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Rhizosphere effect of *Andropogon pumilus* Roxb. on soil nematodes, soil organic matter and nitrogen

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Abstract. The rhizosphere effect of *Andropogon pumilus* Roxb. on soil nematodes, percent organic matter and percent total nitrogen has been studied and compared with non-rhizosphere soils. The proportion of plant parasites and microbivores were considerably higher than the proportion of miscellaneous feeders and predators in the rhizosphere than in the root free soils. Nematode population in the rhizosphere reached a peak during the flowering stage in November. Nematode density, percent organic matter and percent total nitrogen were significantly more in the rhizosphere soil than the root free soil. In the rhizosphere soil nematode abundance showed a significant positive correlation with percent organic matter and percent total nitrogen indicating that the root exudates promote increase in the population of micro-organisms and nematodes.

Keywords. *Andropogon pumilus*; rhizosphere; soil nematode; organic matter; nitrogen.

1. Introduction

Soil nematode populations show a close relationship with the roots in the soil (Yeates 1979). As root grows through the soil it alters the soil conditions in its immediate vicinity and in doing so has important effects on the microbial population on the soil (Parkinson 1967). Various groups of soil micro-organisms like bacteria, fungi, actinomycetes, algae, protozoa and nematodes are stimulated in the root region because of root exudates. In recent years much work has been done on the interactions between the plant roots and soil bacteria and fungi. The present investigation was taken up to evaluate the rhizosphere effect on different trophic groups of soil nematodes and soil nutrients like organic matter and nitrogen and their interactions.

2. Materials and methods

This investigation was carried out at the bottom of the Savanna type tropical hill ecosystem located in the campus of Sambalpur University, Orissa. *Andropogon pumilus* Roxb. was the dominant grass species of the study site. At the commencement of rain during mid June 1981, the seedlings of various species of grasses and non-grasses grew up. In order to distinguish the rhizosphere and non-rhizosphere regions of the dominant grass species, the seedlings of other grasses and non-grasses were removed from the very beginning. Samples of rhizosphere and non-rhizosphere soils were taken

to study the nematode trophic groups and to determine the percent total organic matter and percent total nitrogen at monthly intervals for one year from July 1981 to June 1982. Five plants were sampled at random. The soil surrounding the root and the root free soil were collected up to a depth of 10 cm by a screw-type auger.

To extract soil nematodes 250 cm^3 of soil was processed by a combination of Cobb's decanting and sieving method (Cobb 1918) and the Baermann funnel technique (Southey 1970). Samples remained in the funnel for 24 hr. Late juvenile stages and adults were only counted. The nematodes obtained were classified into four ecological trophic groups: (i) plant parasitic forms, (ii) microbivores, (iii) miscellaneous feeders and (iv) predators. After counting, total number per various trophic groups/100 g dry soil was calculated. Percent organic matter and percent total nitrogen were determined respectively by the muffle furnace method (Paine 1971; Reiners and Reiners 1972) and micro-kjeldhahl method (Jackson 1973).

The rhizosphere effect on soil nematodes was assessed by comparing the number of nematodes in unit weight of rhizosphere soil (R) with the soil (S) distant from roots—thus giving the R/S value.

3. Results

Seedlings of *Andropogon pumilus* Roxb grew up immediately after the commencement of rain in mid-June and reached the flowering stage in November. There appeared a gradual decline in the growth of the grass after November. Due to irregular rains few short new branches appeared during February and March but became dead during summer months. Table 1 shows the influence of grass rhizosphere and root-free soil on the nematode population. The nematode population of the rhizosphere increased gradually with growth of the grass from seeding to flowering stage, reaching a maximum (375/100 g dry soil) during November and then gradually declined reaching a minimum (87/100 g dry soil) during June. But this trend was not discernible in the non-rhizosphere soil throughout the year. The R/S ratio for plant parasites, miscellaneous feeders and predators increased till November and then with the death of the plant gradually declined. But the R/S ratio for microbivores gradually increased with the growth of the plant and was relatively more from October to March and then suddenly declined during the summer months. Taking the total nematodes into consideration the R/S ratio reached a maximum (6) during the peak growth of the grass in November and a minimum (2) during the death of the grass in June.

The population density of almost all the trophic groups of nematodes and of total number of nematodes of the rhizosphere soil differed significantly from that of the non-rhizosphere soil ($t = 6{\cdot}196$, $p < 0{\cdot}01$).

Percent organic matter and percent total nitrogen in the rhizosphere region increased with the growth of the plant and reached a peak in December (3·6 g %) and November (0·07 g %) respectively and then declined with the death of the grass (table 2). But this trend was not observed in the root free soil. Applying the t test, a significant difference was also observed in the percent organic matter and percent total nitrogen of the rhizosphere and non-rhizosphere soils ($t = 7{\cdot}313p < 0{\cdot}01$ for percent organic matter and $t = 8{\cdot}995$, $p < 0{\cdot}01$ for percent total nitrogen).

Table 1. Soil nematode population/100 g dry soil of the rhizosphere and non-rhizosphere soils and the *R/S* ratio during the study period.

Year and Month	Plant parasites			Microbivores			Miscellaneous feeders			Predators			Total		
	R	*S*	*R/S*	*R*	*S*	*R/S*	*R*	*S*	*R/S*	*R*	*S*	*R/S*	*R*	*S*	*R/S*
1981															
Jul.	51·4	14·3	3·6	4·7	1·7	2·8	96·5	44·8	2·2	9·3	3·7	1·5	160·4	64·5	2·5
Aug.	59·6	18·8	3·2	5·4	1·6	3·3	106·3	48·3	2·2	1·9	0·9	2·2	173·3	69·6	2·5
Sep.	89·8	19·8	4·5	8·8	2·6	3·4	89·4	37·7	2·4	4·9	1·8	2·7	192·9	61·9	3·1
Oct.	116·4	23·9	4·9	11·4	1·8	6·2	106·1	33·6	3·2	7·2	1·6	4·4	241·2	60·9	4·0
Nov.	202·6	23·3	8·7	17·9	2·6	6·8	123·8	33·7	3·7	13·0	2·8	4·6	375·2	62·5	6·0
Dec.	85·8	10·2	8·4	14·5	1·3	11·3	120·8	34·4	3·5	7·1	2·6	2·8	228·1	48·4	4·7
1982															
Jan.	75·9	10·6	7·1	14·5	2·4	6·1	112·4	46·0	2·4	13·3	4·3	3·1	216·1	63·3	3·4
Feb.	99·0	14·2	7·0	21·6	3·1	6·9	95·2	45·2	2·1	8·3	2·5	3·3	224·1	64·9	3·5
Mar.	63·2	12·3	5·1	18·2	1·6	10·9	85·5	33·3	2·6	11·2	2·9	3·9	178·0	50·1	3·6
Apr.	63·5	12·2	5·2	6·2	1·9	3·2	51·0	34·8	1·5	8·0	3·7	2·2	128·7	52·6	2·4
May	46·3	19·7	2·4	5·5	2·0	2·7	58·9	33·7	1·8	3·2	1·2	2·6	113·9	56·7	2·0
Jun.	42·2	23·5	1·8	3·0	1·0	2·9	38·6	23·9	1·6	3·2	1·5	2·1	86·9	49·8	1·8

r = Rhizosphere; *s* = Non-rhizosphere.

4. Discussion

4.1 *Nematode density*

The nematode density increased during the rainy season, the growing phase of the grass, reaching a maximum in November, the flowering stage of the grass. After the death of the grass the nematode density declined. The decrease in the nematode density after the seed formation could possibly be attributed to reduced root secretions and decreased soil moisture levels. The aggregation of plant parasitic forms in the rhizosphere region resulted due to roots on which they feed. Microbivores increased from November to March, an indication that they depend upon the dead roots of the grass for their food and helped in decomposition. The miscellaneous feeders and predators were also more in the rhizosphere region and this was possibly due to the presence of large numbers of soil micro-organisms like bacteria, fungi, actinomycetes, algae and protozoa on which they feed and predate. The microbivores and miscellaneous feeders are found in the upper layers of the soil (Mishra and Dash 1981) and the nematode biomass is more dependent on the above ground biomass than the below ground biomass (Dash and Pradhan 1982). The litter layer and the high concentration of organic matter were perhaps the causes of greater concentration of microbivores and miscellaneous feeders in the rhizosphere.

The rhizosphere effect on bacteria (*R/S* values ranging from 10 to 20) was greater than with fungi (Subba Rao 1977). The present investigation showed a positive rhizosphere effect with nematodes and at no stage a negative *R/S* ratio was observed.

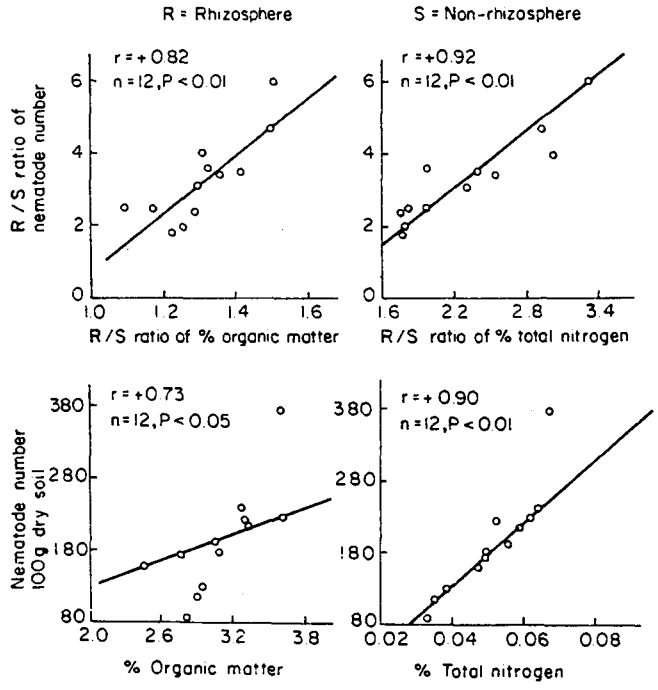

Figure 1. Relationship of nematode number with percent organic matter and percent total nitrogen.

4.2 *Nutrients*

Organic matter is a source of nutrients especially nitrogen. The main source of organic matter in the soil is the plant tissue and under natural conditions large quantities of this organic residue is supplied by the roots. In this investigation, the increase in organic matter with growth of the grass was due to the presence of roots in the rhizosphere. The percent total nitrogen was also more in the rhizosphere because of organic matter and the micro-organisms. Nematode abundance is linked with percent soil organic carbon (Yeates 1979). In this study the nematode number showed a significant positive correlation with the percent organic matter ($r = +0{\cdot}73$, $n = 12$, $p < 0{\cdot}05$) and with the percent total nitrogen ($r = +0{\cdot}90$, $n = 12$, $p < 0{\cdot}01$) in the rhizosphere region (figure 1). When the R/S ratio of percent organic matter and percent total nitrogen were taken into account separately, it was observed that R/S ratio of nematode population was more dependent on the percent total nitrogen ($r = +0{\cdot}92$, $n = 12$, $p < 0{\cdot}01$) than the percent organic matter ($r = +0{\cdot}82$, $n = 12$, $p < 0{\cdot}01$). A significantly negative correlation between the nematode population and the C/N ratio of the rhizosphere region was observed ($r = -0{\cdot}68$). The rhizosphere effect on soil nematodes, percent organic matter and percent total nitrogen in this study site was more pronounced perhaps due to the poor soil characteristic features.

Table 2. Percent organic matter, percent total nitrogen of the rhizosphere and non-rhizosphere soils of the grass and the R/S ratio during the study period.

Year and Month	Percent organic matter			Percent total nitrogen		
	R	*S*	*R/S*	*R*	*S*	*R/S*
1981						
Jul.	2·46	2·23	1·10	0·05	0·03	1·85
Aug.	2·76	2·35	1·17	0·05	0·03	2·00
Sep.	3·04	2·35	1·30	0·06	0·02	2·33
Oct.	2·26	2·49	1·31	0·06	0·02	3·05
Nov.	3·60	2·39	1·51	0·07	0·02	3·35
Dec.	3·62	2·41	1·50	0·06	0·02	2·95
1982						
Jan.	3·32	2·44	1·36	0·06	0·02	2·57
Feb.	3·30	2·31	1·42	0·05	0·02	2·41
Mar.	3·09	2·32	1·33	0·05	0·03	2·00
Apr.	2·97	2·31	1·29	0·04	0·02	1·77
May	2·89	2·29	1·26	0·04	0·02	1·80
Jun.	2·81	2·30	1·23	0·03	0·02	1·79

R/S values calculated taking R and S values up to 3 decimals.

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