THE EFFECTS OF CONTROLLING FOUR SPECIES OF NEMATODES ON GRAIN SORGHUM, *SORGHUM BICOLOR* (L.) MOENCH

By

BRUCE EDWARD NOWLIN

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

1975

Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
MASTER OF SCIENCE
May, 1977

THE EFFECTS OF CONTROLLING FOUR SPECIES OF NEMATODES ON GRAIN SORGHUM, *SORGHUM BICOLOR* (L.) MOENCH

Thesis Approved:

Roy V. Sturgeon
Thesis Adviser

Larry J. Young

Charles C. Russell

Norman N. Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

The author wishes to express his appreciation to Dr. R. V. Sturgeon, Jr., thesis adviser, for his confidence and guidance during this study. Special appreciation is also due to committee members, Dr. C. C. Russell and Dr. H. C. Young, Jr. for critical review of the manufscript.

Many thanks to Dr. Russell for help in species identification of nematodes and many helpful suggestions during the study.

The author would like to thank Dr. R. D. Morrison for his suggestions and cooperation in conducting the statistical analysis, and also Mark Blanchard of the Department of Statistics for his assistance.

Much appreciation is due to Mr. Ken Jackson and also to many co-workers who helped so much during the course of this study.

Finally, to his wife Karen, and daughter Laurel, the author expresses his love, and thanks them for their sacrifices and patience during this study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Production of grain sorghum, Sorghum bicolor, (L.) Moench, is a large-scale operation in the southwestern United States. The bulk of the crop is used for livestock feed. In 1975, Oklahoma ranked fifth in the United States in production of sorghum for grain, and the crop ranked fourth among Oklahoma crops with a value of $58,938,000 (12). The price of grain sorghum has more than doubled in the last four years, and in 1975 Oklahoma produced 25.1 million bushels on 660,000 acres (12).

The sorghum plant is better adapted for growing in the subhumid and semiarid Southwest than any other grain crop, having a high resistance to dessication, an extensive fibrous root system, and effective means of reducing water loss from the leaves. The crop tolerates a wide range of soil types and environmental conditions. Sorghum will tolerate salinity, alkalinity, and poor drainage fairly well and can grow successfully on soils that range in pH from 5.5 to 8.5 (10).

Since hybrid grain sorghums were introduced in the 1950s, yields have increased more than 25% (10), and grain sorghum has displayed the highest annual rate of increase in yield among the major crops in areas where it is grown (11).

By growing varieties tolerant and/or resistant to insects and diseases (including nematodes), improved fertility programs, new herbicides, and proper cultural methods, yields can be increased even further.

CHAPTER II

REVIEW OF LITERATURE

In 1971, the Society of Nematologists Committee on Crop Losses estimated that sorghum grown for grain and forage in the United States suffers a six percent loss annually due to the effects of plant-parasitic nematodes (1). This involves the loss of almost $48 million per year due to nematodes on sorghum alone.

Much of the research on sorghum has been done in the southeastern United States on sudangrass (*Sorghum sudanense*) and related species as summer cover crops (2, 4, 5, 6, 9, 14, 16). Most of these researchers have found that grain sorghum and sudangrass, as well as closely related crops such as millets (*Panicum* spp. and *Pennisetum* spp.), and corn (*Zea mays*) are poor summer cover crops because they favor the buildup of plant-parasitic nematodes that can devastate the main cash crop to be grown. Brodie, et al. (2) in 1970, reported that three of the five nematode species they worked with developed best on millet (*Panicum ramosum*) and sudangrass. They concluded that as the use of these two crops as summer cover crops in tomato transplant fields is quite common, it apparently hastens the abandonment of newly cleared land for transplant production.

Good, et al., in 1965 (6), showed that millet and sudangrass grown before tomatoes caused reduced tomato plant stands and irregular growth patterns, which were attributed to large numbers of *Belonolaimus longicaudatus*, the sting nematode, and *Pratylenchus branchyurus*, the smooth-headed root lesion nematode.

Rhoades, in 1976 (14), reported that high numbers of the sting nematode and moderate numbers of root knot nematodes (*Meloidogyne incognita* and *M. javanica*) were maintained by sorghum (*S. bicolor*) as a summer cover crop. Also, yields of cabbage, cucumber, and snap beans were lower following sorghum than following a poor host of the nematodes.

In a host range study, Rohde and Jenkins (16) found sudangrass to be a good host of *Trichodorus christiei* (now *Paratrichodorus minor*), the stubby root nematode. Also listed as a good host was corn, which is a member of the same sub-family as sorghum.

Kinloch (9) monitored population changes of nematodes for two years in woodland areas cleared for agricultural use. He found populations of *P. brachyurus* undetected in the woodland increased to 207 and 108 per 100 cc of soil under sorghum and corn. *Xiphinema americanum*, the American dagger nematode, and *T. christiei* increased under sorghum, and populations of *Helicotylenchus* spp., the spiral nematode, were maintained on sorghum.

Studying the responses of root lesion nematodes to various plants, Endo (4) reported corn and sorghum to be very suitable hosts to *Pratylenchus zeae*, while millet and sudangrass were suitable hosts. All had considerably fewer *P. brachyurus* than sudangrass, which was a suitable host for this species.

Good (5), in a six-year study of nematode population changes under summer cover crops and fallow following early spring tomato plants each spring, found that *T. christiei* was abundant on milo (sorghum), millet (*P. ramosum*), and sudangrass. Milo also supported large populations of *P. brachyurus*, *P. zeae*, and *Tylenchorhynchus claytoni*.

Other researchers have dealt with the effects of nematodes on sorghum in instances other than as cover crops. Chevres-Roman, in 1967 (3), found that *Trichodorus porosus*, *T. claytoni*, and *P. zeae* significantly influenced plant growth of corn and sorghum as measured by green and dry matter production and height. Parasitized plants removed much less N and K from the soil than did healthy plants. Water utilization and water use efficiency of the crops were also decreased where suppression of plant growth by the nematodes was pronounced.

Johnson and Burton (8) compared millet and sorghum-sudangrass hybrids grown in nematicide-treated and untreated soil and found that controlling plant parasitic nematodes increased plant height and forage yield. Stunting of plants and reduction in yield were greater as the number of *Pratylenchus* spp. and B. *longicaudatus* present in the rhizosphere increased.

Tarte (18), working with field populations of *P. zeae* on corn, adjusted field plot populations to a range of levels by previously cropping to hosts of different suitability. A highly significant negative correlation was found between preplant numbers of *P. zeae* and yield of corn. Higher yields were obtained following poor hosts, and lower yields were obtained after good hosts, including corn and sorghum.

The Rockefeller Foundation Report (15) in 1966 from India, reported that pearl millet and corn yields could be increased by controlling nematodes with soil fumigation with DD.

Orr, in 1967 (13), reported grain sorghum in west Texas infested with the cotton root knot nematode, *Meloidogyne incognita acrita*. Plants were chlorotic, stunted, had reduced stands, and reduced yields. In greenhouse studies, he also showed a 15% yield reduction and delayed blooming in plants infested with the nematodes.

CHAPTER III

MATERIALS AND METHODS

A hybrid grain sorghum, variety GSA 1210, was planted June 17, 1976, at the Sandy Lands Agronomy Research Station at Mangum, Oklahoma, in a Meno loamy fine sand soil. The area had been sampled by the author the previous season, and was known to be infested with moderate to very high populations of the following nematodes: *Belonolaimus longicaudatus* Rau, 1958, sting nematode; *Pratylenchus zeae* Graham, 1951, root lesion nematode; *Paratrichodorus minor* (Colbran, 1956) Siddiqi, 1974 (formerly *Trichodorus christiei*), stubby root nematode; and *Xiphinema americanum* Cobb, 1913, American dagger nematode.

This dryland study consisted of six replications of two chemical treatments and a nontreated control arranged in a randomized, complete block design. Plots were two 22.9 meter rows, planted 100 centimeters apart. Two nematicides, carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate) 10% granules (Furadan) at a rate of 2.2 kilograms active ingredient (ai) per hectare, and aldicarb (2-methyl-2-2(methylthio)-propionaldehyde *O*-methylcarbamoyl) oxime) 15% granules (Temik) at a rate of 1.1 kilograms ai per hectare were used to control nematodes so comparisons of plant responses between nematode infested plants and those with reduced nematode populations could be made. The treatments were applied at planting time in the seed furrow with a Gandy 901 Junior granular applicator mounted on a John Deere planter.

Prior to planting, soil samples were taken from each plot for nematode analysis. Three weeks later, July 8, another soil sample was taken from all plots. Soil plus root samples were taken August 4, September 9, and September 30. Within each plot, four soil and root samples were taken at random and mixed. A subsample of soil and roots was then taken from this for nematode extraction. One hundred ml of each soil sample were processed using a modification of the Seinhorst sedimentation technique as described by Goodey (7), and all root samples were processed by placing subsamples of the root systems in 250 ml flasks and aerating them by bubbling air through them (17). Samples were counted in a counting dish using a stereoscopic microscope. Root samples were incubated for four weeks, and counts of *P. zeae* were taken at the end of each week.

Plots were harvested on October 25, 26, and 27. Twenty plants per plot were randomly selected and harvested, and data on plant height (including head), head length, and stem diameter were taken from each plant at that time. Heads, roots, and soil from each plant were bagged and brought back to Stillwater. Six meters of row per plot were harvested to obtain grain yield data.

A 100-ml sample of soil from each of the 20 plants per plot was processed for nematodes, but due to lack of space, only 12 root samples out of every 20 per plot were incubated for extraction of *P. zeae*.

Twelve root systems were randomly selected from each plot for root incubation. First, soil was washed from the root system with running water, and excess water was removed by shaking. Fresh root volume was measured by placing the root system into a 1.5 liter beaker and catching the displaced water in a pan. The amount of water displaced was measured in a graduated cylinder. The excess water was then blotted from the root system and the fresh weight measured on a Mettler P1200 balance. A subsample of the root system was then weighhed and put into a 250-ml flask for root incubation for four weeks (*P. zeae* counts were made at the end of two and four weeks). From these counts, numbers of *P. zeae* per gram of root weight were obtained. Since a preliminary analysis showed an increase in the variance of the count as the count increased, the statistical analysis on the nematode counts was made by using log(count + 1).

Another subsample was weighed and placed into a paper bag to be put into a drying oven to get the percentage of dry weight. The remaining eight root systems per plot were handled as above except without the subsample for root incubation for *P. zeae*.

The samples for oven drying were placed in drying ovens at the Agronomy Research Station in Stillwater for 72 hours at 49°C. These were then figured for percentage of dry weight, and this percentage was multiplied by the fresh root weight to arrive at the dry root weight per root system.

The head from each plant was threshed individually using a Vogel-type plant and head thresher. The seeds were then cleaned using a McGill-Bates aspirator and weighed on a Mettler P1200 balance. The seeds from each head were then counted on an Electronic Counter. Heads from the six meters of row per plot were threshed on a Vogel Stationary thresher, and grain weighed on the Mettler balance.

CHAPTER IV

RESULTS AND DISCUSSION

Plant measurements taken at harvest time are summarized in Figure 1. Both nematicide applications increased the number of seeds per head by a highly significant margin (.01 level). Plants growing in plots treated with aldicarb averaged 272 more seeds per head and in plots treated with carbofuran 224 more seeds per head than did plants growing in untreated plots. Aldicarb also significantly (.05 level) increased the weight of 1,000 seeds over the untreated plots. Nematicide application also significantly (.05 level) increased plant height and grain weight per head in both cases. Grain yield per plot increased with both nematicide applications, but this increase was only at the .10 level of significance. Carbofuran increased grain yield by 271 grams and aldicarb by 237 grams per plot (100 cm x 6 meters). The LSD .10 was 228 grams. (All analyses of variance data and LSDs are given in the Appendix.) This lower level of significance may have been due in part to a difference in plant population numbers in treated versus untreated plots. It is recommended to future researchers in this area to take plant population data at various points in the season.

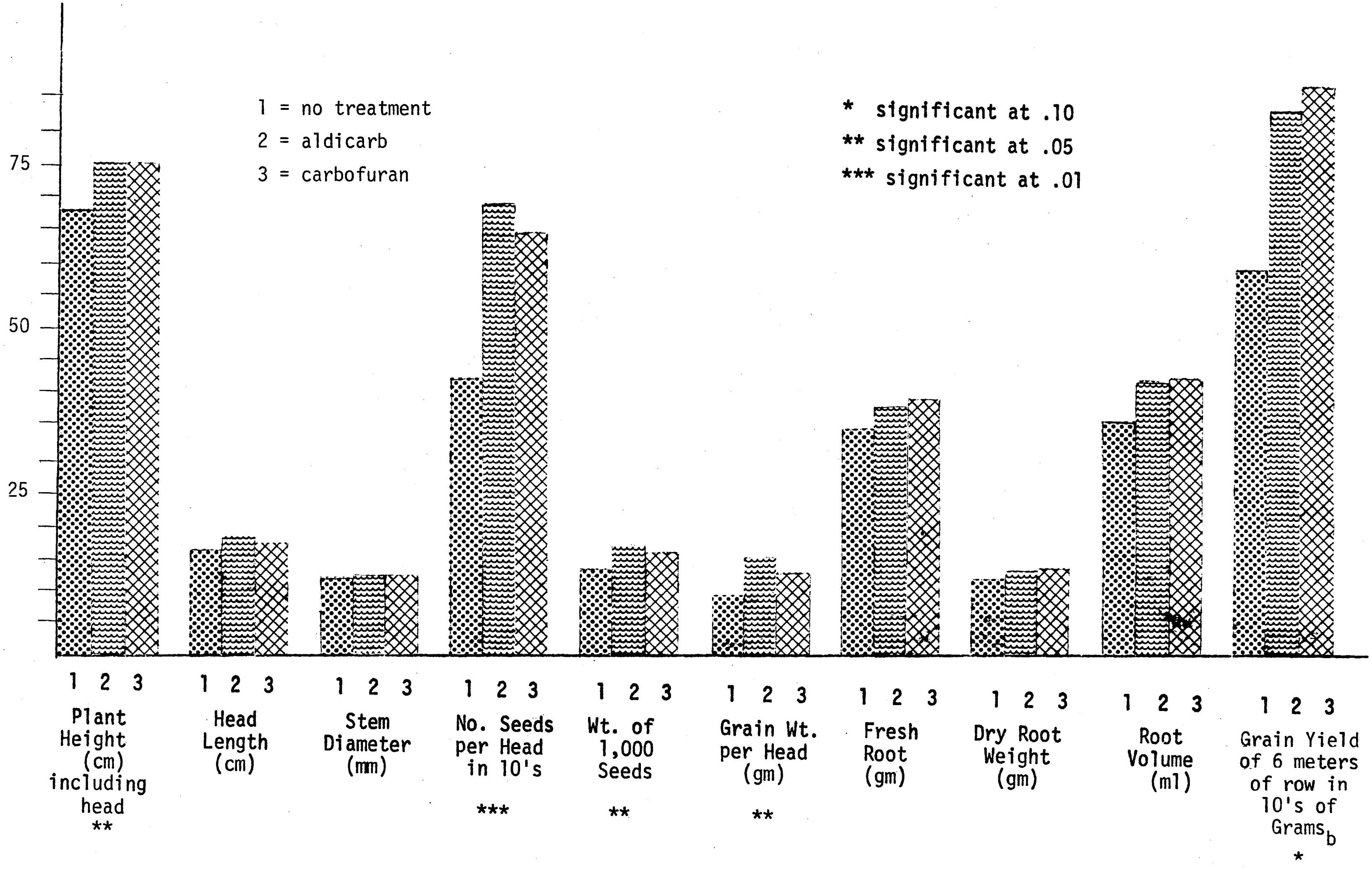

Figure 1. Effects of Nematicide Applications on Sorghum Yields[a]
a. Average of Treatment Response from Six Plots, 20 Plants per Plot
b. Grain Yield is Average of Treatment Response from Six Plots

No statistical difference in treated compared to untreated plots was observed with head length, stem diameter, fresh root weight, dry root weight, or root volume.

Nematode soil population data by treatment is presented in Figures 2 through 5. Nematode populations from 100 ml of soil are expressed as log(count + 1). On the first five sampling dates (6/17, 7/8, 8/4, 9/9, and 9/30) each treatment is depicted as an average of six plots. On the last date (10/25), which was at harvest time, the treatments are averages of 100 ml of soil from 120 plants.

There was a significant difference (.05 level) in soil populations of *Belonolaimus longicaudatus* on two dates (Figure 2). On 8/4, the carbofuran-treated plots had significantly fewer *B. longicaudatus* than did the untreated plots; however, even the number in the untreated plots was probably too low to be damaging. On 9/9, the aldicarb-treated plots had significantly lower populations than either carbofuran or untreated plots.

Pratylenchus zeae populations in treated plots (Figure 3) showed a significant difference from untreated plots on the last three sampling dates. On 9/9, aldicarb-treated plots had significantly (.05) fewer than untreated plots. On 9/30 and 10/25, the untreated plots had significantly (.01) higher populations than did either of the treated plots.

Numbers of *Paratrichodorus minor* (Figure 4) showed a significant difference between treatments on three dates. On 8/4, aldicarb-treated plots had significantly (.05) fewer

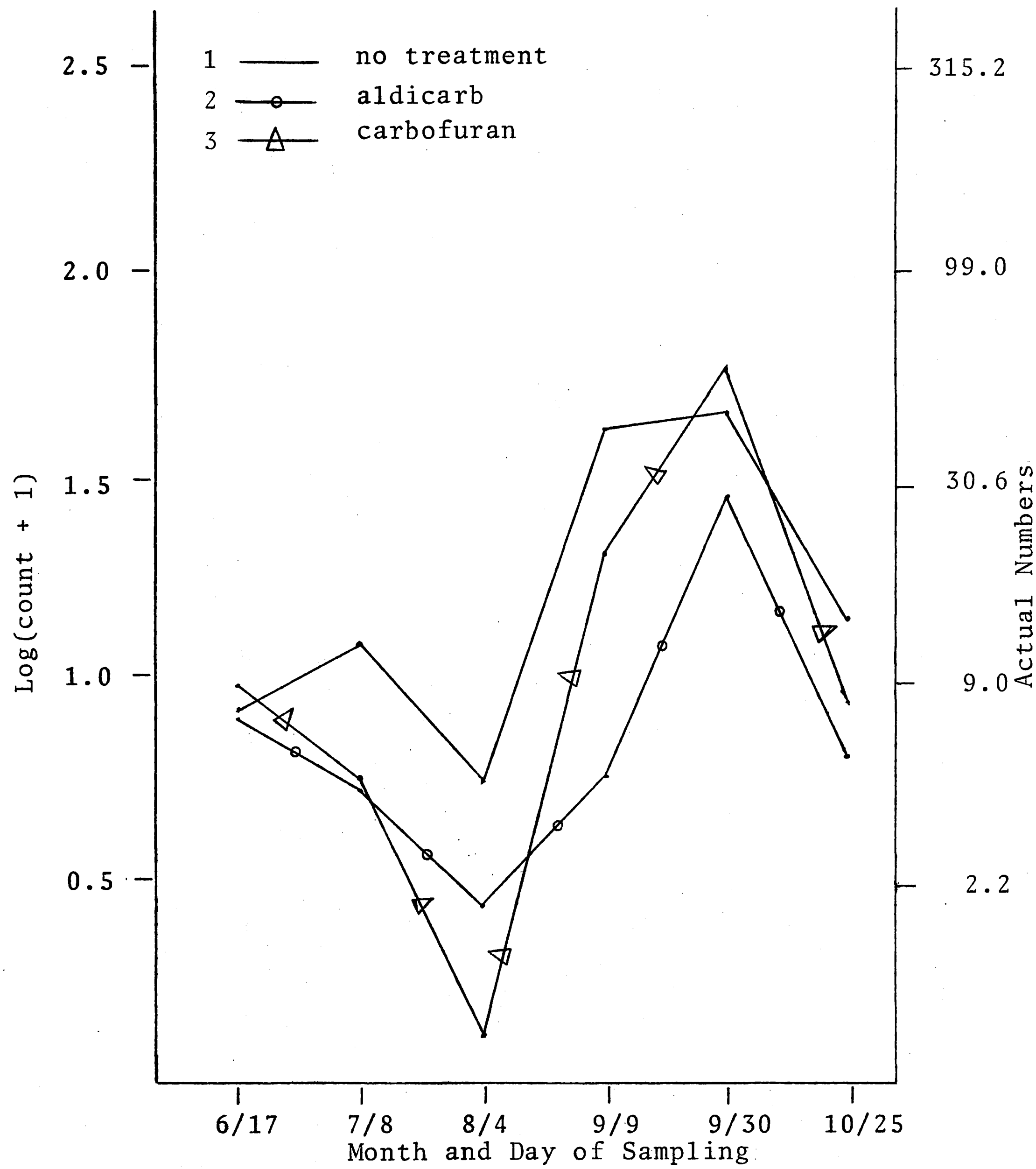

Figure 2. Log(count + 1) of <u>Belonolaimus longicaudatus</u> per 100 ml of Soil on Six Sampling Dates

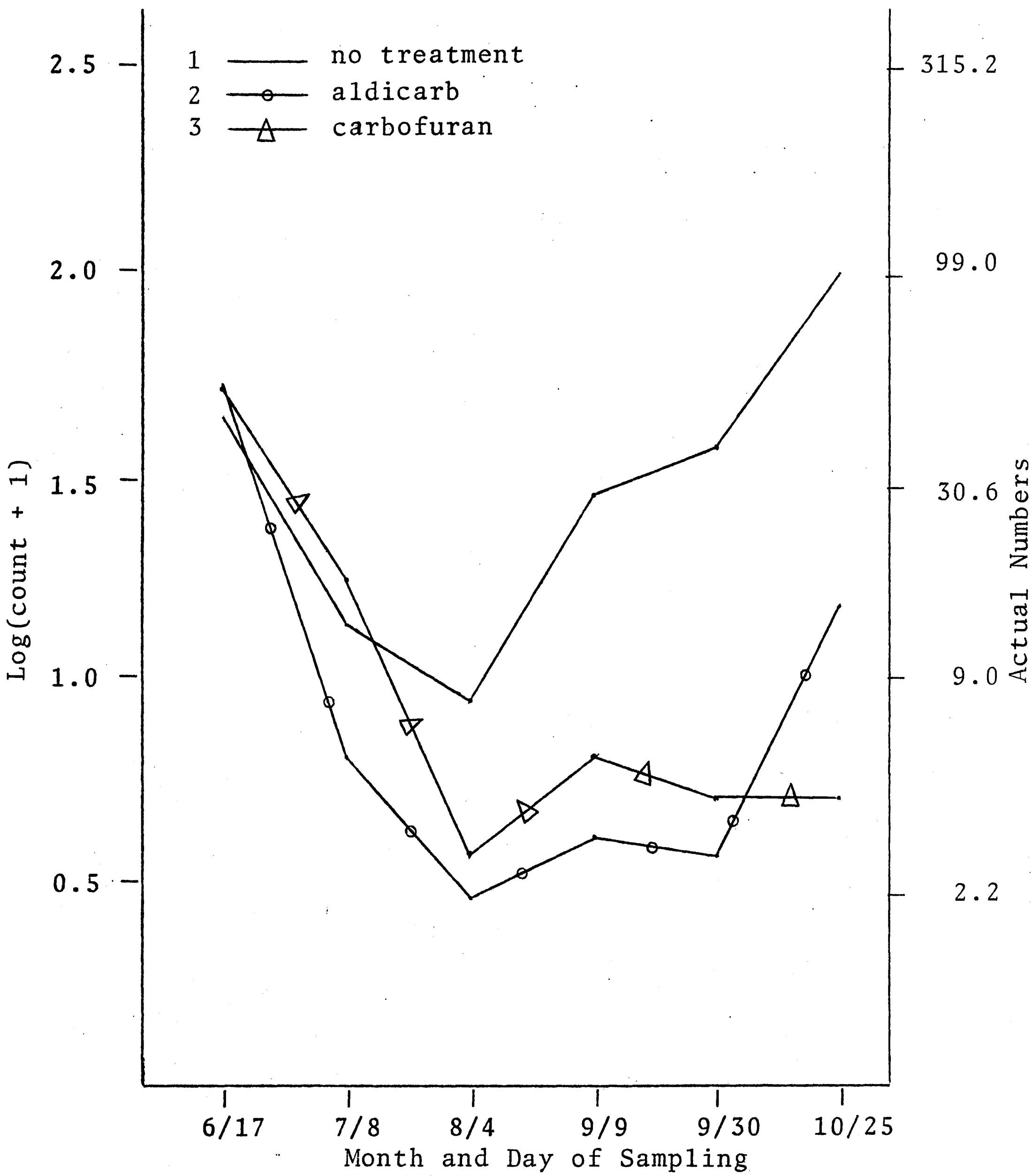

Figure 3. Log(count + 1) of *Pratylenchus zeae* per 100 ml of Soil on Six Sampling Dates

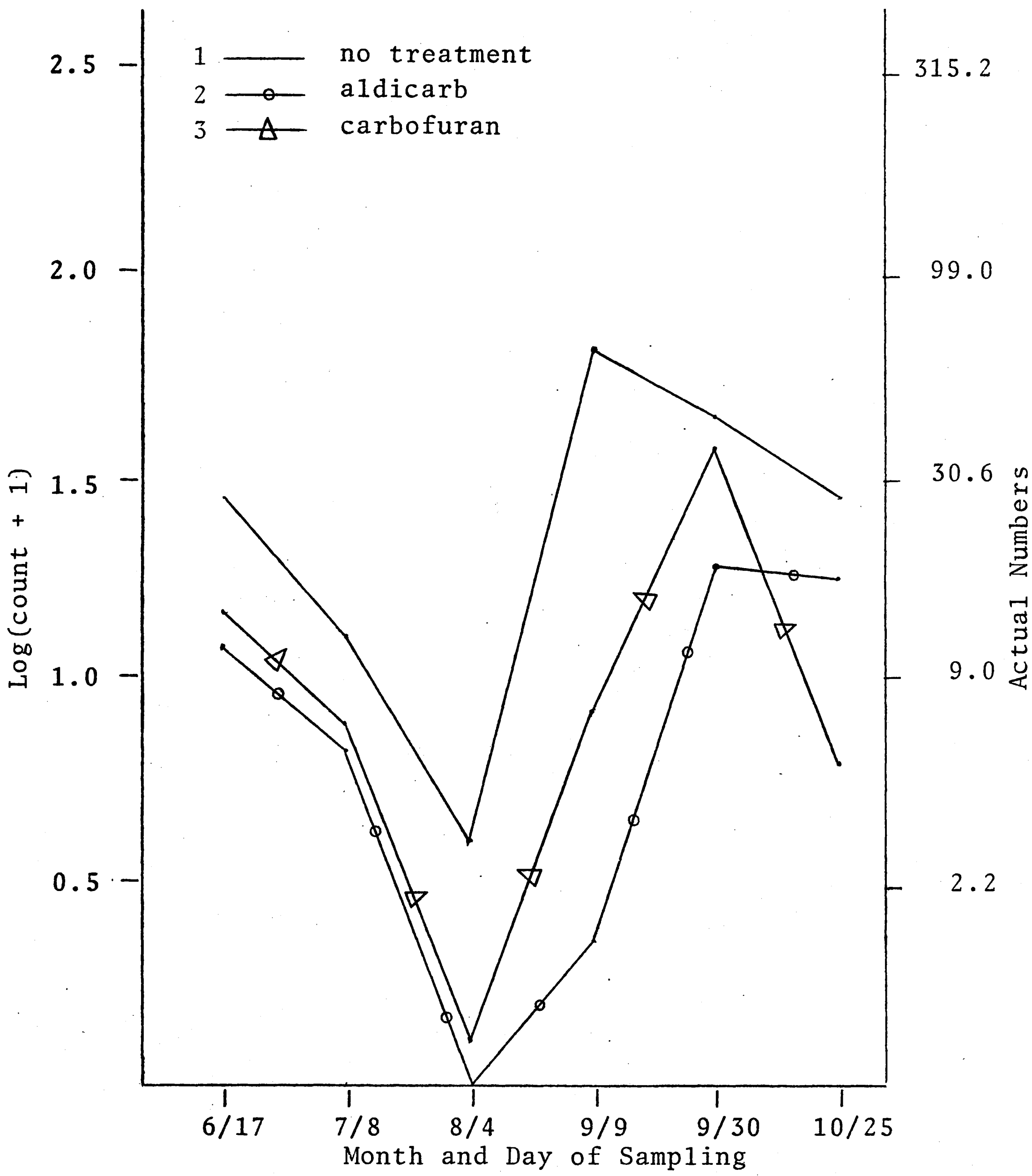

Figure 4. Log(count + 1) of Paratrichodorus minor per 100 ml of Soil on Six Sampling Dates

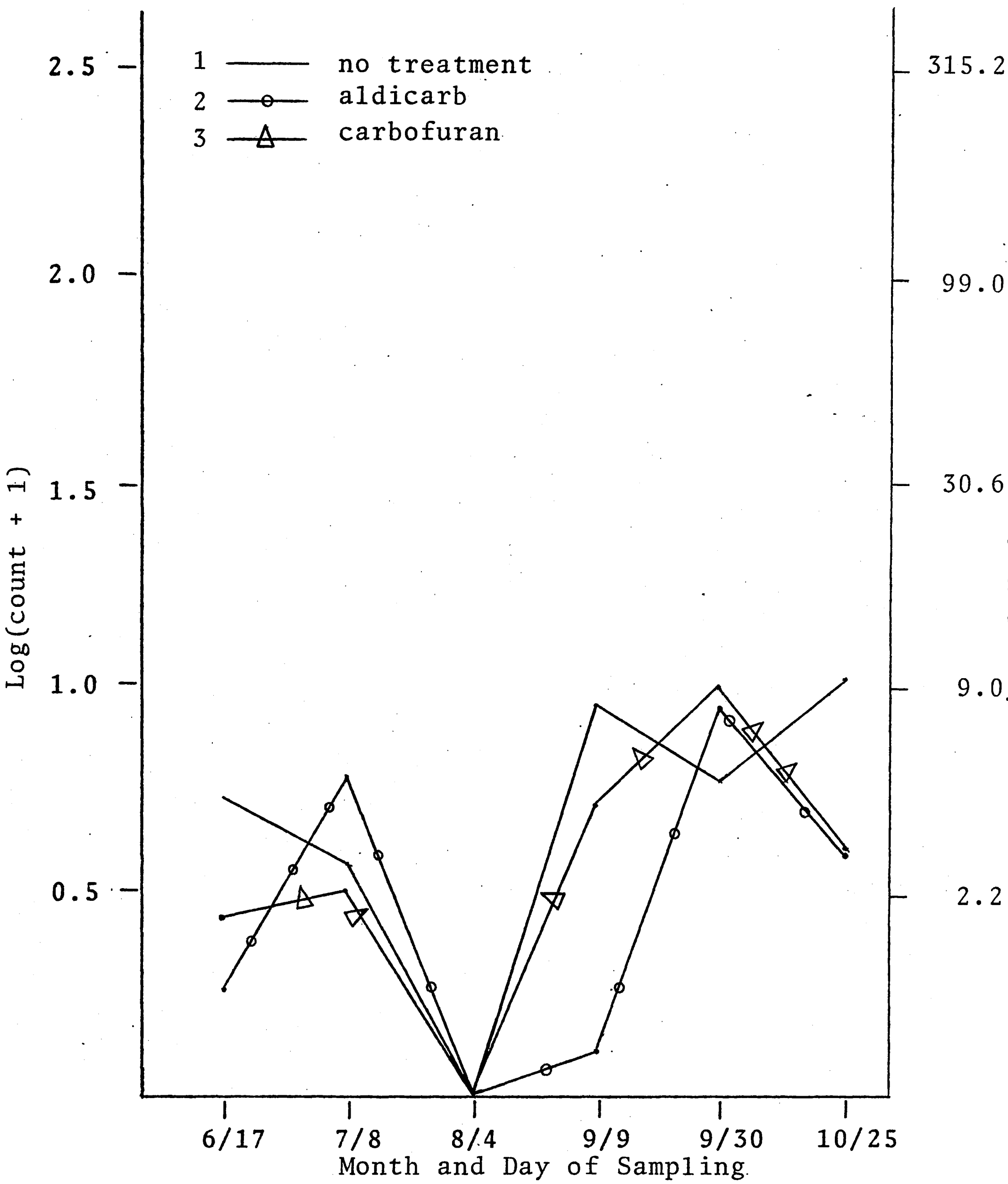

Figure 5. Log (count + 1) of _Xiphinema_ _americanum_ per 100 ml of Soil on Six Sampling Dates

numbers than untreated plots. On 9/9, the aldicarb and carbofuran showed highly significant (.01) reductions in populations when compared to untreated plots. The 10/25 sampling showed a highly significant difference (.01) between all three treatments. Carbofuran had a significantly lower population than aldicarb and untreated, and aldicarb had a significantly lower population than the untreated plots.

Xiphinema americanum (Figure 5) had only one sampling date with a statistically significant difference in populations. At harvest time (10/25) the untreated plots had significantly (.05) higher numbers than the treated plots.

Pratylenchus zeae per gram of root weight data (Figure 6) was taken at three times during the growing season and at harvest time. All four dates showed a highly significant (.01) reduction in number of *P. zeae* per gram of root weight in treated versus untreated plots. Number of *P. zeae* per gram of root weight appears to be of great significance, particularly early in the season when low differences in soil populations exist. Root samples should have been taken on 7/8, even though the plants were only three weeks old.

Since both of the nematicides used are systemic, it is easy to understand why reduction of numbers of *P. zeae* per gram of root weight in treated plots is so much more dramatic than soil population reductions. Reliance on soil populations of *P. zeae* alone during the growing season would have greatly underestimated the actual population present in soil plus roots.

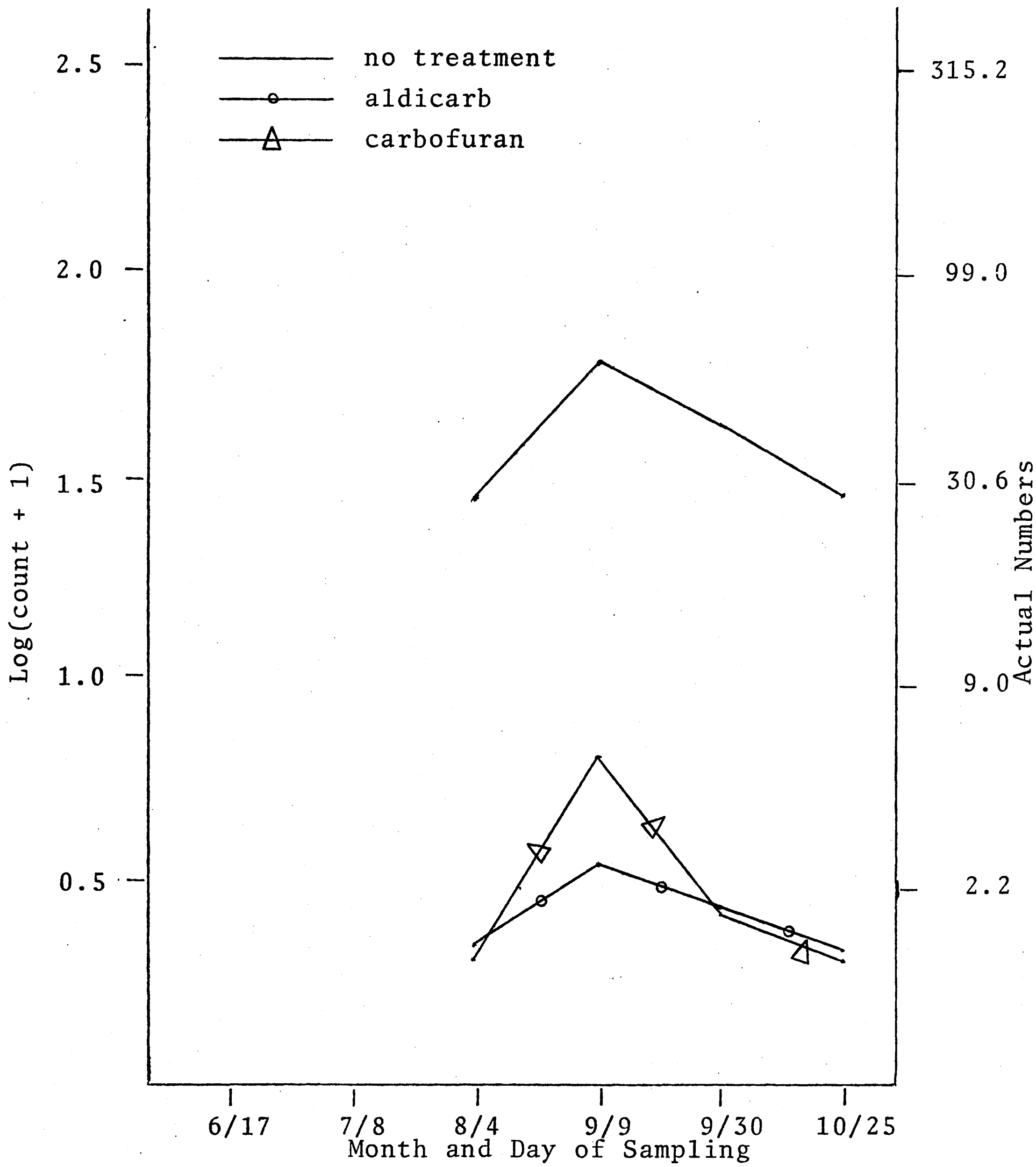

Figure 6. Log (count + 1) of Pratylenchus zeae per Gram of Root Weight on Four Sampling Dates

The study was planted on June 17 in excellent soil moisture, and 3.6 cm of rain fell during the remainder of the month. Rainfall by month during the growing season is presented in Figure 7. From June 25 until August 31, only 5.6 cm of rain was recorded. The average maximum temperature for the month of August was 38°C, with an average maximum wind velocity of 11.1 knots. The first frost occurred on October 20, with a low of -3.3°C.

Soil nematode populations tended to follow the pattern of rainfall (Figure 7). With more rainfall, more nematodes were recovered in all plots, and with less rainfall fewer nematodes were recovered. This may have been due to nematodes dying as moisture decreased and egg hatch as moisture increased. It also may have been due to downward migration of the nematodes as topsoil moisture decreased. Another reason for decreased numbers as moisture decreased could be that as water loss from the plants was reduced as the plants went into semi-dormancy, less root mass was being produced to maintain or increase the population, and as root growth proliferated with rainfall, nematode populations increased. It would be of value in further investigations of this nature to undertake vertical distribution studies, at each sampling date if possible, to detect nematode movement or migration as related to plant growth and soil moisture levels.

It is interesting to note that few of the average treatment soil populations are large enough to cause much concern

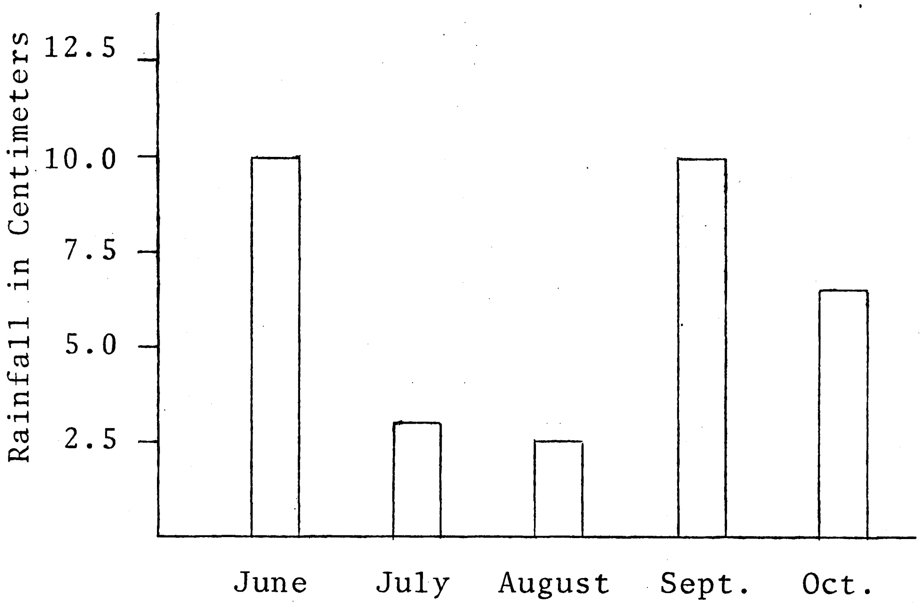

Figure 7. Amount of Rainfall in Centimeters by Month at Sandy Lands Research Station, Mangum, Oklahoma, 1976

when looked at alone. However, when the numbers of the four species of nematodes are added together, a considerable number of nematodes is represented. These populations added together are more likely to cause some of the yield reductions noted in this study than any one species alone.

CHAPTER V

SUMMARY

1. Application of aldicarb and carbofuran significantly increased the number of seeds per head.
2. Aldicarb significantly increased weight of 1,000 seeds over untreated plots.
3. Aldicarb and carbofuran significantly increased plant height over untreated plots.
4. Aldicarb and carbofuran significantly increased grain weight per head over untreated plots.
5. No statistical differences in treated compared to untreated plots was observed with head length, stem diameter, fresh root weight, dry root weight, or root volume.
6. Soil nematode populations tended to follow the pattern of rainfall. With increased rainfall, increased numbers of nematodes were recovered in all plots.
7. In future studies, vertical distribution studies should be made to detect nematode movement as related to plant growth and soil moisture levels.
8. Numbers of *Pratylenchus zeae* per gram of root weight were significantly reduced with nematicide application.
9. *P. zeae* per gram of root weight appears to be of greater importance than soil populations of *P. zeae* in determining plant infestation levels.

LITERATURE CITED

1. Anonymous. 1971. Estimated crop losses due to plant-parasitic nematodes in the United States. Suppl. to J. Nematol. Special Publication No. 1. 7 p.

2. Brodie, B. B., J. M. Good, and C. A. Jaworski. 1970. Population dynamics of plant nematodes in cultivated soil: Effect of summer cover crops in newly cleared land. J. Nematol. 2:217-222.

3. Chevres-Roman, R. 1967. Influence of certain nematodes and number of consecutive plantings of sorghum and corn on forage production, chemical composition of plant and soil, and water use efficiency. (Abstr.) Nematologica 13:139.

4. Endo, Burton Y. 1959. Responses of root-lesion nematodes, Pratylenchus brachyurus and P. zeae, to various plants and soil types. Phytopathology 49:417-421.

5. Good, J. M. 1968. Relation of plant parasitic nematodes to soil management practices. P. 113-118. In G. C. Smart, Jr. and V. G. Perry (eds.). Tropical Nematology. Univ. of Florida Press, Gainesville.

6. Good, J. M., N. A. Minton and C. A. Jaworski. 1965. Relative susceptibility of selected cover crops and Coastal bermudagrass to plant nematodes. Phytopathology 55:1026-1030.

7. Goodey, J. Basil. 1957. Laboratory methods for work with plant and soil nematodes. Technical Bulletin No. 2. Ministry of Agriculture, Fisheries and Food. Her Majesty's Stationery Office, London. 47 p.

8. Johnson, A. W., and G. W. Burton. 1973. Comparison of millet and sorghum-sudangrass hybrids grown in untreated soil and soil treated with two nematicides. J. Nematol. 5:54-59.

9. Kinloch, R. A. 1974. Influence of cropping on nematode fauna of Southern Coastal Plain woodlands. (Abstr.) J. Nematol. 6:144-145.

10. Kramer, N. W., and W. M. Ross. 1970. Cultivation of grain sorghum in the United States. In Sorghum Production and Utilization. J. S. Wall and W. M. Ross (eds.) AVI Publishing Co., Westport, Conn. 702 p.

11. Moore, C. A., and D. G. Nelson. 1970. The future of grain sorghum. In Sorghum Production and Utilization. J. S. Wall and W. M. Ross (eds.) AVI Publishing Co., Westport, Conn. 702 p.

12. Oklahoma Agricultural Statistics - 1975. Issued 1976. Compiled by John E. Cochrane and W. H. Kastens, State Statisticians. Oklahoma Dept. of Agric. and USDA. 91 p.

13. Orr, C. C. 1967. Observations of cotton root-knot nematode in grain sorghum in west Texas. Plant Dis. Reptr. 51:29.

14. Rhoades, H. L. 1976. Effect of *Indigofera hirsuta* on *Belonolaimus longicaudatus*, *Meloidogyne incognita*, and *M. javanica* and subsequent crop yields. Plant Dis. Reptr. 60:384-386.

15. Rockefeller Foundation. 1966. Program in the Agricultural Sciences. Annual Report. 1964-1965. Rockefeller Fndn., N.Y. 262 p.

16. Rohde, R. A., and W. R. Jenkins. 1957. Host range of a species of *Trichodorus* and its host parasite relationships on tomato. Phytopathology 47:295-298.

17. Russell, C. C. 1976. Unpublished root incubation method. Personal Communication.

18. Tarte, R. 1971. The relationship between preplant populations of *Pratylenchus zeae* and growth and yield of corn. (Abstr.) J. Nematol. 3:330-331.

APPENDIXES

TABLE I

ANALYSES OF VARIANCE FOR YIELD PARAMETERS

Source	DF	Plant height	Head length	Stem diameter	# Seeds per head	Weight of 1,000 seeds	Grain wt. per head	Fresh root weight	Dry root weight	Root Volume	Grain Yield Per Plot
		Mean Squares									
Rep	5	2463.52	396.57	62.67	13,350,804.1	2,492.79	9100.15	4376.30	4208.09	426.35	1,694,830.46
Treatment	2	1909.21	54.85	11.41	2,548,894.7	429.00	1062.52	751.52	1564.87	82.53	131,125.28
Rep X Treatment (Error)	10	406.54	28.824	12.49	284,446.2	87.16	179.94	1066.44	1460.54	145.98	47,439.88
$LSD_{.05}$		5.8	1.54	1.02	153.4	2.68	3.86	9.40	3.47	10.99	280.19

TABLE II

ANALYSES OF VARIANCE FOR POPULATIONS OF *BELONOLAIMUS LONGICAUDATUS* FOR SIX SAMPLING DATES[1]

Source	DF	Mean Squares 6/17	7/8	8/4	9/9	9/30	10/25
Rep	5	1.13	1.18	.52	1.53	1.43	17.60
Treatment	2	.01	.23	.61	1.13	.15	3.31
Rep X Treatment (Error)	10	.15	.20	.13	.17	.22	2.32
$LSD_{.05}$		.49	.57	.46	.53	.61	.44

1. All mean square and LSD values are expressed as log(count + 1)

TABLE III

ANALYSES OF VARIANCE FOR SOIL POPULATIONS OF *PRATYLENCHUS ZEAE* ON SIX SAMPLING DATES[1]

		Mean Squares					
Source	DF	6/17	7/8	8/4	9/9	9/30	10/25
Rep	5	.61	.50	1.07	1.99	.93	5.4
Treatment	2	.02	.31	.38	1.15	1.77	50.66
Rep X Treatment (Error)	10	.08	.22	.24	.29	.15	6.23
$LSD_{.05}$		.36	.61	.63	.69	.50	.74

1. All mean square and LSD values are expressed as log(count + 1)

TABLE IV

ANALYSES OF VARIANCE FOR POPULATIONS OF *PARATRICHODORUS MINOR* ON SIX SAMPLING DATES[1]

		Mean Squares					
Source	DF	6/17	7/8	8/4	9/9	9/30	10/25
Rep	5	.24	.16	.22	.37	.31	1.57
Treatment	2	.22	.12	.62	3.1	.23	13.87
Rep X Treatment (Error)	10	.09	.38	.15	.14	.14	.92
$LSD_{.05}$		.38	.79	.50	.48	.48	.28

1. All mean square and LSD values are expressed as log(count + 1)

TABLE V

ANALYSES OF VARIANCE FOR POPULATIONS OF *XIPHINEMA AMERICANUM* ON SIX SAMPLING DATES[1]

Source	DF	Mean Squares 6/17	7/8	8/4	9/9	9/30	10/25
Rep	5	1.74	1.84	0	1.67	3.57	29.66
Treatment	2	.32	.13	0	1.10	.09	7.47
Rep X Treatment (Error)	10	.09	.05	0	.59	.13	1.41
$LSD_{.05}$		.39	.29	0	.99	.47	.34

1. All mean square and LSD values are expressed as log(count + 1)

TABLE VI

ANALYSES OF VARIANCE FOR *PRATYLENCHUS ZEAE* PER GRAM ROOT WEIGHT AT FOUR SAMPLING DATES[1]

Source	DF	Mean Squares 8/4	9/9	9/30	10/25
Rep	5	.25	.11	.06	1.53
Treatment	2	2.54	2.52	2.86	31.54
Rep X Treatment (Error)	10	.13	.08	.07	.14
$LSD_{.05}$		.46	.37	.34	.14

1. All mean square and LSD values are expressed as log(count + 1)

VITA

Bruce Edward Nowlin

Candidate for the Degree of

Master of Science

Thesis: THE EFFECTS OF CONTROLLING FOUR SPECIES OF NEMATODES ON GRAIN SORGHUM, SORGHUM BICOLOR (L.) MOENCH

Major Field: Plant Pathology

Biographical:

Personal Data: Born in Chickasha, Oklahoma, June 17, 1952, the son of Alvin and Betty Nowlin.

Education: Attended Minco High School, Minco, Oklahoma, from September, 1966 to May, 1969; graduated from Fort Cobb High School, Fort Cobb, Oklahoma, in May, 1970; attended Scone High School, Scone, New South Wales, Australia from September, 1970 until June, 1971 as a Rotary Exchange Student sponsored by the Fort Cobb Rotary Club; attended Oklahoma State University from August, 1971 to May, 1975, receiving the Bachelor of Science degree with major in University Studies; completed requirements for the Master of Science degree with major in Plant Pathology at Oklahoma State University in May, 1977.

Professional Experience: Field Program Supervisor of Oklahoma State University Peanut Pest Management Programs, May through August of 1975 and 1976. Plant Disease Diagnostic Laboratory Technician, September through April, 1974-1977.