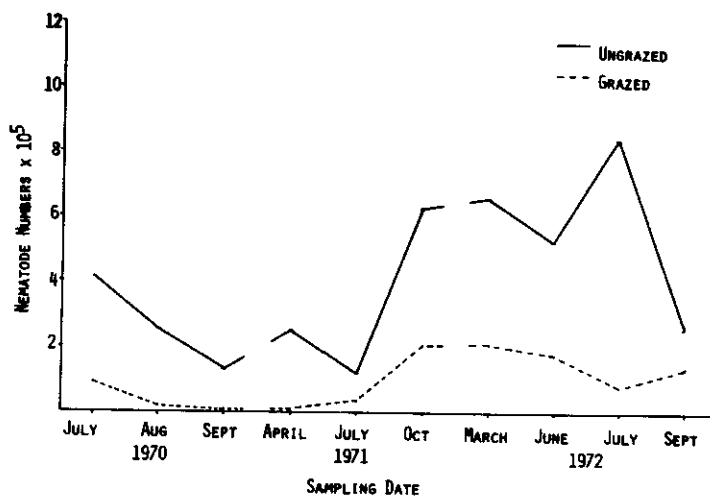


Fig. 8. Effect of grazing intensity and sampling date on number of *Xiphinema* spp./m² to 60 cm depth at the Cottonwood site.

would be an increase in soil biological activity through the addition of cattle feces and an increase in soil compaction through trampling.

Effects of grazing intensity and sampling depth on numbers of Tylenchorhynchus spp., Helicotylenchus spp. and Xiphinema spp. are shown in Figs. 9, 10 and 11 for the July, 1970, sampling. Effects of sampling depth are basically similar to those shown in Fig. 4, since the majority of all three taxa occurred above 20 cm. An interesting contrast was noted, however, in comparing Figs. 9 and 10. The Tylenchorhynchus spp. appear to be limited to primarily the upper 10 cm of soil with the Helicotylenchus spp. beginning to predominate at or below this level. This condition is especially apparent in the grazed treatment (Table A6). Possible explanations include an apparent antagonism between these two genera (22) and the preference of Tylenchorhynchus spp. for higher soil temperatures (19, 24, 34). Disruption of this natural segregation through cultivation aids in explaining the low numbers of both taxa in winter wheat (Triticum aestivum L.) fields adjacent to the Cottonwood site (unpublished data). Preference of Xiphinema spp. for conditions in the ungrazed treatment were again apparent (Fig. 11).

Figures 12 and 13 show the effects of grazing intensity and sampling depth on the biomass of Helicotylenchus spp. and Xiphinema spp., respectively, for the July, 1970, sampling. A comparison of Figs. 10 and 11 with 12 and 13 reveals the principal reason for the higher biomass of plant feeding nematodes in the ungrazed treatment (Fig. 3) to be the much larger size of the Xiphinema spp. For example, on the above

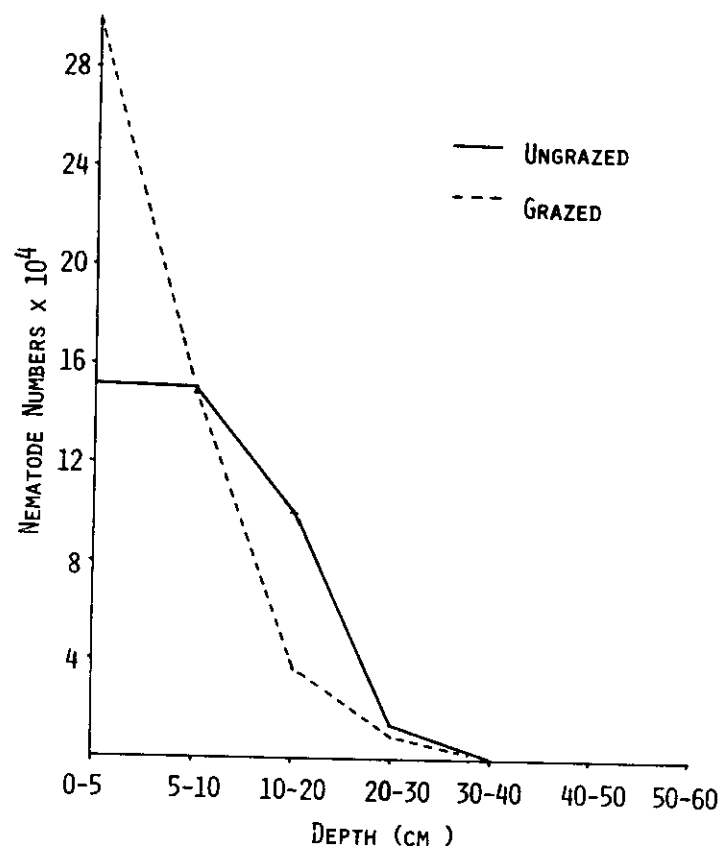


Fig. 9. Effect of grazing intensity and sampling depth on number of *Tylenchorhynchus* spp./m² at the Cottonwood site, July, 1979.

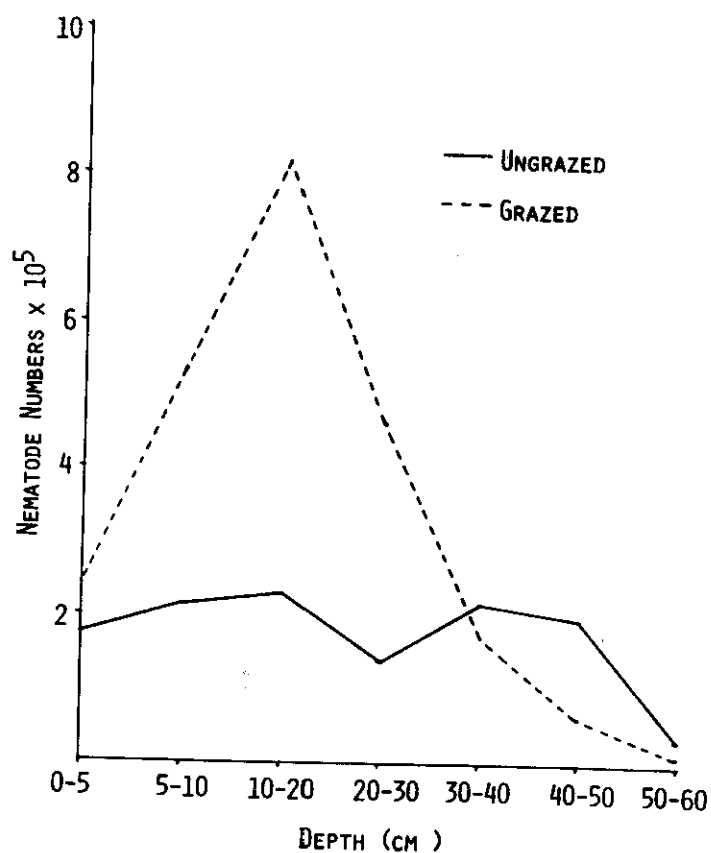


Fig. 10. Effect of grazing intensity and sampling depth on number of *Helicotylenchus* spp./m² at the Cottonwood site, July, 1970.

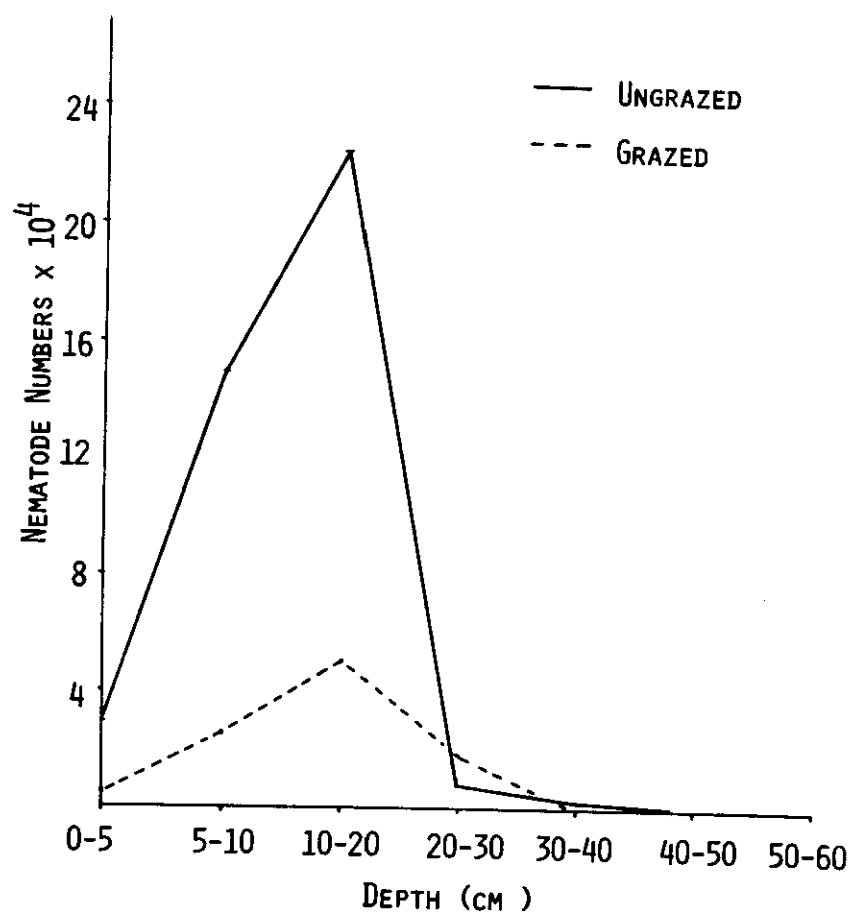


Fig. 11. Effect of grazing intensity and sampling depth on number of Xiphinema spp./m² at the Cottonwood site, July, 1970.

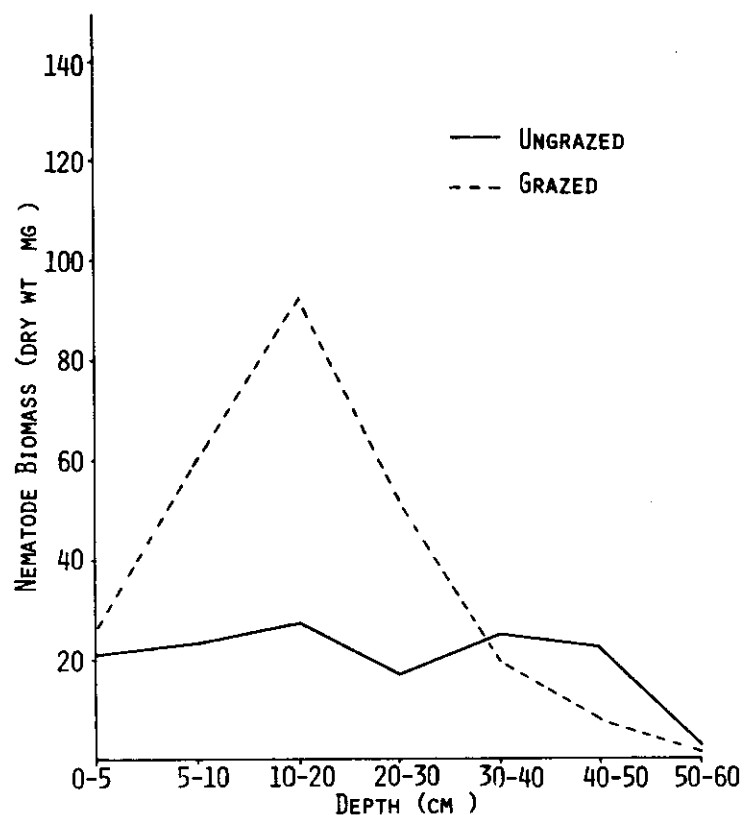


Fig. 12. Effect of grazing intensity and sampling depth on biomass of *Helicotylenchus* spp./m² at the Cottonwood site, July, 1970.

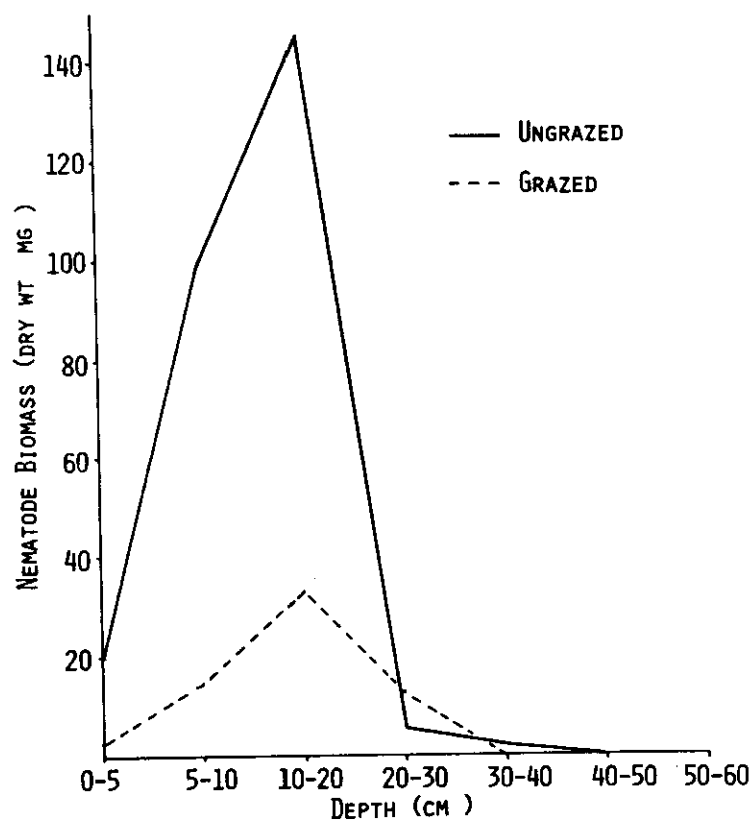


Fig. 13. Effect of grazing intensity and sampling depth on biomass of *Xiphinema* spp./m² at the Cottonwood site, July, 1970.

sampling date 234,000 Helicotylenchus spp. weighed 256 mg whereas only 41,000 Xiphinema spp. weighed 273 mg.

Other trophic levels were also studied and the effects of grazing intensity and sampling date on the numbers of predaceous and saprophagous forms are shown in Fig. 14. Initially, this figure was prepared to show a possible predator-prey relationship and, on the basis of numbers, it would appear that the saprophagous forms might provide a sufficient food source. In addition, some of the predaceous forms are known to feed upon certain saprophagous nematodes (32). However, when the biomass of predaceous and saprophagous forms is compared, (Figs. 15 and 16 respectively) it is apparent that the saprophagous forms are not the sole food source of the predators. The large biomass of the predaceous forms in spite of their relatively low numbers is due to the large size of these aggressive nematodes. The biomass of the predaceous forms is nearly as large as that of the plant feeding (Fig. 3) and plant feeders are probably also utilized as a food source. It thus appears that the predators may be an important element in biological control of plant feeding populations. However, predaceous nematodes do not feed only on other nematodes. Enchytraeid eggs, mites, mite eggs, protozoa and oligochaetes are known to be preyed upon and no doubt other soil-inhabiting animals. It is also possible that certain of the forms included among the predaceous (Table 2) are omnivorous (10, 27, 30) and also feed upon plant material.

Total nematode biomass estimates obtained in the present study are within the range of those reported in previous work (Table 3) in spite of the wide diversity of habitats and extraction techniques.

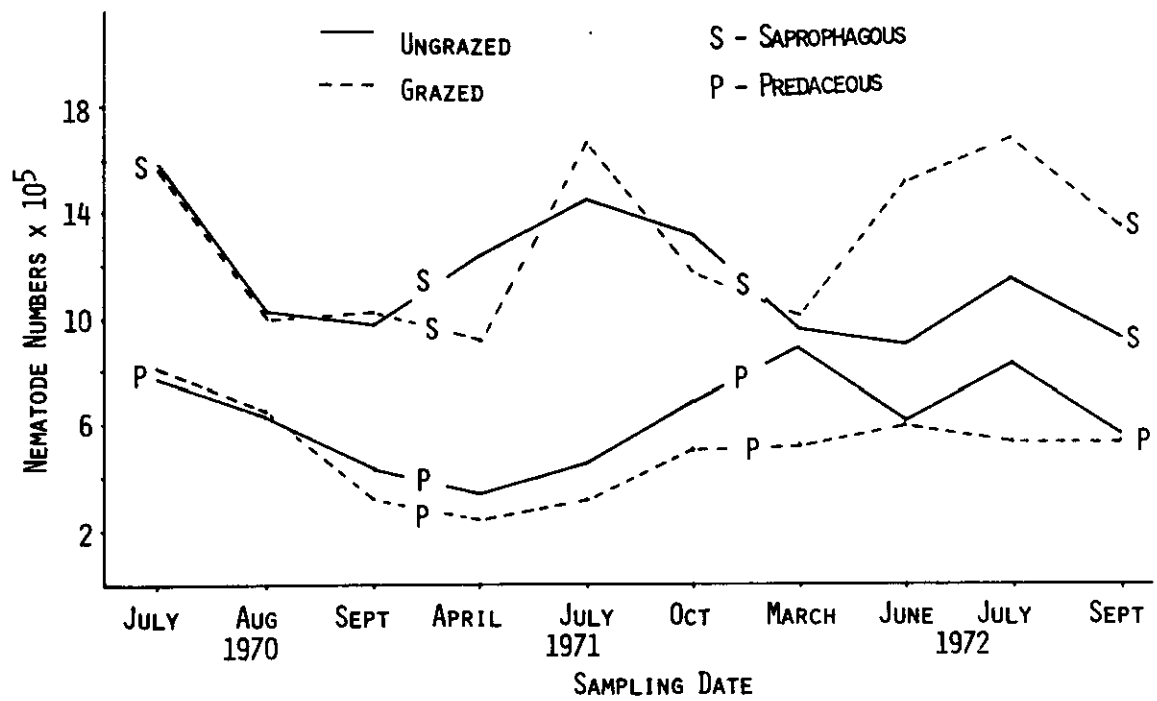


Fig. 14. Effect of grazing intensity and sampling date on number of predaceous and saprophagous nematodes/ m^2 to 60 cm depth at the Cottonwood site.

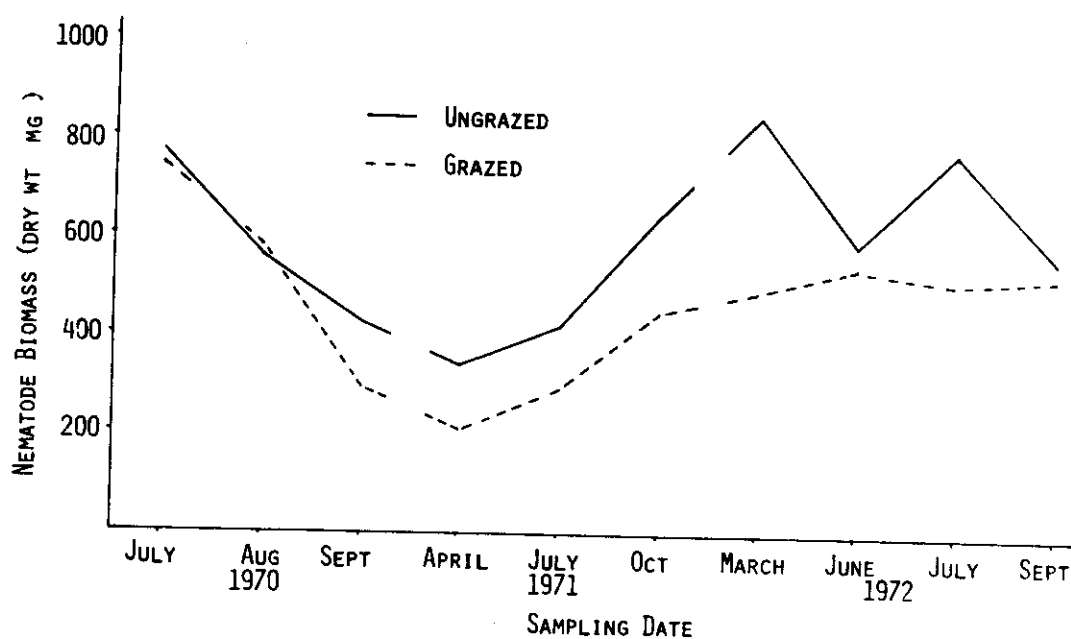


Fig. 15. Effect of grazing intensity and sampling date on biomass of predaceous nematodes/m² to 60 cm depth at the Cottonwood site.

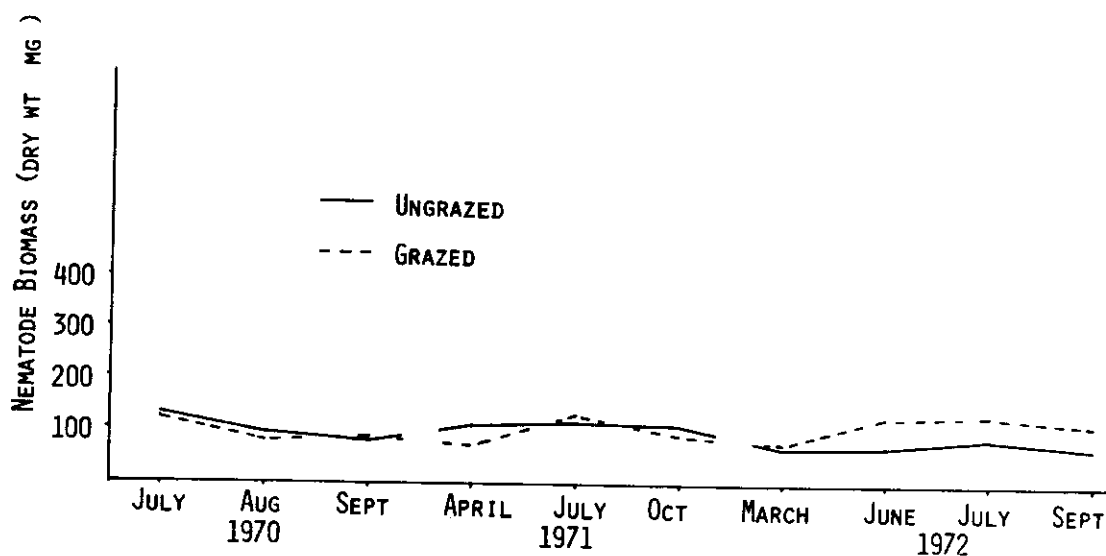


Fig. 16. Effect of grazing intensity and sampling date on biomass of saprophagous nematodes/m² to 60 cm depth at the Cottonwood site.

Table 3. A comparison of estimates of biomass of nematode populations from several habitats with those obtained at the Cottonwood site.

Habitat	Biomass (g/m ² wet wt)	Country	Sampling depth (cm)	Source
Grassland	5.0	Switzerland	15	(26)
Grassland	8 - 17.8	Denmark	5	(18)
<u>Juncus</u> moor peat	0.48 - 0.75	England	6	(2)
Cultivated (wheat)	0.56	Soviet Union	-	(36)
Grassland	1.1 - 13.8	Canada	30	(35)
Beech forest	4.1	Germany	25	(33)
Oak forest	15.2	Germany	25	(33)
Aspen forest	1.86	Sweden	24	() ^a
Pine forest	0.3	Sweden	2-4	() ^a
Old field	0.5 - 3.0	U.S.A.	80	(5)
Cottonwood site	2.0 - 7.1	U.S.A.	60	

^aSohlenius (personal communication).

Nematicide studies

Nematicide treatment significantly reduced nematode numbers in field plots at the Cottonwood site (Table 4). The analysis of variance (Table A10) for data obtained on the second sampling date revealed a significant treatment by depth interaction. As indicated in Fig. 17, the effectiveness of the nematicide rapidly diminished below 30 cm in depth; however, this might be expected since the majority of roots, which transport the nematicide, occur above 30 cm. The nematicide was generally more effective in reducing populations of plant feeding forms than those of other trophic levels (Table 4). Significant reductions, however, did occur among predaceous and saprophagous forms, indicating that the chemical possesses substantial rhizosphere activity. Species diversity was also reduced by nematicide treatment (Table 5). Nematode

Table 4. Effect of nematicide treatment on numbers of nematodes in heavily grazed range at the Cottonwood site.

Sampling date		Depth (cm)	Trophic level		
			Plant feeding	Predaceous	Sapro-phagous
6 July, 1972	Check	0-5	1266 ^a	244	707
		5-10	864	123	116
	Treated	0-5	169	123	309
		5-10	74	20	37
	Percent reduction	0-5	87	50	67
		5-10	91	84	68
	t	0-5	4.02***	1.27	2.98**
		5-10	3.07**	3.56***	2.69**

	21 July, 1972 ^b				
	Check	0-5	2030	270	1044
		5-10	1013	83	133
		10-20	1169	73	70
		20-30	456	16	39
		30-40	237	11	14
		40-50	78	4	43
		50-60	54	8	44
	Treated	0-5	222	74	246
		5-10	108	24	16
		10-20	49	4	16
		20-30	161	10	17
		30-40	295	10	39
		40-50	214	8	53
		50-60	73	2	16
	Percent reduction	0-5	89	73	76
		5-10	89	71	88
		10-20	96	95	77
		20-30	65	37	56
		30-40	--	9	--
		40-50	--	--	--
		50-60	--	75	64

5 April, 1973	Check	0-10	4949 ^c	551	1808
	Treated	0-10	892	264	868
	Percent reduction		82	52	52
	t		6.97***	6.77***	7.10***

^aEach value is mean of 5 replications, number/4.2cm diameter core to indicated depth.

^bAnalysis of variance is shown in Table A12.

^cEach value is mean of 10 replications, number/6x6x10 cm block.

**Significant at .05 level.

***Significant at .01 level.

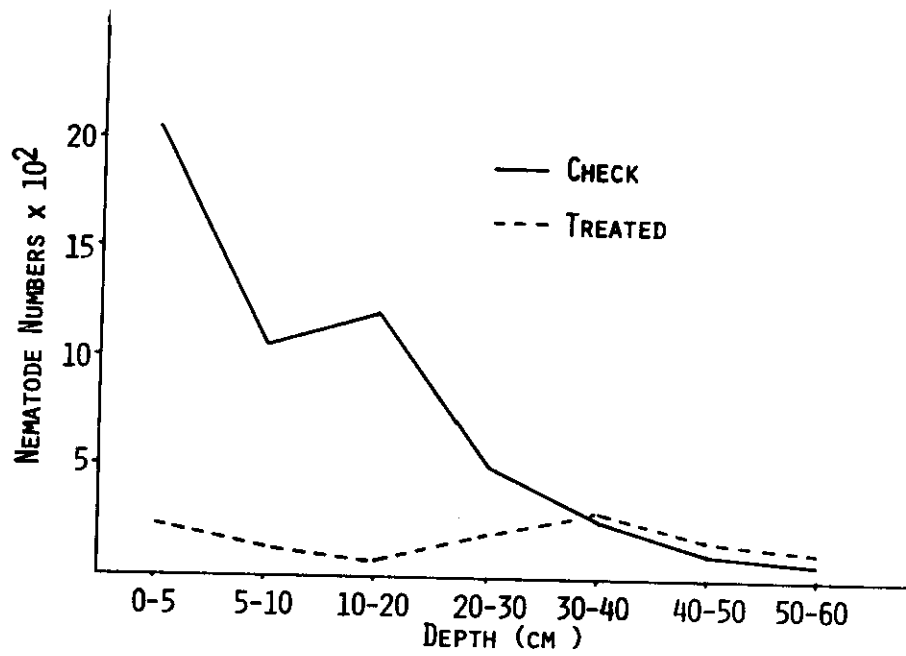


Fig. 17. Effect of nematicide treatment and sampling depth on number of plant feeding nematodes at the Cottonwood site.

Table 5. Nematodes identified among randomly selected individuals from check and nematicide treated plots at the Cottonwood site.

Check	Treated
<u>Acrobeles ctenocephalus</u>	<u>Acrobeles ctenocephalus</u>
<u>Aphelenchus avenae</u>	<u>Acrobeloides minor</u>
<u>Aporcelaimellus obscurus</u>	<u>Aphelenchoides sp.</u>
<u>Aporcelaimellus obscurus</u>	<u>Aporcelaimellus conoides</u>
<u>Axonchium sp.</u>	<u>Basiroides conurus</u>
<u>Bastiania sp.</u>	<u>Belondira apitica</u>
<u>Belondira apitica</u>	<u>Cephalobus persegnis</u>
<u>Boleodorus similis</u>	<u>Chiloplacus contractus</u>
<u>Cephalobus persegnis</u>	<u>Eucephalobus oxyuroides</u>
<u>Chiloplacus contractus</u>	<u>Eudorylaimus sp.</u>
<u>Discolaimus texanus</u>	<u>Helicotylenchus glissus</u>
<u>Ditylenchus microdens</u>	<u>Helicotylenchus leiocephalus</u>
<u>Dorylaimellus tenuidens</u>	<u>Heterodera larvae</u>
<u>Eucephalobus oxyuroides</u>	<u>Mononchus papillatus</u>
<u>Eudorylaimus longicardius</u>	<u>Paratylenchus brevihastatus</u>
<u>Eudorylaimus miser</u>	<u>Plectus parietinus</u>
<u>Helicotylenchus glissus</u>	<u>Pratylenchus tenuis</u>
<u>Helicotylenchus leiocephalus</u>	<u>Tylencholaimellus sp.</u>
<u>Leptonchus obtusus</u>	<u>Tylenchorhynchus robustoides</u>
<u>Mesodorylaimus sp.</u>	<u>Tylenchus exiguus</u>
<u>Mononchus papillatus</u>	<u>Tylenchus fusiformis</u>
<u>Nygolaimus sp.</u>	<u>Tylenchus parvissimus</u>
<u>Plectus parietinus</u>	
<u>Prismatolaimus sp.</u>	
<u>Tylencholaimellus striatus</u>	
<u>Tylencholaimellus sp.</u>	
<u>Tylenchorhynchus nudus</u>	
<u>Tylenchorhynchus robustoides</u>	
<u>Tylenchus exiguus</u>	
<u>Tylenchus parvissimus</u>	
<u>Wilsonema sp.</u>	
<u>Xiphinema americanum</u>	

control appeared to be deteriorating on the final sampling date (Table 4), however, significant reductions did occur among all trophic levels.

Significant growth increases resulted on all clipping dates (Table 6). Figure 18 compares representative amounts of herbage from treated and check plots obtained on the first clipping date.

Clipping weights were increased from 28 to 59% in treated plots (Table 6). Initial clipping of half of the field plots was accomplished with hand-powered clippers and consequently much of the crown material was not removed. Electrically-powered clippers were used for all subsequent clippings and as indicated in Table 6 the overall amount of herbage obtained on the second clipping was substantially greater. A further indication of the increased vigor of plants in treated plots was the 45% increase in weight of regrowth obtained on the final

Table 6. Effect of nematicide treatment on growth of range grasses in heavily grazed range at the Cottonwood site.

Clipping date		Clipping weight ^a	Percent increase	F
6 July, 1972	Check	52.52 ^b		
	Treated	83.24	59	24.07***
21 July, 1972	Check	109.05 ^b		
	Treated	139.80	28	10.81**
26 September, 1972	Check	35.98 ^c		
	Treated	52.35	45	15.16***

^aTotal dry herbage weight in g/0.5m².

^bEach value is mean of five replications.

^cEach value is mean of ten replications.

**Significant at .05 level.

***Significant at .01 level.

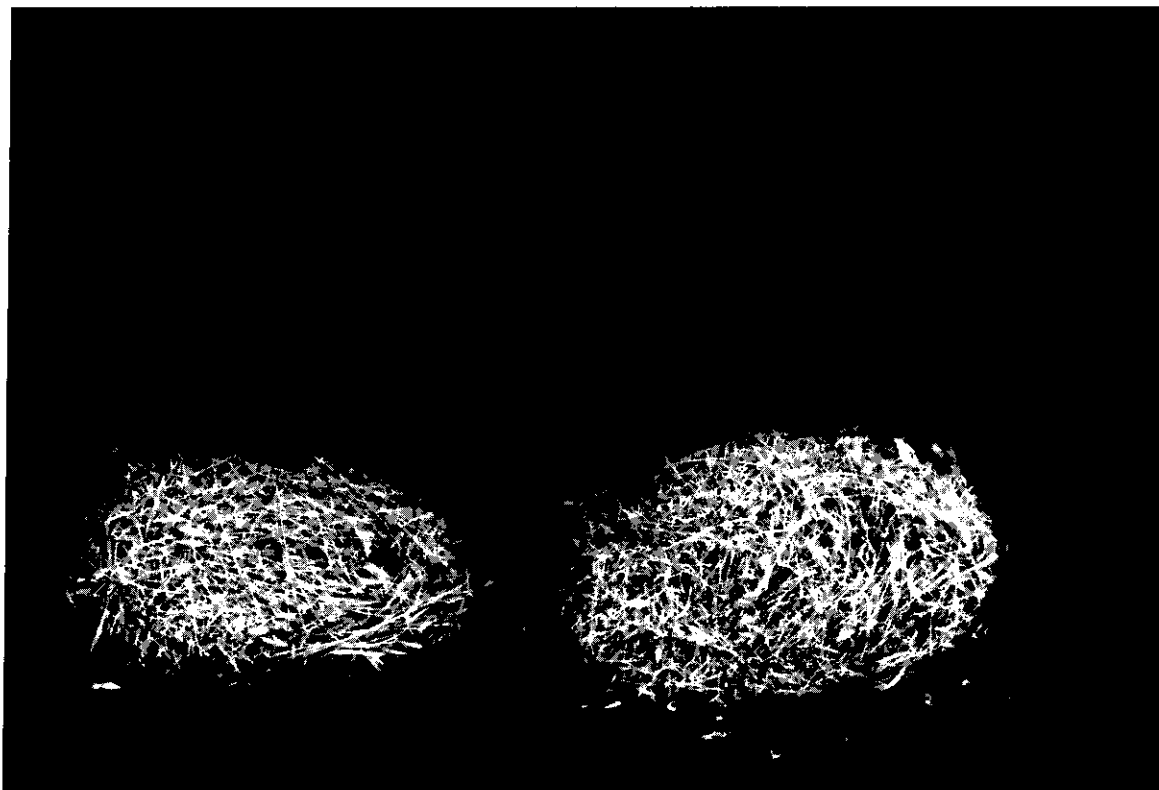


Fig. 18. Effect of nematocidal treatment on amounts of herbage obtained on the initial clipping of field plots at the Cottonwood site - treated on right.

clipping date. The numbers of selected aboveground arthropods extracted from herbage on the second clipping was generally higher in treated plots (Table 7), although no statistically significant differences existed within taxa.

Results obtained in greenhouse experiments substantiate those obtained in field plots. In the initial greenhouse experiment (Table 8) nematicide treatment significantly reduced nematode numbers among all trophic levels and substantially improved the top and root growth of treated grass (Fig. 19). In the second experiment nematode control was again excellent (Table 9) and clipping weights in treated pots were increased by 31% (Table 10). The confined nature and consequent more thorough nematicide coverage of plants in the greenhouse experiments would explain the greater reduction in nematode numbers. Plants in greenhouse experiments were watered and fertilized regularly and, since it has been demonstrated that stresses in the physical environment increase nematode injury to plants (25), clipping weight increases in treated pots were generally not as great as those obtained in the field study.

It is probable a portion of observed growth increases resulted from insect control since Vydate[®] is an insecticide as well as a nematicide. However, the peak biomass of aboveground arthropods at Cottonwood in 1970 was 0.385 g/m^2 (17), while in the present study the peak nematode biomass was 1.773 g/m^2 , or about 5 times greater than the arthropods. Thus, it is apparent that plant feeding nematodes not only occupy a

Table 7. Effect of nematicide treatment on numbers of selected above-ground arthropods in heavily grazed range at the Cottonwood site.

	Arthropod taxa							
	Pseudococcidae	Arachnida	Phloeothripidae	Thripidae	Formicidae	Araneae	Entomobryidae	Sminthuridae
Check	9 ^a	117	6	4	0.5	0.2	0.6	0.5
Treated	21	126	14	5	0.5	0.2	0.8	0

^aExtracted from herbage with Berlese funnels, each value is mean of five replications (McDaniel, unpublished data).

Table 8. Effect of nematicide treatment on nematode numbers in soil cores in greenhouse experiment I.

	Trophic level		
	Plant feeding	Predaceous	Saprophagous
Initial population	8,448 ^a	1,352	9,580
Check	15,462 ^b	1,378	12,516
Treated	765	134	1,436
Percent reduction	95	90	89
t	6.14***	6.70***	5.32***

^aEach value is mean of three replications.

^bEach value is mean of six replications seven months after treatment.

***Significant at .01 level.

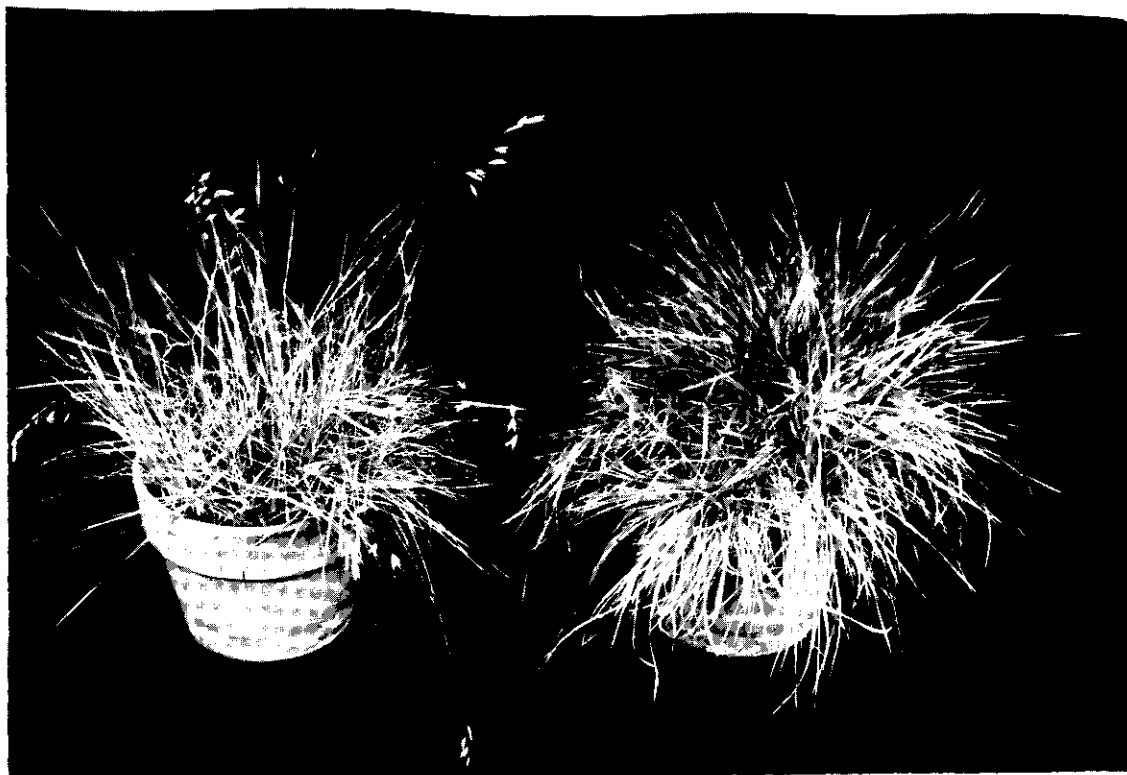


Fig. 19. Effect of nematicide treatment on growth of range grasses in soil cores in greenhouse experiment I. A. Top growth - treated on right. B. Root growth - treated on right.

Table 9. Effect of nematicide treatment on nematode numbers in soil cores in greenhouse experiment II.

	Trophic level		
	Plant feeding	Predaceous	Saprophagous
Check	6,733 ^a	611	27,176
Treated	240	96	1,272
Percent reduction	96	84	95
t	5.61***	4.54***	6.13***

^aEach value is mean of six replications seven months after treatment.

***Significant at .01 level.

Table 10. Effect of nematicide treatment on growth of range grasses in soil cores in greenhouse experiment II.

	Cumulative clipping weight	Root and crown weight
Check	9.27 ^a	10.87
Treated	12.15	12.32
Percent increase	31	13
t	2.70**	1.06

^aEach value is mean of six replications, dry wt in g.

**Significant at .05 level.

significant proportion of the invertebrate biomass at the Cottonwood site, but also function as controllers of productivity in range.

Nematode intake studies

Data thus far presented, while demonstrating the importance of nematodes, is deficient in one respect; it does not allow a direct comparison of nematode consumption with that of other consumers as is necessary to quantify energy flow in an ecosystem study. In an attempt to correct this deficiency a formula for estimating invertebrate intake developed by Lewis (14) was modified to estimate intake for plant feeding nematodes (Table 11). Metabolic rates were obtained from published values (3, 6, 11, 12, 16) and corrected for the mean of soil temperatures at 10 and 20 cm depths based on Cottonwood abiotic data (15). The growing season was divided into three periods; April-June, July-August and September-October, and the average plant feeding nematode biomass for each period was obtained from the three years of data. The next two values (Table 11), cal/ml O_2 and cal/g, were obtained from Lewis (14). Activity requirement was included to compensate for the nearly inactive condition of nematodes in a respirometer as compared to those in soil actively feeding or moving about in search of a host. The assimilation efficiency was obtained from Lewis (14). Calculations, with the omission of constants, are shown in Table 12 for the grazed and ungrazed treatment. Estimates of herbage net primary production at Cottonwood in 1970 (14) for the various components are shown in Table 13.

Table 11. Formula for estimating intake in g/m^2 for plant feeding nematodes at the Cottonwood site.
Adapted from Lewis (14).

Temp-corrected metabolic rate at field temp ml O_2 /gr/hr (dry wt)	Nematode weight - X dry wt in g/m^2	Calories/ ml O_2 (4.8)	Calories/ gram (4500)	Activity X requirement (2)	Assimilation ÷ efficiency (0.50)	Hours X in period
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$$= \frac{\text{intake } (\text{g/m}^2)}{}$$

Table 12. Calculations for estimation of intake in g/m^2 for plant feeding nematodes at the Cottonwood site.

<u>Grazed</u>	
Date:	
April - June: $(3.5) \times (0.3887) \times (\quad)^a \times (2184) =$	12.7
July - August: $(7.4) \times (0.4047) \times (\quad)^a \times (1488) =$	19.0
Sept. - October: $(3.5) \times (0.3529) \times (\quad)^a \times (1464) =$	<u>7.7</u>
Total	39.4
<u>Ungrazed</u>	
April - June: $(3.5) \times (0.5521) \times (\quad)^a \times (2184) =$	18.0
July - August: $(7.4) \times (0.6130) \times (\quad)^a \times (1488) =$	28.7
Sept. - October: $(3.5) \times (0.4614) \times (\quad)^a \times (1464) =$	<u>10.1</u>
Total	56.8

^aConstants: See Table 11.

Table 13. Estimated net primary productivity for grazed and ungrazed treatments at the Cottonwood site, 1970. From Lewis (14).

Component	Treatment	
	Grazed	Ungrazed
Aboveground herbage	247 ^a	450
Aboveground crowns and stolons	33	104
Belowground crowns	113	113
Roots	226	261

^aOven dry weight in g/m^2 .

Presence of an adequate food base for plant feeding nematodes in terms of net root production is apparent (Table 13). A comparison of estimated intake of primary producers by cattle, small mammal, bird and insect populations with that for nematodes is shown in Table 14.

Table 14. Estimated intake of primary producers by cattle, small mammal, bird, insect and nematode populations at the Cottonwood site.^a

Treatment	Cattle ^b	Small mammal	Bird	Insect	Nematode
Grazed	22 ^c	0.3	0.10	3.9	39
Ungrazed	37	0.3	0.06	1.9	57

^aAll values except those for nematodes were obtained from Lewis (14).

^bHypothetical cattle populations - based on moderate stocking rate.

^cIntake in g/m².

The comparatively high intake for plant feeding nematode populations (Table 14) is due in part to their large biomass. The mean nematode biomass for the grazed and ungrazed treatments is 0.38 and 0.54 g/m² while that for cattle is 1.69 and 2.85 g/m². Although the biomass for cattle is higher, the metabolic rate for nematodes is much higher, as would be expected on the basis of their much smaller size (12), and consequently their intake is greater. It should also be kept in mind when interpreting Table 14 that nematodes are indigenous and cattle are introduced. Thus, it might be expected that nematode populations are more efficient in utilizing the available food sources. A possible

deficiency of the formula in Table 11 is the assumption that nematodes were active throughout the entire April-October period. While precipitation was above normal for all of the sampling years (Lewis, personal communication), it is possible that either soil moisture or soil temperature may at times have been at levels that would limit nematode activity. Studies designed to determine the effects of soil moisture and temperature on nematode populations native to the Cottonwood site are currently underway.

CONCLUSIONS

Results presented demonstrate that soil inhabiting nematodes constitute a significant proportion of the consumer biomass at the Cottonwood site. Biomass of plant feeding forms was significantly greater in the ungrazed treatment due mainly to the high numbers of dagger nematode, Xiphinema americanum. Biomass of predaceous forms was also greater in the ungrazed treatment and overall nearly equaled that of the plant feeding forms, thus indicating their potential as agents of biological control. Biomass of saprophagous forms was considerably less than that of the other trophic levels and also showed little treatment response.

An inverse relationship between numbers of Tylenchorhynchus spp. and Helicotylenchus spp. was noted in the grazed treatment. Tylenchorhynchus spp. appeared nearly limited to the upper 10 cm of soil with Helicotylenchus spp. predominating with increasing depth, indicating a possible antagonistic relationship between these taxa.

The diversity of taxa was found to decrease with increasing sampling depth, a response attributed to a decrease in variety of food sources. Total number of nematodes also decreased with increasing sampling depth and approximately 70% of the nematodes occurred above 20 cm.

Nematicide treatment of range grasses in field and greenhouse studies significantly reduced nematode populations, increased above-ground herbage weight, and further, provided a demonstration of the importance of nematodes as controllers of productivity in range.

A formula was used to estimate nematode intake at the Cottonwood site and, surprisingly, plant feeding nematodes were found to consume more range grass than cattle. In addition, comparisons of nematode intake with that of several other consumer populations indicated that nematodes are major consumers at the Cottonwood site. The large biomass, high metabolic rate and indigenous nature of the nematode populations were suggested as probable reasons for the high intake.

Overall, it is apparent that soil inhabiting nematodes constitute a significant pathway of energy flow in a grassland ecosystem. They also are probably responsible for a significant proportion of the below-ground nutrient recycling.

Results of the present study are not applicable to Cottonwood alone since several surveys (unpublished data) have shown the existence of equally high nematode numbers throughout the range area of western South Dakota. In addition, Thorne (31) has commented on the general distribution of nematode species in prairie sod in the Northern Great Plains. Assuming that nematodes could be controlled, and, further, that what they now consume could be made available to cattle, it appears that the carrying capacity of the range could be doubled. Economic benefits of such a situation are obvious, however, the reverse is true under present conditions and in terms of economic loss plant feeding nematodes in range appear to be a major biotic agent of plant disease in the Northern Great Plains.

An obvious response to the above is to ask what can be done about nematodes in range. One of the first things that might be done is to

follow grazing recommendations. Certain of the desirable range grass species rapidly disappear under heavy grazing, probably because they cannot tolerate high populations of cattle grazing on shoots and high numbers of nematodes grazing on roots. Nematicide treatment is not now economically feasible and with presently available chemicals may be ecologically undesirable. Interseeding nematode resistant or tolerant grasses (providing they could be found) might also provide an answer. At present there is little interseeding of grasses in South Dakota range, apparently because of a previous lack of success. One of the reasons for previous failures may well be due to nematodes. Another possibility is a management regime that would operate to the advantage of cattle and disadvantage to nematodes. Nematode numbers, taxa and biomass data of the type presented in this study for a greater variety of range conditions might provide the basis for such a regime. Whatever the answer might be, continued research on nematodes in range is justified.

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APPENDIX A

APPENDIX TABLES

Table A1. Influence of grazing intensity and sampling depth on species encountered among randomly selected individuals at the Cottonwood site.

Date: July and October 1971, March 1972

Depth: 0-5 cm

Grazed	Ungrazed
<u>Acrobeles complexus</u>	<u>Acrobeles complexus</u>
<u>Acrobeles ctenocephalus</u>	<u>Acrobeles ctenocephalus</u>
<u>Acrobeloides sp.</u>	<u>Aphelenchus avenae</u>
<u>Aphelenchoides centralis</u>	<u>Aporcelaimellus conoides</u>
<u>Aporcelaimellus clamus</u>	<u>Aporcelaimellus obscurioides</u>
<u>Aporcelaimellus conoides</u>	<u>Aporcelaimellus obscurus</u>
<u>Aporcelaimellus obscurus</u>	<u>Aporcelaimellus porcus</u>
<u>Axonchium micans</u>	<u>Axonchium micans</u>
<u>Boleodorus acutus</u>	<u>Axonchium solitare</u>
<u>Cephalobus persegneis</u>	<u>Belondira apitica</u>
<u>Cervidellus sp.</u>	<u>Boleodorus thylactus</u>
<u>Chiloplacus contractus</u>	<u>Cephalobus persegneis</u>
<u>Ditylenchus microdens</u>	<u>Ditylenchus caudatus</u>
<u>Dorylaimellus sp.</u>	<u>Ditylenchus microdens</u>
<u>Eucephalobus oxyuroides</u>	<u>Dorylaimellus tenuidentis</u>
<u>Eudorylaimus monohystera</u>	<u>Eucephalobus oxyuroides</u>
<u>Eudorylaimus conicaudatus</u>	<u>Eudorylaimus acuticauda</u>
<u>Eudorylaimus loacuticauda</u>	<u>Eudorylaimus longicardius</u>
<u>Helicotylenchus glissus</u>	<u>Eudorylaimus modestus</u>
<u>Helicotylenchus leiocephalus</u>	<u>Eudorylaimus sodakus</u>
<u>Labronema rapax</u>	<u>Helicotylenchus leiocephalus</u>
<u>Laimydorus flexus</u>	<u>Heterodera sp.</u>
<u>Mesodorylaimus pseudobastiani</u>	<u>Laimydorus flexus</u>
<u>Nygolaimus paratenuis</u>	<u>Leptonchus sp.</u>
<u>Paratylenchus vexans</u>	<u>Longidorus crassus</u>
<u>Plectus parietinus</u>	<u>Monhystera sp.</u>
<u>Pratylenchus tenuis</u>	<u>Mononchus papillatus</u>
<u>Prismatolaimus sp.</u>	<u>Nygolaimus macrobrachyurus</u>
<u>Solidens vulgaris</u>	<u>Paratylenchus vexans</u>
<u>Thonus major</u>	<u>Plectus parietinus</u>
<u>Thonus nothus</u>	<u>Pungentus monohystera</u>
<u>Tripyla arenicola</u>	<u>Tripyla arenicola</u>
<u>Tylencholaimellus sp.</u>	<u>Tylencholaimellus striatus</u>
<u>Tylencholaimus proximus</u>	<u>Tylencholaimellus sp.</u>
<u>Tylenchorhynchus robustoides</u>	<u>Tylenchorhynchus acutus</u>
<u>Tylenchus exiguus</u>	<u>Tylenchorhynchus robustoides</u>
<u>Tylenchus parvissimus</u>	<u>Tylenchus exiguus</u>
<u>Xiphinema americanum</u>	<u>Xiphinema americanum</u>
<u>Xiphinema vuittenezi</u>	<u>Xiphinema vuittenezi</u>
<u>Wilsonema sp.</u>	

Table A1. Continued.

Date: July and October 1971, March 1972

Depth: 5-10 cm

Grazed	Ungrazed
<u>Acrobeles complexus</u>	<u>Acrobeles complexus</u>
<u>Akrotonus vigor</u>	<u>Akrotonus vigor</u>
<u>Aporcelaimellus obscuroides</u>	<u>Aporcelaimellus obscuroides</u>
<u>Aporcelaimellus obscurus</u>	<u>Aporcelaimellus obscurus</u>
<u>Aporcelaimellus porcus</u>	<u>Axonchium micans</u>
<u>Axonchium micans</u>	<u>Cephalobus persegnis</u>
<u>Boleodorus acutus</u>	<u>Dorylaimellus sp.</u>
<u>Cephalobus persegnis</u>	<u>Eucephalobus oxyroides</u>
<u>Ditylenchus microdens</u>	<u>Eudorylaimus sp.</u>
<u>Dorylaimellus sp.</u>	<u>Helicotylenchus glissus</u>
<u>Eudorylaimus miser</u>	<u>Helicotylenchus leiocephalus</u>
<u>Helicotylenchus glissus</u>	<u>Heterodera sp.</u>
<u>Helicotylenchus leiocephalus</u>	<u>Longidorus crassus</u>
<u>Leptonchus obtusus</u>	<u>Mononchus papillatus</u>
<u>Paratylenchus pesticus</u>	<u>Nygolaimus macrobrachyurus</u>
<u>Paratylenchus vexans</u>	<u>Nygolaimus papilloides</u>
<u>Pratylenchus scribneri</u>	<u>Nygolaimus parabrachyurus</u>
<u>Prismatolaimus sp.</u>	<u>Nygolaimus paratenuis</u>
<u>Tylencholaimellus striatus</u>	<u>Paratylenchus vexans</u>
<u>Tylenchorhynchus maximus</u>	<u>Prismatolaimus sp.</u>
<u>Tylenchorhynchus robustoides</u>	<u>Pungentus monohystera</u>
<u>Tylenchus exiguus</u>	<u>Tylencholaimellus sp.</u>
<u>Xiphinema americanum</u>	<u>Tylenchorhynchus acutus</u>
	<u>Tylenchorhynchus nudus</u>
	<u>Tylenchorhynchus robustoides</u>
	<u>Tylenchus exiguus</u>
	<u>Xiphinema americanum</u>
	<u>Xiphinema vuittenezi</u>

Date: July and October 1971, March 1972

Depth: 10-20 cm

<u>Acrobeles sp.</u>	<u>Acrobeles complexus</u>
<u>Akrotonus vigor</u>	<u>Akrotonus vigor</u>
<u>Aporcelaimellus obscurus</u>	<u>Aporcelaimellus obscurus</u>
<u>Axonchium</u>	<u>Belondira apitica</u>
<u>Bastiania sp.</u>	<u>Boleodorus acutus</u>
<u>Belondira apitica</u>	<u>Cephalobus persegnis</u>

Table A1. Continued.

Grazed	Ungrazed
<u>Cephalobus persegnis</u>	<u>Ditylenchus caudatus</u>
<u>Cervidellus sp.</u>	<u>Dorylaimellus sp.</u>
<u>Ditylenchus sp.</u>	<u>Eudorylaimus dubius</u>
<u>Dorylaimellus nodochordus</u>	<u>Eudorylaimus miser</u>
<u>Dorylaimellus tenuidens</u>	<u>Helicotylenchus glissus</u>
<u>Eudorylaimus miser</u>	<u>Helicotylenchus leiocephalus</u>
<u>Helicotylenchus glissus</u>	<u>Longidorus crassus</u>
<u>Helicotylenchus leiocephalus</u>	<u>Mononchus papillatus</u>
<u>Paratylenchus vexans</u>	<u>Nygolaimus macrobrachyurus</u>
<u>Pratylenchus hexincisus</u>	<u>Paratylenchus brevihastatus</u>
<u>Pratylenchus scribneri</u>	<u>Paratylenchus vexans</u>
<u>Tylencholaimellus striatus</u>	<u>Pungentus monohystera</u>
<u>Tylencholaimus proximus</u>	<u>Tripyla arenicola</u>
<u>Tylenchorhynchus robustoides</u>	<u>Tylencholaimellus striatus</u>
<u>Tylenchus exiguus</u>	<u>Tylenchorhynchus nudus</u>
<u>Tylenchus fusiformis</u>	<u>Tylenchorhynchus robustoides</u>
<u>Tylenchus parvissimus</u>	<u>Tylenchus exiguus</u>
<u>Xiphinema americanum</u>	<u>Xiphinema americanum</u>

Date: July and October 1971

Depth: 20-30 cm

Aporcelaimellus obscurus
Basiroides conurus
Chiloplacus contractus
Dorylaimellus tenuidens
Dorylaimellus sp.
Eucephalobus oxyuroides
Eudorylaimus sp.
Helicotylenchus glissus
Helicotylenchus leiocephalus
Nygolaimus macrobrachyurus
Trophurus minnesotensis
Tylencholaimellus sp.
Tylenchorhynchus acutus
Tylenchus exiguus
Tylenchus fusiformis
Tylenchus parvissimus
Xiphinema americanum

Aporcelaimellus sp.
Cephalobus persegnis
Dorylaimoides sp.
Helicotylenchus glissus
Helicotylenchus leiocephalus
Longidorus crassus
Nygolaimus parabrachyurus
Paratylenchus vexans
Pungentus monohystera
Pratylenchus scribneri
Psilenchus hilarulus
Tylenchorhynchus robustoides
Tylenchus exiguus
Tylenchus sp.
Xiphinema americanum

Table A1. Continued.

Date: July and October 1972

Depth: 30-40 cm

Grazed	Ungrazed
<u>Acrobeles complexus</u>	<u>Acrobeles complexus</u>
<u>Aporcelaimellus obscuroides</u>	<u>Aporcelaimellus obscuroides</u>
<u>Aporcelaimellus obscurus</u>	<u>Basiroides conurus</u>
<u>Cephalobus persegnis</u>	<u>Cephalobus persegnis</u>
<u>Chiloplacus sp.</u>	<u>Chiloplacus contractus</u>
<u>Dorylaimellus tenuidens</u>	<u>Ditylenchus caudatus</u>
<u>Eudorylaimus sp.</u>	<u>Helicotylenchus glissus</u>
<u>Helicotylenchus glissus</u>	<u>Helicotylenchus leiocephalus</u>
<u>Helicotylenchus leiocephalus</u>	<u>Longidorus crassus</u>
<u>Paratylenchus brevihastatus</u>	<u>Pratylenchus tenuis</u>
<u>Pratylenchus tenuis</u>	<u>Pungentus monohystera</u>
<u>Trophurus minnesotensis</u>	<u>Tylencholaimellus sp.</u>
<u>Tylenchus exiguus</u>	<u>Tylenchus exiguus</u>
<u>Tylenchus parvissimus</u>	<u>Tylenchus parvissimus</u>
<u>Tylenchus plattensis</u>	<u>Xiphinema americanum</u>
<u>Xiphinema americanum</u>	

Date: July and October 1971

Depth: 40-50 cm

<u>Acrobeles sp.</u>	<u>Acrobeles sp.</u>
<u>Aporcelaimellus obscuroides</u>	<u>Aphelenchus sp.</u>
<u>Basiroides conurus</u>	<u>Aporcelaimellus obscuroides</u>
<u>Cephalobus persegnis</u>	<u>Aporcelaimellus obscurus</u>
<u>Dorylaimellus sp.</u>	<u>Basiroides conurus</u>
<u>Eudorylaimus sp.</u>	<u>Cephalobus persegnis</u>
<u>Helicotylenchus glissus</u>	<u>Chiloplacus contractus</u>
<u>Helicotylenchus leiocephalus</u>	<u>Ditylenchus caudatus</u>
<u>Paratylenchus brevihastatus</u>	<u>Eudorylaimus sp.</u>
<u>Paratylenchus vexans</u>	<u>Helicotylenchus glissus</u>
<u>Pratylenchus scribneri</u>	<u>Helicotylenchus leiocephalus</u>
<u>Trophurus minnesotensis</u>	<u>Paratylenchus vexans</u>
<u>Tylencholaimellus sp.</u>	<u>Psilonchus elongatus</u>
<u>Tylenchus exiguus</u>	<u>Pungentus monohystera</u>
<u>Tylenchus parvissimus</u>	<u>Tylenchorhynchus robustoides</u>
<u>Xiphinema americanum</u>	<u>Tylenchus exiguus</u>
	<u>Xiphinema americanum</u>

Table A1. Continued.

Date: July and October 1971

Depth: 50-60 cm

Grazed	Ungrazed
<u>Acrobeles</u> sp.	<u>Aporcelaimellus</u> sp.
<u>Acroboloides</u> sp.	<u>Basiria graminophila</u>
<u>Aporcelaimellus obscurus</u>	<u>Basiroides conurus</u>
<u>Basiroides conurus</u>	<u>Cephalobus persegnis</u>
<u>Cephalobus persegnis</u>	<u>Ditylenchus caudatus</u>
<u>Cervidellus serricephalus</u>	<u>Eudorylaimus</u> sp.
<u>Chiloplacus contractus</u>	<u>Helicotylenchus glissus</u>
<u>Dorylaimellus tenuidens</u>	<u>Helicotylenchus leiocephalus</u>
<u>Dorylaimoides teres</u>	<u>Plectus</u> sp.
<u>Eudorylaimus</u> sp.	<u>Trophurus minnesotensis</u>
<u>Helicotylenchus leiocephalus</u>	<u>Tylencholaimellus</u> sp.
<u>Nothotylenchus</u> sp.	<u>Tylenchus exiguus</u>
<u>Paratylenchus brevihastatus</u>	<u>Tylenchus parviissimus</u>
<u>Tylenchus exiguus</u>	
<u>Tylenchus parviissimus</u>	
<u>Tylenchus plattensis</u>	
<u>Wilsonema</u> sp.	
<u>Xiphinema americanum</u>	

Table A2. Effect of grazing intensity, sampling date and sampling depth on numbers and biomass of plant feeding, predaceous and saprophagous nematodes at the Cottonwood site.

July, 1970

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,097,800 ^a	0.1429 ^b	378,200	0.3468	849,000	0.0675
5-10	1,078,200	0.1238	139,800	0.1282	337,000	0.0268
10-20	1,397,200	0.1692	142,800	0.1306	157,000	0.0125
20-30	876,200	0.0820	34,800	0.0318	92,000	0.0073
30-40	346,800	0.0282	22,200	0.0203	50,000	0.0040
40-50	233,400	0.0219	51,600	0.0472	42,000	0.0033
50-60	68,400	0.0093	33,600	0.0307	66,000	0.0052
Total	5,098,000	0.5773	803,000	0.7356	1,593,000	0.1266
					Grand Total: 7,494,000	
					1.4395	

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,055,000	0.1361	332,500	0.3050	830,000	0.0660
5-10	1,049,800	0.1834	173,700	0.1538	273,000	0.0217
10-20	1,427,600	0.2261	148,400	0.1378	284,000	0.0226
20-30	536,400	0.0375	39,600	0.0969	69,000	0.0055
30-40	559,200	0.0389	25,800	0.0236	58,000	0.0046
40-50	610,400	0.0389	36,600	0.0335	48,000	0.0038
50-60	357,400	0.0123	15,600	0.0143	37,000	0.0029
Total	5,595,800	0.7839	772,200	0.7699	1,599,000	0.1271
					Grand Total: 7,967,000	
					1.6809	

^aAvg. of six replications - number/m².

^bDry weight in g/m².

Table A2. Continued.

August, 1970

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,531,200 ^a	0.1471 ^b	185,300	0.1703	598,500	0.0476
5-10	504,000	0.0558	136,500	0.1248	147,000	0.0117
10-20	747,400	0.0865	175,600	0.1622	100,000	0.0080
20-30	600,200	0.0611	73,800	0.0675	51,000	0.0041
30-40	418,800	0.0349	31,200	0.0285	60,000	0.0048
40-50	181,000	0.0098	15,000	0.0137	23,000	0.0018
50-60	59,000	0.0048	15,000	0.0137	23,000	0.0018
Total	4,041,600	0.4000	632,400	0.5807	1,002,500	0.0798
Grand Total:					5,676,500	1.0605

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	799,800	0.0612	122,200	0.1130	688,000	0.0547
5-10	835,900	0.1124	154,100	0.1417	164,000	0.0130
10-20	923,800	0.1497	122,200	0.1130	101,000	0.0080
20-30	652,200	0.0585	80,800	0.0744	33,000	0.0026
30-40	359,400	0.0405	61,600	0.0569	33,000	0.0026
40-50	241,000	0.0151	15,000	0.0137	36,000	0.0029
50-60	142,600	0.0161	50,400	0.0461	28,000	0.0022
Total	3,954,700	0.4535	606,300	0.5588	1,083,000	0.0860
Grand Total:					5,644,000	1.0983

^aAvg. of six replications - number/m².^bDry weight in g/m².

Table A2. Continued.

September, 1970

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	691,100 ^a	0.0791 ^b	147,400	0.1358	684,500	0.0544
5-10	196,300	0.0452	73,200	0.0673	103,000	0.0082
10-20	830,000	0.0437	52,800	0.0486	100,000	0.0080
20-30	416,200	0.0348	22,800	0.0208	41,000	0.0033
30-40	245,800	0.0246	13,200	0.0121	20,000	0.0016
40-50	71,600	0.0058	11,400	0.0104	38,000	0.0030
50-60	45,600	0.0017	2,400	0.0021	61,000	0.0047
Total	2,496,600	0.2349	323,200	0.2970	1,047,500	0.0832
						Grand Total: 3,867,300
						0.6151

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	648,400	0.0453	136,100	0.1273	489,500	0.0389
5-10	541,500	0.0467	117,000	0.1073	94,500	0.0075
10-20	999,600	0.1173	110,400	0.1009	204,000	0.0162
20-30	610,200	0.0716	49,800	0.0455	77,000	0.0061
30-40	646,200	0.0563	28,800	0.0263	46,000	0.0037
40-50	319,800	0.0226	19,200	0.0176	49,000	0.0039
50-60	95,600	0.0047	5,400	0.0049	32,000	0.0025
Total	3,861,300	0.3645	466,700	0.4298	992,000	0.0788
						Grand Total: 5,320,000
						0.8731

^aAvg. of six replications - number/m².^bDry weight in g/m².

Table A2. Continued.

April, 1971

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-10	1,990,000 ^a	0.1815 ^b	231,200	0.2134	795,000	0.0632
10-20	328,000	0.0276	3,200	0.0029	12,000	0.0010
20-30	163,000	0.0063	0	0.0000	32,000	0.0025
30-40	159,000	0.0063	0	0.0000	47,000	0.0037
40-50	26,000	0.0008	0	0.0000	11,000	0.0009
50-60	35,000	0.0008	0	0.0000	32,000	0.0025
Total	2,701,000	0.2233	234,400	0.2163	929,000	0.0729
					Grand Total:	3,864,400 0.5125

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-10	1,127,000	0.2148	329,000	0.3092	1,093,000	0.0869
10-20	569,200	0.0703	32,800	0.0305	58,000	0.0046
20-30	151,000	0.0062	0	0.0000	44,000	0.0035
30-40	358,600	0.0154	2,400	0.0022	38,000	0.0030
40-50	166,000	0.0067	0	0.0000	21,000	0.0017
50-60	85,000	0.0034	0	0.0000	17,000	0.0014
Total	2,456,800	0.3168	364,200	0.3419	1,271,000	0.1011
					Grand Total:	4,092,000 0.7598

^aAvg. of six replications - number/m².^bDry weight in g/m².

Table A2. Continued.

July, 1971

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,041,900 ^a	0.0734 ^b	127,600	0.1180	1,071,000	0.0851
5-10	559,800	0.0365	61,200	0.0560	208,500	0.0166
10-20	1,012,600	0.0553	47,400	0.0433	173,000	0.0138
20-30	919,000	0.0697	27,000	0.0247	75,000	0.0060
30-40	510,200	0.0315	31,800	0.0291	74,000	0.0059
40-50	322,000	0.0196	18,000	0.0161	52,000	0.0041
50-60	169,000	0.0066	9,000	0.0082	30,000	0.0024
Total	4,534,500	0.2926	322,000	0.2954	1,683,500	0.1339
Grand Total:					6,540,000	0.7219

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	696,200	0.0706	205,800	0.1958	847,500	0.0674
5-10	594,700	0.0431	49,300	0.0461	211,500	0.0168
10-20	926,800	0.0911	88,200	0.0829	157,000	0.0125
20-30	584,200	0.0455	37,800	0.0353	57,000	0.0045
30-40	617,400	0.0390	36,600	0.0335	64,000	0.0051
40-50	491,800	0.0288	13,200	0.0121	83,000	0.0066
50-60	191,600	0.0103	14,400	0.0132	33,000	0.0026
Total	4,102,700	0.3284	445,300	0.4189	1,453,000	0.1155
Grand Total:					6,001,000	0.8628

^aAvg. of eight replications - number/m².^bDry weight in g/m².

Table A2. Continued.

October, 1971

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,272,500 ^a	0.0988 ^b	195,000	0.1783	791,000	0.0629
5-10	665,500	0.0746	114,300	0.1045	139,000	0.0111
10-20	1,251,600	0.1766	119,400	0.1092	102,000	0.0081
20-30	691,400	0.0822	45,600	0.0417	69,000	0.0055
30-40	337,000	0.0265	15,000	0.0137	43,000	0.0034
40-50	123,200	0.0096	7,800	0.0071	31,000	0.0025
50-60	58,000	0.0013	0	0	20,000	0.0016
Total	4,469,200	0.4696	497,100	0.4545	1,195,000	0.0951
						Grand Total: 6,161,300
						1.0192

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	299,900	0.0592	209,100	0.1988	829,500	0.0659
5-10	695,600	0.1502	168,900	0.1593	184,000	0.0146
10-20	1,283,800	0.2855	197,200	0.1838	185,000	0.0147
20-30	787,400	0.1134	92,600	0.0864	47,000	0.0037
30-40	336,400	0.0278	18,600	0.0170	38,000	0.0030
40-50	179,800	0.0123	7,200	0.0066	27,000	0.0021
50-60	187,800	0.0088	1,200	0.0011	14,000	0.0011
Total	3,770,700	0.6572	694,800	0.6530	1,324,500	0.1051
						Grand Total: 5,790,000
						1.4153

^aAvg. of eight replications - number/m².^bDry weight in g/m².

Table A2. Continued.

March, 1972

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,180,500 ^a	0.0933 ^b	220,000	0.2091	677,500	0.0539
5-10	785,500	0.1024	123,000	0.1153	125,500	0.0100
10-20	1,290,400	0.1757	125,600	0.1170	116,000	0.0092
20-30	641,000	0.0715	30,000	0.0274	36,000	0.0029
30-40	265,600	0.0170	11,400	0.0104	39,000	0.0031
40-50	149,200	0.0083	13,200	0.0121	28,000	0.0022
50-60	43,600	0.0034	11,400	0.0104	5,000	0.0004
Total	4,356,400	0.4716	534,600	0.5017	1,027,000	0.0817
Grand Total:						5,918,000 1.0550

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	931,300	0.1205	327,700	0.3173	575,000	0.0457
5-10	910,200	0.2248	214,300	0.2026	190,000	0.0151
10-20	1,035,800	0.2283	198,200	0.1870	73,000	0.0058
20-30	663,600	0.1366	130,400	0.1198	48,000	0.0038
30-40	612,800	0.0463	19,200	0.0176	19,000	0.0015
40-50	308,600	0.0152	5,400	0.0049	34,000	0.0027
50-60	99,200	0.0039	1,800	0.0016	42,000	0.0033
Total	4,561,500	0.7756	897,000	0.8508	981,000	0.0779
Grand Total:						6,439,500 1.7043

^aAvg. of six replications - number/m².^bDry weight in g/m².

Table A2. Continued.

June, 1972

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,241,900 ^a	0.1123 ^b	300,100	0.2792	1,061,000	0.0843
5-10	1,199,700	0.0994	133,800	0.1236	197,500	0.0157
10-20	1,088,000	0.1243	62,000	0.0573	80,000	0.0064
20-30	635,000	0.0732	48,000	0.0439	62,000	0.0049
30-40	461,600	0.0447	38,400	0.0355	50,000	0.0040
40-50	211,600	0.0137	11,400	0.0104	68,000	0.0054
50-60	60,400	0.0036	9,600	0.0088	49,000	0.0039
Total	4,898,200	0.4712	603,300	0.5587	1,567,500	0.1246
					Grand Total:	7,069,000 1.1545

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	581,200	0.0716	219,800	0.2068	567,000	0.0451
5-10	527,300	0.1291	83,700	0.0797	140,000	0.0111
10-20	668,400	0.1770	185,600	0.1804	123,000	0.0098
20-30	525,800	0.1102	77,200	0.0737	13,000	0.0010
30-40	321,400	0.0394	24,600	0.0225	36,000	0.0029
40-50	367,800	0.0251	7,200	0.0066	25,000	0.0020
50-60	143,600	0.0114	5,400	0.0049	11,000	0.0009
Total	3,135,500	0.5638	603,500	0.5746	915,000	0.0728
					Grand Total:	4,654,000 1.2112

^aAvg. of six replications - number/m².^bDry weight in g/m².

Table A2. Continued.

July, 1972

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,785,100 ^a	0.1343 ^b	268,900	0.2517	1,254,000	0.0997
5-10	768,700	0.0632	125,300	0.1159	205,500	0.0163
10-20	783,000	0.0624	82,000	0.0762	73,000	0.0058
20-30	610,200	0.0374	30,800	0.0284	58,000	0.0046
30-40	394,800	0.0232	24,200	0.0224	32,000	0.0025
40-50	399,000	0.0188	18,000	0.0165	40,000	0.0032
50-60	152,800	0.0095	16,200	0.0148	21,000	0.0017
Total	4,893,600	0.3488	565,400	0.5259	1,683,500	0.1338
					Grand Total:	7,142,500
						1.0085

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	752,700	0.0917	290,300	0.2728	679,000	0.0540
5-10	986,200	0.3045	178,800	0.1687	179,000	0.0142
10-20	1,123,200	0.2380	158,800	0.1520	158,000	0.0126
20-30	907,200	0.1148	134,800	0.1301	54,000	0.0043
30-40	654,000	0.0736	45,000	0.0419	25,000	0.0020
40-50	744,600	0.0469	23,400	0.0214	13,000	0.0010
50-60	383,200	0.0166	10,800	0.0099	19,000	0.0015
Total	5,551,100	0.8861	841,900	0.7968	1,127,000	0.0896
					Grand Total:	7,520,000
						1.7725

^aAvg. of eight replications - number/m².^bDry weight in g/m².

Table A2. Continued.

September, 1972

Depth (cm)	Grazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	1,138,900 ^a	0.1023 ^b	249,600	0.2343	976,000	0.0776
5-10	648,700	0.0791	123,300	0.1159	113,500	0.0090
10-20	832,800	0.0925	100,200	0.0946	116,000	0.0092
20-30	688,200	0.0468	53,800	0.0508	65,000	0.0052
30-40	329,200	0.0159	34,800	0.0344	36,000	0.0029
40-50	189,600	0.0145	5,400	0.0053	62,000	0.0049
50-60	147,000	0.0030	0	0	16,000	0.0013
Total	3,974,400	0.3541	567,100	0.5353	1,384,500	0.1101
						Grand Total: 5,926,000
						0.9995

Depth (cm)	Ungrazed					
	Plant Feeding		Predaceous		Saprophagous	
	Number	Biomass	Number	Biomass	Number	Biomass
0-5	363,600	0.0412	165,900	0.1586	575,500	0.0458
5-10	578,100	0.1030	140,400	0.1336	131,500	0.0105
10-20	775,400	0.1314	175,600	0.1718	71,000	0.0056
20-30	543,400	0.0460	49,600	0.0473	46,000	0.0037
30-40	285,200	0.0255	39,800	0.0400	30,000	0.0024
40-50	226,800	0.0107	10,200	0.0097	16,000	0.0013
50-60	100,000	0.0046	0	0	45,000	0.0036
Total	2,872,500	0.3624	581,500	0.5610	915,000	0.0729
						Grand Total: 4,369,000
						0.9963

^aAvg. of six replications - number/m².^bDry weight in g/m².

Table A3. The analysis of variance for 1970 nematode number and biomass data by trophic levels.

<u>Numbers</u>					
Source	df	ss	ms	F	Sign.
Treatment (Trt)	1	18773.37	18773.37	0.65	NS
Date (Da)	2	1320343.00	660171.30	22.99	***
Depth (De)	6	19005020.00	3167503.00	110.31	***
Trophic (Trp)	2	10922080.00	5461039.00	190.19	***
Trt x Da	2	78720.78	39360.39	1.37	NS
Trt x De	6	461217.30	76869.55	2.68	**
Da x De	12	1310693.00	109224.40	3.80	***
Trt x Trp	2	57244.78	28622.39	1.00	NS
Da x Trp	4	699868.70	174967.20	6.09	***
De x Trp	12	5681418.00	473451.50	16.49	***
Trt x Da x De	12	258776.60	21564.71	0.75	NS
Trt x Da x Trp	4	178902.20	44725.56	1.56	NS
Trt x De x Trp	12	488479.90	40706.66	1.42	NS
Da x De x Trp	24	1218904.00	50787.68	1.77	**
Trt x Da x De x Trp	24	651484.10	27145.17	0.95	NS
Error	630		28713.52		

<u>Biomass</u>					
Source	df	ss	ms	F	Sign.
Treatment (Trt)	1	85281.07	85281.07	3.07	*
Date (Da)	2	2787748.00	1393874.00	50.17	***
Depth (De)	6	18364320.00	3060721.00	110.17	***
Trophic (Trp)	2	9716697.00	4858348.00	174.87	***
Trt x Da	2	100781.60	50390.82	1.81	NS
Trt x De	6	891144.80	148524.10	5.35	***
Da x De	12	2944653.00	245387.70	8.83	***
Trt x Trp	2	104050.60	52025.31	1.87	NS
Da x Trp	4	954603.10	238650.80	8.59	***
De x Trp	12	6812333.00	567694.40	20.43	***
Trt x Da x De	12	307704.00	25642.00	0.92	NS
Trt x Da x Trp	4	78779.44	19694.86	0.71	NS
Trt x De x Trp	12	628679.60	52389.97	1.89	**
Da x De x Trp	24	2922907.00	121787.80	4.38	***
Trt x Da x De x Trp	24	459587.40	19149.48	0.69	NS
Error	630		27782.75		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

Table A4. The analysis of variance for 1971 nematode number and biomass data by trophic levels.

<u>Numbers</u>					
Source	df	ss	ms	F	Sign.
Treatment (Trt)	1	26133.33	26133.33	1.07	NS
Date (Da)	2	1779015.00	889507.70	36.42	***
Depth (De)	5	14139780.00	2827955.00	115.78	***
Trophic (Trp)	2	8096411.00	4048205.00	165.74	***
Trt x Da	2	19303.72	9651.86	0.40	NS
Trt x De	5	431140.80	86228.16	3.53	***
Da x De	10	599547.30	59954.73	2.45	***
Trt x Trp	2	155862.00	77931.00	3.19	**
Da x Trp	4	880354.20	220088.60	9.01	***
De x Trp	10	4155994.00	415599.40	17.02	***
Trt x Da x De	10	60939.17	6093.92	0.25	NS
Trt x Da x Trp	4	56976.11	14244.03	0.58	NS
Trt x De x Trp	10	1081714.00	108171.40	4.43	***
Da x De x Trp	20	997176.10	49858.81	2.04	***
Trt x Da x De x Trp	20	311185.30	15559.27	0.64	NS
Error	678		24424.53		

<u>Biomass</u>					
Source	df	ss	ms	F	Sign.
Treatment (Trt)	1	381938.90	381938.90	16.79	***
Date (Da)	2	4208916.00	2104458.00	92.52	***
Depth (De)	5	10597790.00	2119559.00	93.18	***
Trophic (Trp)	2	4274562.00	2137281.00	93.96	***
Trt x Da	2	121497.60	60748.79	2.67	*
Trt x De	5	269237.30	53847.45	2.37	**
Da x De	10	3474480.00	347448.00	15.27	***
Trt x Trp	2	183387.50	91693.77	4.03	**
Da x Trp	4	1582676.00	395668.90	17.39	***
De x Trp	10	3735111.00	373511.10	16.42	***
Trt x Da x De	10	521660.00	52116.00	2.29	**
Trt x Da x Trp	4	65933.56	16483.39	0.72	NS
Trt x De x Trp	10	369844.20	36984.42	1.63	*
Da x De x Trp	20	2655328.00	132766.40	5.84	***
Trt x Da x De x Trp	20	365374.90	18268.75	0.80	NS
Error	678		22746.24		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

Table A5. The analysis of variance for 1972 nematode number and biomass data by trophic levels.

<u>Numbers</u>					
Source	df	ss	ms	F	Sign.
Treatment (Trt)	1	375448.60	375448.60	20.52	***
Date (Da)	3	538693.90	179564.60	9.81	***
Depth (De)	6	30476430.00	5079406.00	277.59	***
Trophic (Trp)	2	1549762.00	774881.00	423.48	***
Trt x Da	3	299879.00	99959.66	5.46	***
Trt x De	6	2895979.00	482663.20	26.38	***
Da x De	18	758855.70	42158.65	2.30	***
Trt x Trp	2	338510.90	169255.50	9.25	***
Da x Trp	6	565522.90	94253.81	5.15	***
De x Trp	12	9104265.00	758688.70	41.46	***
Trt x Da x De	18	862493.90	47916.33	2.62	***
Trt x Da x Trp	6	208553.80	34758.97	1.90	*
Trt x De x Trp	12	1774756.00	147896.30	8.08	***
Da x De x Trp	36	683006.10	18972.39	1.04	NS
Trt x Da x De x Trp	36	730836.80	20301.02	1.11	NS
Error	923		18298.00		

<u>Biomass</u>					
Source	df	ss	ms	F	Sign.
Treatment (Trt)	1	1213514.00	1213514.00	44.03	***
Date (Da)	3	965769.60	321923.20	11.68	***
Depth (De)	6	35608530.00	5934755.00	215.31	***
Trophic (Trp)	2	17312440.00	8656218.00	314.05	***
Trt x Da	3	1049545.00	349848.30	12.69	***
Trt x De	6	2643658.00	440609.70	15.99	***
Da x De	18	1220357.00	66797.61	2.46	***
Trt x Trp	2	1089012.00	544506.00	19.75	***
Da x Trp	6	710785.20	118464.20	4.30	***
De x Trp	12	17660220.00	1471685.00	53.39	***
Trt x Da x De	18	1528674.00	84926.31	3.08	***
Trt x Da x Trp	6	735356.80	122559.50	4.45	***
Trt x De x Trp	12	1390923.00	115910.30	4.21	***
Da x De x Trp	36	1134428.00	31511.89	1.14	NS
Trt x Da x De x Trp	36	1519465.00	42207.36	1.53	**
Error	923		27563.35		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

Table A6. Continued.

		<u>Taxa grouping</u>								
		<u>Tylenchorhynchus</u>	<u>Helicotylenchus</u>	<u>Paratylenchus</u>	<u>Tylenchinae- Psilenchinae</u>	<u>Xiphinema</u>	<u>Pratylenchus</u>	<u>Dorylaimida</u>	<u>Mononchus</u>	<u>Rhabditida</u>
<u>Depth (cm)</u>										
March, 1972	0-5	835	79	250	967	11	11	520	128	1355
	5-10	467	201	260	362	130	17	335	45	251
	10-20	125	551	152	286	107	0	181	17	116
<u>Grazed</u>	20-30	51	273	66	192	36	3	50	0	36
	30-40	5	69	52	126	3	3	19	0	39
	40-50	0	25	41	75	0	0	22	0	28
	50-60	0	3	11	22	0	0	19	0	5
<u>Ungrazed</u>	0-5	305	274	160	753	123	0	619	284	1150
	5-10	200	250	295	360	496	5	536	107	380
	10-20	98	309	153	150	222	0	252	47	73
	20-30	14	212	93	139	122	0	209	5	48
	30-40	0	255	59	279	7	0	32	0	19
	40-50	3	63	25	214	0	0	9	0	34
	50-60	0	9	8	81	0	0	3	0	42
June, 1972	0-5	528	33	82	1445	30	17	872	77	2122
	5-10	550	200	105	1315	54	11	411	21	395
	10-20	95	256	78	517	90	14	95	5	80
<u>Grazed</u>	20-30	9	298	70	192	34	0	80	0	62
	30-40	3	214	37	175	9	0	59	3	50
	40-50	0	45	17	139	3	0	19	0	68
	50-60	0	5	35	14	0	0	16	0	49
<u>Ungrazed</u>	0-5	139	38	129	568	53	5	576	94	1134
	5-10	250	39	107	277	304	0	194	51	280
	10-20	64	67	97	164	210	0	166	86	123
	20-30	9	161	78	127	116	0	87	25	13
	30-40	0	169	39	78	19	0	41	0	36
	40-50	0	133	115	109	6	0	12	0	25
	50-60	0	56	28	53	3	0	9	0	11

Table A6. Continued.

		<u>Taxa grouping</u>								
		<u>Tylenchorhynchus</u>	<u>Helicotylenchus</u>	<u>Paratylenchus</u>	<u>Tylenchinae- Psilenchinae</u>	<u>Xiphinema</u>	<u>Pratylenchus</u>	<u>Dorylaimida</u>	<u>Mononchus</u>	<u>Rhabditida</u>
		<u>Depth (cm)</u>								
July, 1972	0-5	1100	13	573	1547	38	4	738	95	2508
	5-10	156	57	714	390	56	12	381	22	411
	10-20	32	150	278	248	25	2	120	10	73
	<u>Grazed</u> 20-30	6	159	169	246	5	6	48	2	58
	30-40	2	85	75	216	2	0	37	2	32
	40-50	0	46	94	245	2	0	30	0	40
	50-60	0	28	36	78	0	0	27	0	21
<u>Ungrazed</u>	0-5	150	8	436	524	75	4	771	118	1358
	5-10	195	59	367	383	736	0	456	84	358
	10-20	53	170	366	185	280	0	173	55	158
	20-30	4	232	321	203	94	0	133	25	54
	30-40	2	263	192	126	45	0	65	6	25
	40-50	0	241	237	244	7	0	39	0	13
	50-60	0	58	171	145	2	0	18	0	19
September, 1972	0-5	757	52	150	1028	24	0	667	99	1952
	5-10	309	202	70	479	101	6	326	51	227
	10-20	26	197	81	409	59	10	127	24	116
	<u>Grazed</u> 20-30	29	187	75	366	4	0	68	13	65
	30-40	0	52	58	210	0	0	23	21	36
	40-50	3	19	78	75	13	0	4	3	62
	50-60	0	6	114	27	0	0	0	0	16
<u>Ungrazed</u>	0-5	154	67	111	239	9	0	368	111	1151
	5-10	129	142	188	370	190	6	328	84	263
	10-20	39	145	136	267	129	3	141	91	71
	20-30	19	116	168	193	25	0	56	16	46
	30-40	3	100	62	101	12	0	18	29	30
	40-50	0	45	64	113	0	0	12	3	16
	50-60	0	23	16	61	0	0	0	0	45

^aNumber of nematodes/100 cc of soil.

Table A7. The analysis of variance for 1970 nematode number data by taxa.

<u>Tylenchorhynchus</u> spp.					
Source	df	ss	ms	F	Sign.
Month (M)	2	168557.5	84278.7	2.39	*
Treatment (T)	1	123771.4	123771.4	3.52	*
Depth (D)	6	2570582.0	428430.3	12.17	***
M x T	2	39902.7	19951.4	.57	NS
M x D	12	602092.9	50174.4	1.43	NS
T x D	6	1326993.0	221165.5	6.28	***
M x T x D	12	617031.0	51419.2	1.46	NS
Error	210	7390047.0	35190.7		
<u>Helicotylenchus</u> spp.					
Source	df	ss	ms	F	Sign.
Month (M)	2	387114.4	193557.2	14.59	***
Treatment (T)	1	74845.9	74845.9	5.64	**
Depth (D)	6	510124.6	85020.8	6.41	***
M x T	2	138609.6	69304.8	5.22	***
M x D	12	482702.6	40225.2	3.03	***
T x D	6	184195.2	30699.2	2.31	**
M x T x D	12	134772.8	11231.1	.85	NS
Error	210	2785335.0	13263.5		
<u>Xiphinema</u> spp.					
Source	df	ss	ms	F	Sign.
Month (M)	2	11625.3	5812.7	16.18	***
Treatment (T)	1	20152.4	20152.4	56.10	***
Depth (D)	6	56525.7	9420.9	26.23	***
M x T	2	4235.6	2117.8	5.90	***
M x D	12	25969.3	2164.1	6.02	***
T x D	6	35802.6	5967.1	16.61	***
M x T x D	12	13852.4	1154.4	3.21	***
Error	210	75432.0	359.2		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

Table A8. The analysis of variance for 1971 nematode number data by taxa.

<u>Tylenchorhynchus</u> spp.					
Source	df	ss	ms	F	Sign.
Month (M)	2	129603.6	64801.8	3.28	**
Treatment (T)	1	143737.3	143737.3	7.29	**
Depth (D)	5	1390449.0	278089.7	14.11	***
M x T	2	41776.2	20888.1	1.06	NS
M x D	10	266572.4	26657.2	1.35	NS
T x D	5	780489.4	156097.9	7.92	***
M x T x D	10	213672.8	21367.3	1.03	NS
R(MTD)	36	709429.5	19706.4		
P(RMTD)	190	2304282.0	12127.8	1.62	**
<u>Helicotylenchus</u> spp.					
Source	df	ss	ms	F	Sign.
Month (M)	2	59138.1	29569.0	1.10	NS
Treatment (T)	1	157641.1	157641.1	5.87	**
Depth (D)	5	184860.8	36972.2	1.38	NS
M x T	2	110010.2	55005.1	2.05	NS
M x D	10	717933.7	71793.4	2.67	**
T x D	5	225113.8	45002.8	1.68	NS
M x T x D	10	501664.6	50166.5	1.87	*
R(MTD)	36	966823.5	26856.2		
P(RMTD)	190	3629817.0	19104.3		
<u>Xiphinema</u> spp.					
Source	df	ss	ms	F	Sign.
Month (M)	2	34251.7	17125.9	26.91	***
Treatment (T)	1	22901.8	22901.8	35.99	***
Depth (D)	5	40035.2	8007.0	12.58	***
M x T	2	9535.7	4767.9	7.49	***
M x D	10	70488.3	7048.8	11.08	***
T x D	5	21125.9	4225.2	6.64	***
M x T x D	10	29845.6	2984.6	4.69	***
Error	226	143803.8	636.3		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

Table A9. The analysis of variance for 1972 nematode number data by taxa.

<u>Tylenchorhynchus spp.</u>					
Source	df	ss	ms	F	Sign.
Month (M)	3	15888.6	5296.2	.88	NS
Treatment (T)	1	189778.6	189778.6	31.60	***
Depth (D)	6	1779507.0	296584.5	49.38	***
M x T	3	1208.6	402.9	.07	NS
M x D	18	157350.9	8741.7	1.46	*
T x D	6	638156.9	106359.5	17.71	***
M x T x D	18	121784.9	6765.8	1.13	NS
Error	308	1849940.4	6006.3		

Source	df	ss	ms	F	Sign.
Month (M)	3	37700.3	12566.8	3.16	**
Treatment (T)	1	0.9	0.9	.00	NS
Depth (D)	6	301601.7	50266.9	12.65	***
M x T	3	27678.1	9226.0	2.32	*
M x D	18	138841.3	7713.4	1.94	**
T x D	6	69434.5	11572.4	2.91	***
M x T x D	18	41143.1	2285.7	.58	NS
Error	308	1224053.6	3974.2		

<u>Xiphinema spp.</u>					
Source	df	ss	ms	F	Sign.
Month (M)	3	30575.8	10191.9	6.48	***
Treatment (T)	1	104665.0	104665.0	66.51	***
Depth (D)	6	436358.9	72726.5	46.22	***
M x T	3	37493.9	12498.0	7.94	***
M x D	18	80428.9	4468.3	2.84	***
T x D	6	193246.9	32207.8	20.47	***
M x T x D	18	95133.7	5285.2	3.36	***
Error	308	484668.8	1573.6		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

Table A10. The analysis of variance for data obtained on July 21, 1972 sampling in the nematocide study at the Cottonwood site.

<u>Plant feeding</u>					
Source	df	ss	ms	F	Sign.
Total	70	21265.98			
Total reduction	46	20548.97	446.71		
Mu-Ym	1	12327.88	12327.88		
Treatment (T)	1	2054.46	2054.46	50.09	***
Replications (R)	4	70.43	17.60	0.59	NS
Depth (D)	6	2613.87	435.64	21.75	***
T x R	4	164.37	41.09	1.38	NS
T x D	6	2016.10	469.25	15.71	***
R x D	24	501.83	20.90	0.70	NS
Remainder	24	717.01	29.87		

<u>Predaceous</u>					
Source	df	ss	ms	F	Sign.
Total	70	8275.02			
Total reduction	46	7888.77	171.50		
Mu-Ym	1	3630.46	3630.46		
Treatment (T)	1	194.45	194.45	16.16	***
Replications (R)	4	16.22	4.06	0.25	NS
Depth (D)	6	3395.60	565.93	57.65	***
T x R	4	48.58	12.15	0.76	NS
T x D	6	366.25	61.04	3.79	**
R x D	24	237.20	9.88	0.61	NS
Remainder	24	386.25	16.09		

<u>Saprophagous</u>					
Source	df	ss	ms	F	Sign.
Total	70	16144.92			
Total reduction	46	15827.38	344.07		
Mu-Ym	1	6587.83	6587.83		
Treatment (T)	1	648.28	648.28	28.17	***
Replications (R)	4	93.18	23.29	1.76	NS
Depth (D)	6	6852.72	1142.12	86.57	***
T x R	4	94.75	23.69	1.79	NS
T x D	6	1204.22	200.70	15.17	***
R x D	24	346.40	14.43	1.09	NS
Remainder	24	317.54	13.23		

NS: Nonsignificant at .10 level.

*: Significant at .10 level.

**: Significant at .05 level.

***: Significant at .01 level.

APPENDIX B

FIELD DATA

Nematode Data

The nematode data were collected at the Cottonwood Site on the invertebrate form NREL-30. These data are catalogued under the US/IBP Grassland Biome designation of A2U3094. Examples of the data form and data follow. For the nematode data the column for HOST was used for the depth of the core in which the nematodes were found.



NREL-30 NATURAL RESOURCE ECOLOGY LABORATORY - COLORADO STATE UNIVERSITY - PHONE (303) 491-5571 - FORT COLLINS, COLORADO 80521

EXAMPLE OF DATA

1	2	3	4	5	6
12345678901234567890123456789012345678901234567890123					
3904JDS03097052	2.03	5	20-30	MON MON MONPAP	00 0
3904JDS03097052	2.03	8	20-30	RHA RHA	00 24
3904JDS03097052	2.03	2	30-40	TYL TYL TYLRON	00 0
3904JDS03097052	2.03	2	30-40	TYL TYL HELLEI	00 75
3904JDS03097052	2.03	2	30-40	TYL CRI PARPES	00 24
3904JDS03097052	2.03	2	30-40	TYL TYL TYEEXI	00 0
3904JDS03097052	2.03	2	30-40	DOR LON XIPAME	00 0
3904JDS03097052	2.03	2	30-40	TYL TYL PRASCR	00 0
3904JDS03097052	2.03	2	30-40	DOR DOR EUD	00 24
3904JDS03097052	2.03	5	30-40	MON MON MONPAP	00 0
3904JDS03097052	2.03	8	30-40	RHA RHA	00 24
3904JDS03097052	2.03	2	40-50	TYL TYL TYLCOR	00 0
3904JDS03097052	2.03	2	40-50	TYL TYL HELLEI	00 0
3904JDS03097052	2.03	2	40-50	TYL CRI PARPES	00 24
3904JDS03097052	2.03	2	40-50	TYL TYL TYEEXI	00 48
3904JDS03097052	2.03	2	40-50	DOR LON XIPAME	00 0
3904JDS03097052	2.03	2	40-50	TYL TYL PRASCR	00 0
3904JDS03097052	2.03	2	40-50	DOR DOR EUD	00 24
3904JDS03097052	2.03	5	40-50	MON MON MONPAP	00 0
3904JDS03097052	2.03	8	40-50	RHA RHA	00 48
3904JDS03097052	2.03	2	50-60	TYL TYL TYLCOR	00 0
3904JDS03097052	2.03	2	50-60	TYL TYL HELLEI	00 0
3904JDS03097052	2.03	2	50-60	TYL CRI PARPES	00 0
3904JDS03097052	2.03	2	50-60	TYL TYL TYEEXI	00 0
3904JDS03097052	2.03	2	50-60	DOR LON XIPAME	00 0
3904JDS03097052	2.03	2	50-60	TYL TYL PRASCR	00 0
3904JDS03097052	2.03	2	50-60	DOR DOR EUD	00 0
3904JDS03097052	2.03	5	50-60	MON MON MONPAP	00 0
3904JDS03097052	2.03	8	50-60	RHA RHA	00 48
3904JDS03097052	2.03	2	00-05	TYL TYL TYLRON	00 1119
3904JDS03097052	2.03	2	00-05	TYL TYL HELLEI	00 24
3904JDS03097052	2.03	2	00-05	TYL CRI PARPES	00 24
3904JDS03097052	2.03	2	00-05	TYL TYL TYEEXI	00 276
3904JDS03097052	2.03	2	00-05	DOR LON XIPAME	00 0
3904JDS03097052	2.03	2	00-05	TYL TYL PRASCR	00 0
3904JDS03097052	2.03	2	00-05	DOR DOR EUD	00 425
3904JDS03097052	2.03	5	00-05	MON MON MONPAP	00 75
3904JDS03097052	2.03	8	00-05	RHA RHA	00 919
3904JDS03097052	2.03	2	05-10	TYL TYL TYLRON	00 24
3904JDS03097052	2.03	2	05-10	TYL TYL HELLEI	00 75
3904JDS03097052	2.03	2	05-10	TYL CRI PARPES	00 75
3904JDS03097052	2.03	2	05-10	TYL TYL TYEEXI	00 0
3904JDS03097052	2.03	2	05-10	DOR LON XIPAME	00 0
3904JDS03097052	2.03	2	05-10	TYL TYL PRASCR	00 0
3904JDS03097052	2.03	2	05-10	DOR DOR EUD	00 322
3904JDS03097052	2.03	5	05-10	MON MON MONPAP	00 0
3904JDS03097052	2.03	8	05-10	RHA RHA	00 24

3904JDS03097052	2.03	2	10-20	TYL	TYL	TYLROH	00	0
3904JDS03097052	2.03	2	10-20	TYL	TYL	HELLEI	00	575
3904JDS03097052	2.03	2	10-20	TYL	CRJ	PARPES	00	99
3904JDS03097052	2.03	2	10-20	TYL	TYL	TYEEXI	00	346
3904JDS03097052	2.03	2	10-20	DOR	LON	XIPAME	00	0
3904JDS03097052	2.03	2	10-20	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.03	2	10-20	DOR	DOR	EUD	00	173
3904JDS03097052	2.03	5	10-20	MON	MON	MONPAP	00	0
3904JDS03097052	2.03	8	10-20	RHA	RHA		00	99
3904JDS03097052	2.03	2	20-30	TYL	TYL	TYLROH	00	0
3904JDS03097052	2.03	2	20-30	TYL	TYL	HELLEI	00	299
3904JDS03097052	2.03	2	20-30	TYL	CRJ	PARPES	00	48
3904JDS03097052	2.03	2	20-30	TYL	TYL	TYEEXI	00	397
3904JDS03097052	2.03	2	20-30	DOR	LON	XIPAME	00	0
3904JDS03097052	2.03	2	20-30	TYL	TYL	PRASCR	00	24
3904JDS03097052	2.03	2	20-30	DOR	DOR	EUD	00	0
3904JDS03097052	2.06	2	00-05	TYL	TYL	TYLROH	00	170
3904JDS03097052	2.06	2	00-05	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.06	2	00-05	TYL	CRJ	PARPES	00	24
3904JDS03097052	2.06	2	00-05	TYL	TYL	TYEEXI	00	48
3904JDS03097052	2.06	2	00-05	DOR	LON	XIPAME	00	48
3904JDS03097052	2.06	2	00-05	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	00-05	DOR	DOR	EUD	00	127
3904JDS03097052	2.06	5	00-05	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	00-05	RHA	RHA		00	397
3904JDS03097052	2.06	2	05-10	TYL	TYL	TYLROH	00	75
3904JDS03097052	2.06	2	05-10	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.06	2	05-10	TYL	CRJ	PARPES	00	0
3904JDS03097052	2.06	2	05-10	TYL	TYL	TYEEXI	00	0
3904JDS03097052	2.06	2	05-10	DOR	LON	XIPAME	00	0
3904JDS03097052	2.06	2	05-10	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	05-10	DOR	DOR	EUD	00	127
3904JDS03097052	2.06	5	05-10	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	05-10	RHA	RHA		00	299
3904JDS03097052	2.06	2	10-20	TYL	TYL	TYLROH	00	24
3904JDS03097052	2.06	2	10-20	TYL	TYL	HELLEI	00	173
3904JDS03097052	2.06	2	10-20	TYL	CRJ	PARPES	00	299
3904JDS03097052	2.06	2	10-20	TYL	TYL	TYEEXI	00	75
3904JDS03097052	2.06	2	10-20	DOR	LON	XIPAME	00	0
3904JDS03097052	2.06	2	10-20	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	10-20	DOR	DOR	EUD	00	0
3904JDS03097052	2.06	5	10-20	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	10-20	RHA	RHA		00	75
3904JDS03097052	2.06	2	20-30	TYL	TYL	TYLROH	00	0
3904JDS03097052	2.06	2	20-30	TYL	TYL	HELLEI	00	48
3904JDS03097052	2.06	2	20-30	TYL	CRJ	PARPES	00	127
3904JDS03097052	2.06	2	20-30	TYL	TYL	TYEEXI	00	149
3904JDS03097052	2.06	2	20-30	DOR	LON	XIPAME	00	0
3904JDS03097052	2.06	2	20-30	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	20-30	DOR	DOR	EUD	00	75
3904JDS03097052	2.06	5	20-30	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	20-30	RHA	RHA		00	24

3904JDS03097052	2.06	2	30-40	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.06	2	30-40	TYL	TYL	HELLEI	00	48
3904JDS03097052	2.06	2	30-40	TYL	CRJ	PARPES	00	24
3904JDS03097052	2.06	2	30-40	TYL	TYL	TYEEXI	00	48
3904JDS03097052	2.06	2	30-40	DOR	LON	XIPAME	00	0
3904JDS03097052	2.06	2	30-40	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	30-40	DOR	DOR	EUD	00	0
3904JDS03097052	2.06	5	30-40	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	30-40	RHA	RHA		00	24
3904JDS03097052	2.06	2	40-50	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.06	2	40-50	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.06	2	40-50	TYL	CRJ	PARPES	00	48
3904JDS03097052	2.06	2	40-50	TYL	TYL	TYEEXI	00	24
3904JDS03097052	2.06	2	40-50	DOR	LON	XIPAME	00	0
3904JDS03097052	2.06	2	40-50	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	40-50	DOR	DOR	EUD	00	24
3904JDS03097052	2.06	5	40-50	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	40-50	RHA	RHA		00	48
3904JDS03097052	2.06	2	50-60	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.06	2	50-60	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.06	2	50-60	TYL	CRJ	PARPES	00	48
3904JDS03097052	2.06	2	50-60	TYL	TYL	TYEEXI	00	24
3904JDS03097052	2.06	2	50-60	DOR	LON	XIPAME	00	0
3904JDS03097052	2.06	2	50-60	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.06	2	50-60	DOR	DOR	EUD	00	0
3904JDS03097052	2.06	5	50-60	MON	MON	MONPAP	00	0
3904JDS03097052	2.06	8	50-60	RHA	RHA		00	48
3904JDS03097052	2.07	2	00-05	TYL	TYL	TYLROR	00	48
3904JDS03097052	2.07	2	00-05	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.07	2	00-05	TYL	CRJ	PARPES	00	0
3904JDS03097052	2.07	2	00-05	TYL	TYL	TYEEXI	00	48
3904JDS03097052	2.07	2	00-05	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	00-05	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.07	2	00-05	DOR	DOR	EUD	00	149
3904JDS03097052	2.07	5	00-05	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	00-05	RHA	RHA		00	373
3904JDS03097052	2.07	2	05-10	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.07	2	05-10	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.07	2	05-10	TYL	CRJ	PARPES	00	24
3904JDS03097052	2.07	2	05-10	TYL	TYL	TYEEXI	00	0
3904JDS03097052	2.07	2	05-10	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	05-10	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.07	2	05-10	DOR	DOR	EUD	00	24
3904JDS03097052	2.07	5	05-10	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	05-10	RHA	RHA		00	0
3904JDS03097052	2.07	2	10-20	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.07	2	10-20	TYL	TYL	HELLEI	00	75
3904JDS03097052	2.07	2	10-20	TYL	CRJ	PARPES	00	75
3904JDS03097052	2.07	2	10-20	TYL	TYL	TYEEXI	00	425
3904JDS03097052	2.07	2	10-20	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	10-20	TYL	TYL	PRASCR	00	48
3904JDS03097052	2.07	2	10-20	DOR	DOR	EUD	00	75
3904JDS03097052	2.07	5	10-20	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	10-20	RHA	RHA		00	24

3904JDS03097052	2.07	2	20-30	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.07	2	20-30	TYL	TYL	HELLEI	00	99
3904JDS03097052	2.07	2	20-30	TYL	CRJ	PARPES	00	24
3904JDS03097052	2.07	2	20-30	TYL	TYL	TYEEXI	00	224
3904JDS03097052	2.07	2	20-30	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	20-30	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.07	2	20-30	DOR	DOR	EUD	00	0
3904JDS03097052	2.07	5	20-30	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	20-30	RHA	RHA		00	48
3904JDS03097052	2.07	2	30-40	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.07	2	30-40	TYL	TYL	HELLEI	00	24
3904JDS03097052	2.07	2	30-40	TYL	CRJ	PARPES	00	48
3904JDS03097052	2.07	2	30-40	TYL	TYL	TYEEXI	00	24
3904JDS03097052	2.07	2	30-40	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	30-40	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.07	2	30-40	DOR	DOR	EUD	00	48
3904JDS03097052	2.07	5	30-40	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	30-40	RHA	RHA		00	48
3904JDS03097052	2.07	2	40-50	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.07	2	40-50	TYL	TYL	HELLEI	00	0
3904JDS03097052	2.07	2	40-50	TYL	CRJ	PARPES	00	99
3904JDS03097052	2.07	2	40-50	TYL	TYL	TYEEXI	00	48
3904JDS03097052	2.07	2	40-50	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	40-50	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.07	2	40-50	DOR	DOR	EUD	00	75
3904JDS03097052	2.07	5	40-50	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	40-50	RHA	RHA		00	75
3904JDS03097052	2.07	2	50-60	TYL	TYL	TYLROR	00	0
3904JDS03097052	2.07	2	50-60	TYL	TYL	HELLEI	00	24
3904JDS03097052	2.07	2	50-60	TYL	CRJ	PARPES	00	99
3904JDS03097052	2.07	2	50-60	TYL	TYL	TYEEXI	00	127
3904JDS03097052	2.07	2	50-60	DOR	LON	XIPAME	00	0
3904JDS03097052	2.07	2	50-60	TYL	TYL	PRASCR	00	0
3904JDS03097052	2.07	2	50-60	DOR	DOR	EUD	00	24
3904JDS03097052	2.07	5	50-60	MON	MON	MONPAP	00	0
3904JDS03097052	2.07	8	40-50	RHA	RHA		00	127