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EFFECT OF CONTINUOUS SOIL AMENDMENT WITH CONIFEROUS SAWDUST ON NEMATODES AND MICROORGANISMS

by

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Summary. Sandy soil was amended for six consecutive years with coniferous sawdust at the rate of 8 metric tonnes ha^{-1}. The treatment resulted in a considerable increase in the population of fungi, including *Trichoderma* spp., while there was no apparent effect on bacteria. This was associated with an increase in the density of microbivorous nematodes. Among bacterial feeders cephalobids increased more than rhabditids. Among fungal feeders succession was observed where *Aphelenchoides* spp. increased after the first treatment and decreased later; this was followed by *Ditylenchus* spp., and later by *Filenchus* spp. The treatment also improved soil density and capillary binding of water, and is considered beneficial for soil biotic and abiotic conditions.

Coniferous sawdust, containing about 26-27% lignin, contributes to the increase of light fractions of humic substances in the soil (Amalfitano *et al.*, 1992, N'dayegamiye and Angers, 1993). Although large doses of soil amendment with sawdust may immobilise nitrogen (Beauchemin *et al.*, 1992) at the same time they contribute to the decrease of N losses in the deeper soil layers (Andrzejewski *et al.*, 1981). Moreover, the treatment increases the density of N-fixing microorganisms in the soil (Martensson and Witter, 1990). Thus, soil amendment with coniferous sawdust may be considered as a beneficial treatment for soil conservation. The effect of soil amendments with organic matter on living organisms in the soil is amply documented in the literature. The aim of this work was to investigate the effect of continuous sawdust application on soil inhabiting microorganisms and nematodes.

Methods

Coniferous sawdust was applied to the soil each autumn for six consecutive years (1991-1997) at the rate of 8 metric tonnes ha^{-1}. The experiment was conducted in microplots 0.63 m^2, with each treatment replicated six times. The soil characteristics of the plots are given in Brzeski *et al.* (1993) as they are the same microplots used in a green manuring experiment. The crops grown were: 1992 - pea (*Pisum sativum* L.), 1993 - celeriac (*Apium graveolens* L), 1994 - pea, 1995 - bean (*Phaseolus vulgaris* L.), 1996 - red beet (*Beta vulgaris* L.), 1997 - pea. Soil samples (13 cores to a depth 20 cm on each plot) were taken in April, July and September each year.

The numbers of bacteria, actinomycetes and fungi in the soil samples were determined by plate count technique using selective media. Soil extract agar (soil extract 200 cm^3, glucose 1 g, K_2HPO_4 0.5 g, agar 15 g, distilled water 800 cm^3) was used for bacteria and actinomycetes (Dhinagra and Sinclair, 1995). Fungi were isolated on rose bengal agar (peptone 5 g, glucose 10 g, KH_2PO_4 1 g, $MgSO_4$x7 H_2O 0.5 g, rose bengal 30 mg, agar 20 g, distilled water 1000 cm^3) according to Martin (1950). The results are presented as number of colony-forming units (CFU) per 1 g of soil dry weight (Fig. 1).

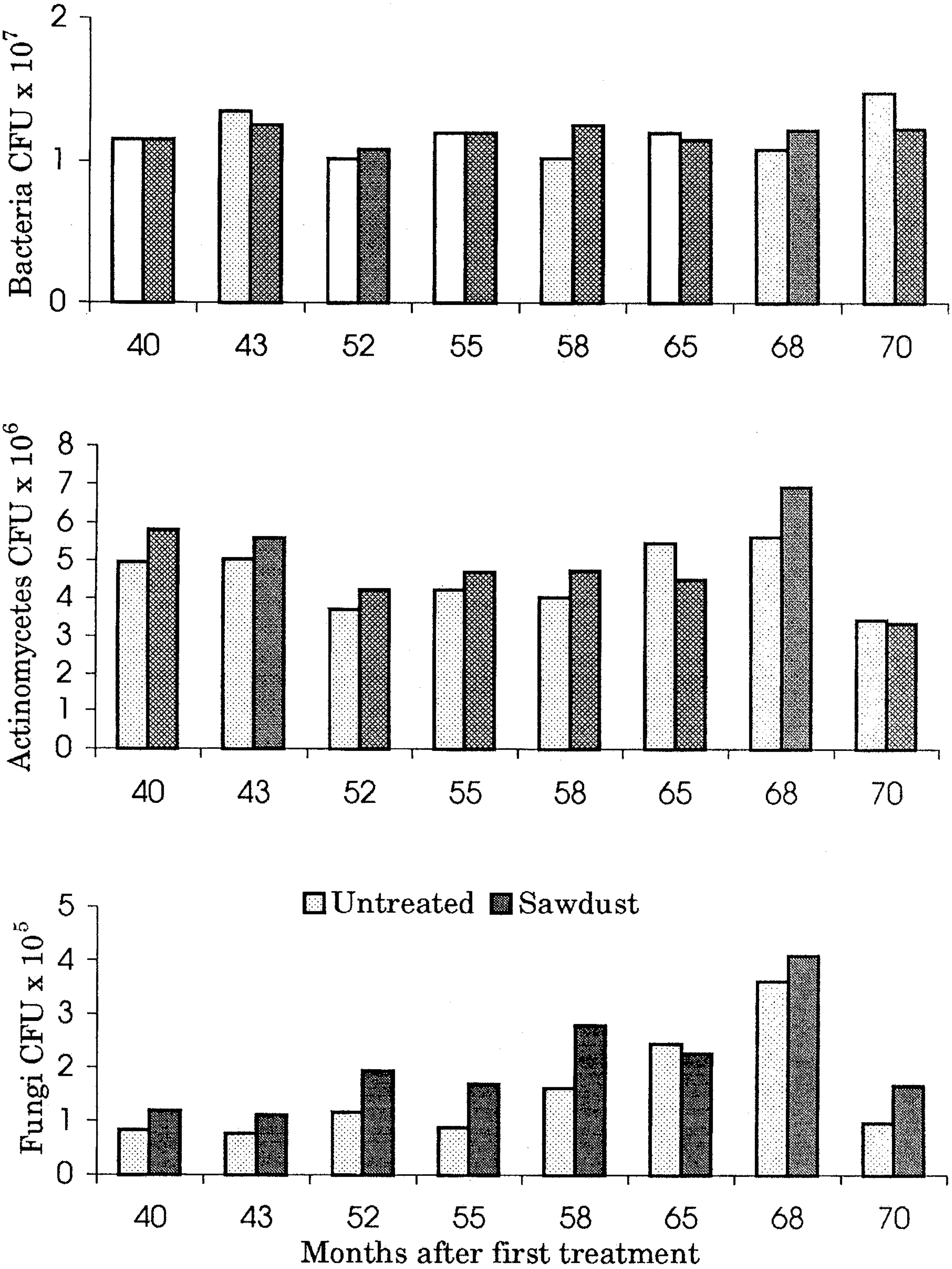

Fig. 1 - Effect of soil amendment with coniferous sawdust on population (CFU) of bacteria, actinomycetes and fungi.

Nematodes were extracted from 100 cm^3 soil samples using decantation and sieving method followed by final separation for two days on extraction sieves with filters. The method yields 80±10% of nematodes present in the soil.

Results

The soil amendment with coniferous sawdust resulted in the significant increase of density of fungi at all sampling dates (Fig. 1) with the exception of spring of the sixth year (month 65) which does not change the general picture. The density of *Trichoderma* spp., analysed in the two last years of the experiment, increased significantly in all samples analysed (Fig. 2). Bacteria did not react to the treatments applied and the number of CFU was almost stable during the entire period of experiment. Actinomycetes increased slightly and insignificantly in almost all analyses conducted.

The total number of nematodes increased slightly at all sampling dates (Fig. 3). This is mainly due to the increase of density of microbial feeding nematodes. The plant parasitic nematodes present in this soil were (named according to decreasing density): *Paratylenchus bukowinensis* Micoletzky, *Heterodera schachtii* Schmidt and *Geocenamus brevidens* (Allen). The sawdust treatment did not affect the density of these nematodes.

Bacterivorous nematodes increased slightly (Fig. 4), mainly due to the increase of Cephalob-

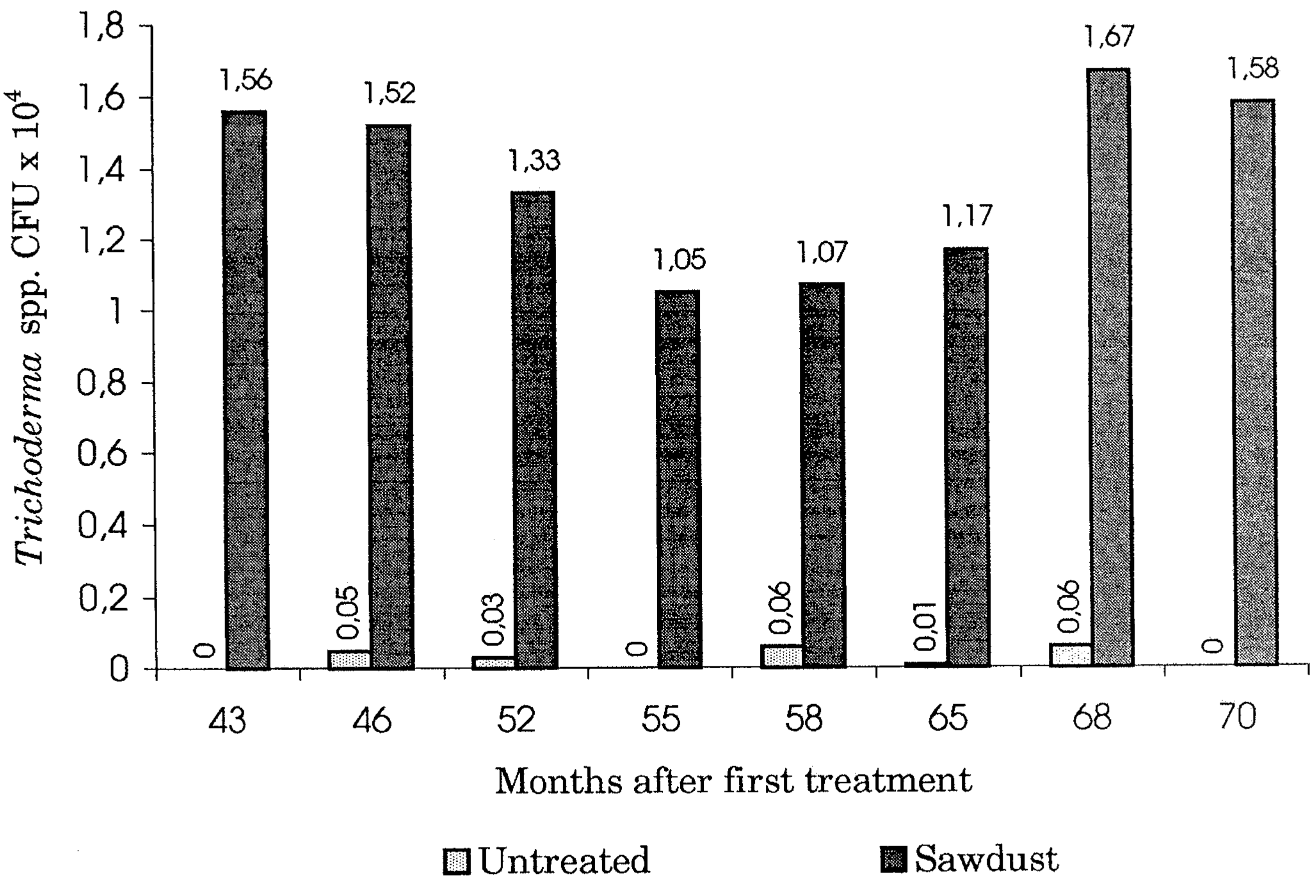

Fig. 2 - Effect of soil amendment with coniferous sawdust on population of *Trichoderma* spp.

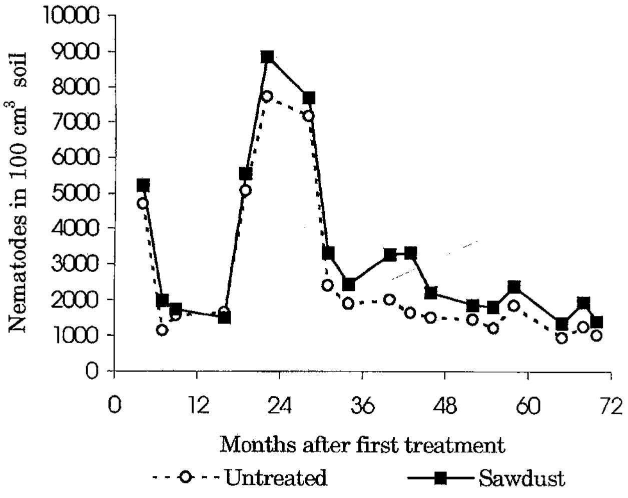

Fig. 3 - Effect soil amendment with coniferous sawdust on density of nematodes.

idae, but not Rhabditidae (Fig. 5). Fungivorous nematodes, increased considerably following sawdust amendment. The density of *Aphelenchoides* spp. increased in the first year following treatment but started to decline in the fourth year. *Ditylenchus* spp. increased in the second year, but the difference between treated and untreated soils began to diminish in the fifth year. Species of *Filenchus* increased considerably in the fourth year and this continued until the termination of the experiment; the density of *Aphelenchus avenae* Bastian increased in the first year, but remained lower on the treated plots thereafter (Fig. 6). No effect of treatment on MI index (Bongers, 1990) showing general health of soil was observed, although density of K-strategists (Dorylaimina and Mononchina) increased in sawdust amended soil (Fig. 7).

Discussion

The increase of microbial feeding nematodes followed the increase of microorganisms. This is in agreement with similar trends observed fol-

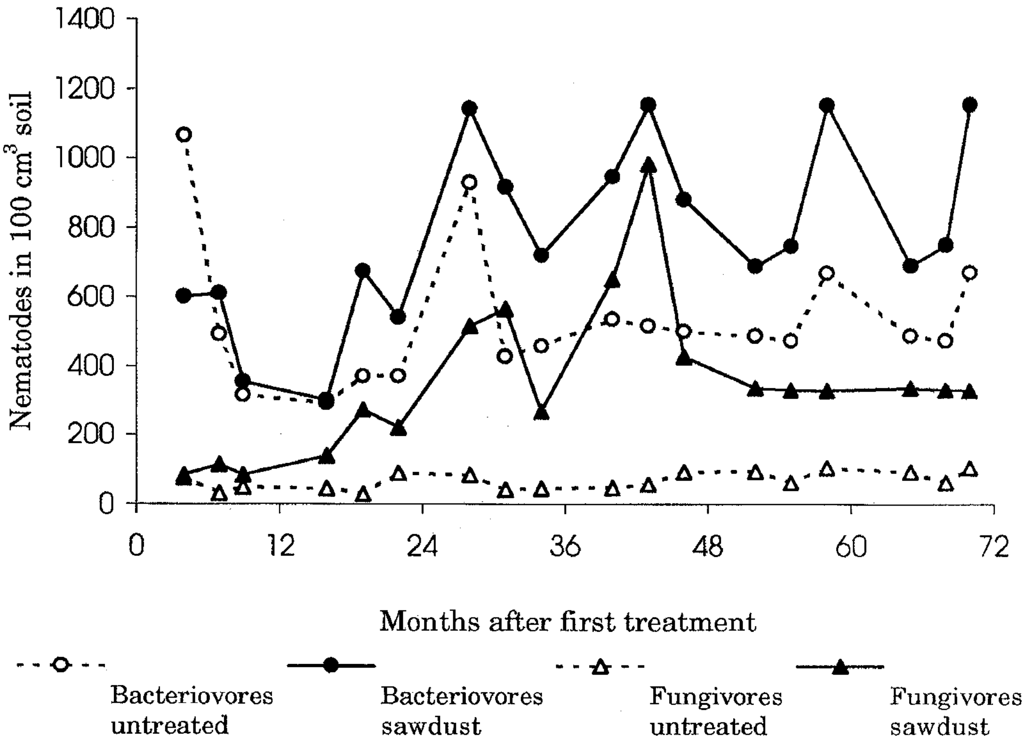

Fig. 4 - Effect of soil amendment with coniferous sawdust on density of bacterivorous and fungivorous nematodes.

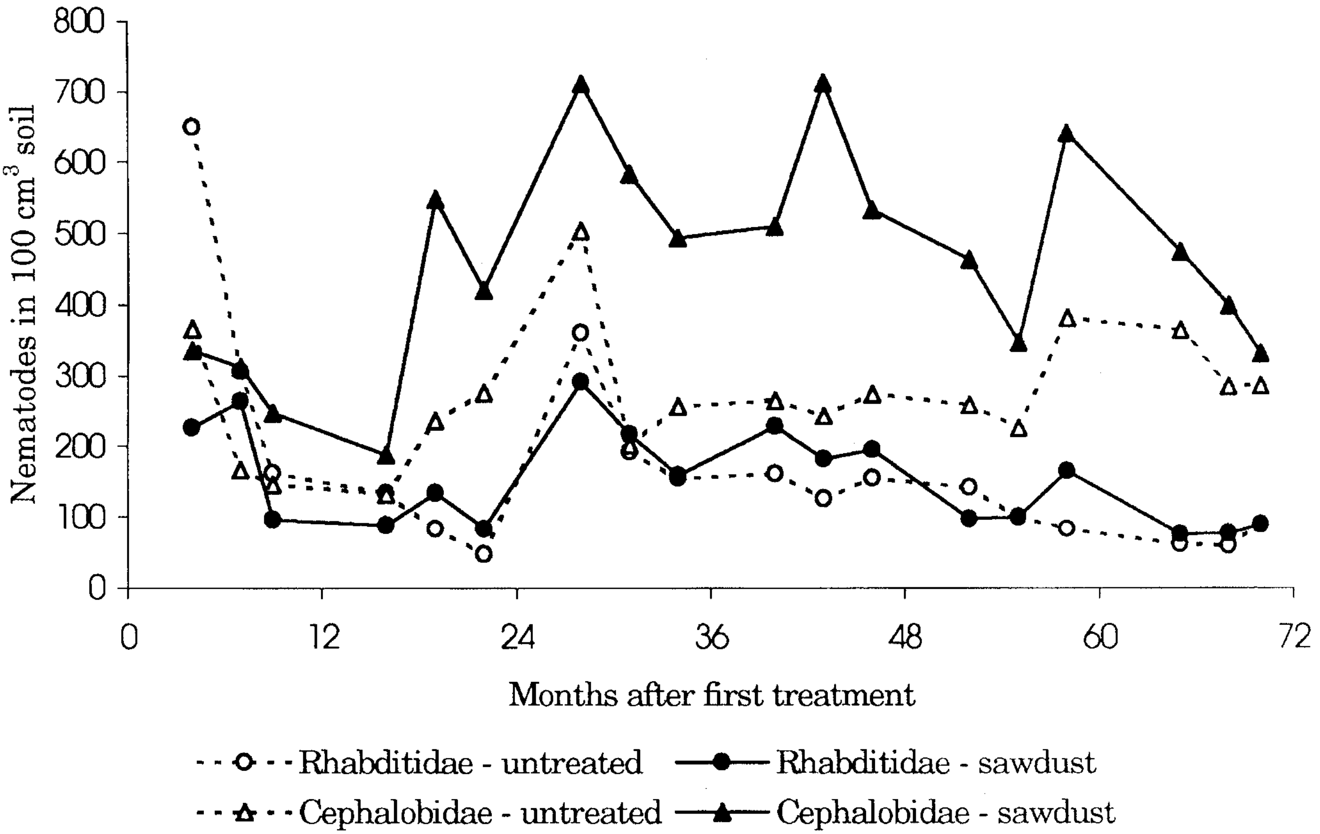

Fig. 5 - Effect of soil amendment with coniferous sawdust on density of Rhabditidae and Cephalobidae.

lowing green manuring (Brzeski *et al.*, 1993), although the range of increase was lower. This difference between green manuring and sawdust soil amendment with respect to the total density of nematodes and reaction of various trophic groups of nematodes has been observed by Mankau (1962). The increase in density is much lower when soil is amended with sawdust, but the effect appears to last longer. The effect of sawdust was observed a year after treatment, while the effect of green manuring diminished greatly after six months (Brzeski *et al.*, 1993). Probably this is because woody materials decompose in soil more slowly than the fresh plant tissues.

The observed increase of microbial feeders indicates that the soil inhabiting nematodes are under constant stress because of lack of food. Among the bacterial feeders, the density of rhabditids was less than cephalobids which may reflect better utilisation of the scarce food resource. Microscopic observations of feeding rhabditids showed large amounts of ingested bacteria passing through the gut quickly and defecated without being digested. This type of feeding has never been observed when various cephalobids were examined.

The increased nematode density also indicates the enhanced mineralization and increased turnover of biogenic elements (Griffiths, 1986; Freckman, 1988). In the case of soil amendment with coniferous sawdust, fungivorous nematodes probably contributed more to mineralization than the bacterivorous species

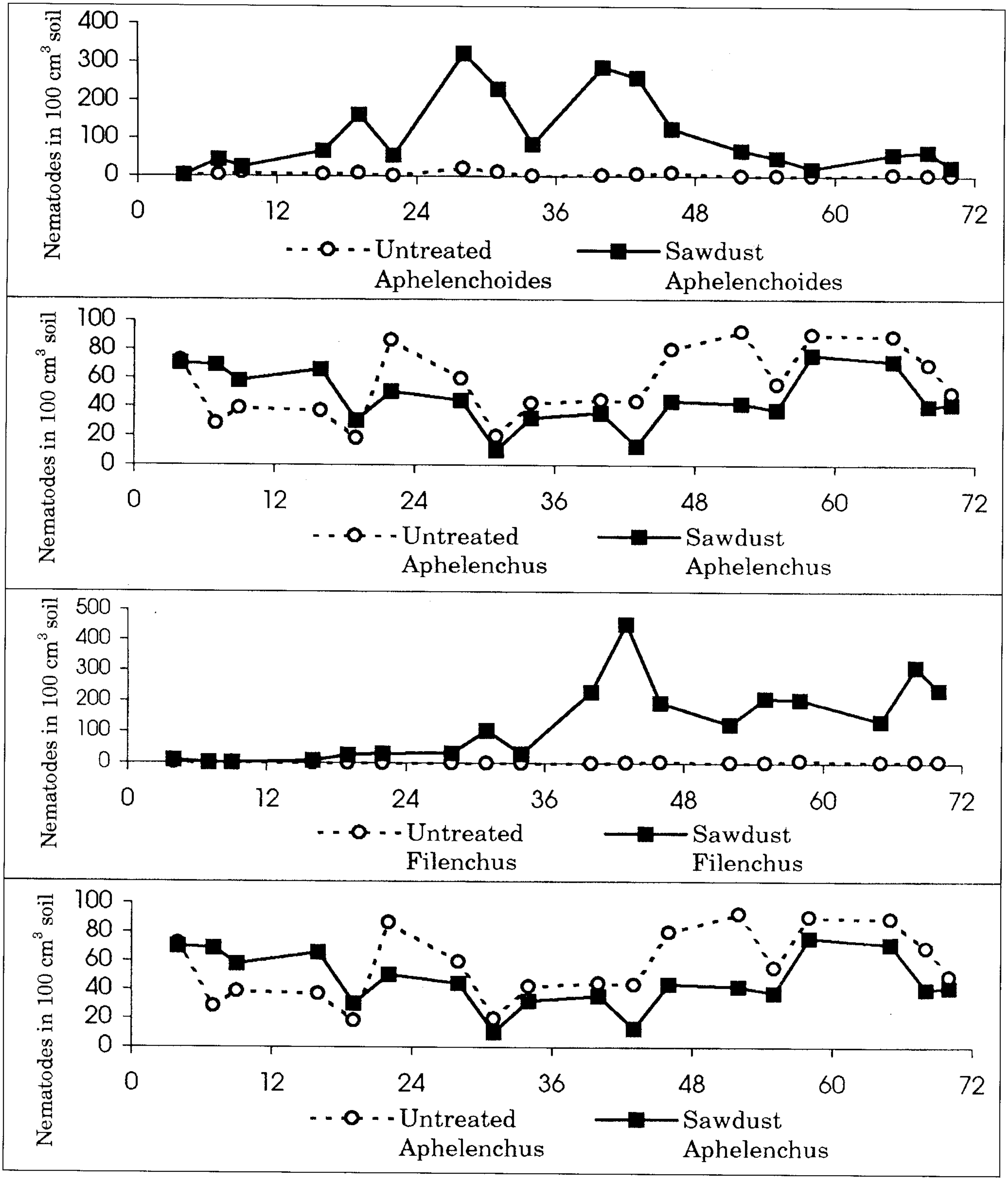

Fig. 6 - Effect of soil amendment with coniferous sawdust on density of fungivorous nematodes.

which is in agreement with the results of similar experiments in New Zealand (Wardle *et al.*, 1993, 1995). The increased number of microbial feeding nematodes may also indicate the stimulation of plant growth (Alphei *et al.*, 1996). However, these improved soil conditions did not reflect on MI index because the proportion of various groups of nematodes did not changhe much due to the treatment.

The sawdust amendment affected the population of *Trichoderma* spp. Species of this genus are well known to be active antagonists and efficient mycoparasites of a wide range of plant pathogens (Cook and Baker, 1983; Chung *et al.*, 1988; Ghisalberti and Sirasithamparam, 1991; Fernandez, 1992) contributing to "soil health". This observation is in agreement with the results of Sierota and Kwaśna (1998a, 1998b).

Soil amendment with sawdust, a low nitrogen organic substance, immobilises N (Beauchemin *et al.*, 1992), but at the same time serves as a nitrogen catch crop. Continuous soil treatment with sawdust did not affect soil pH as the results of measurements at the end of experiment were the same as at the beginning of experiment (pH 7.6). The soil bulk density measured in April of the sixth year was 1.53 $g.cm^{-3}$ in the untreated plots and 1.40 $g.cm^{-3}$ in the treated plots, a decrease of almost 10%. At the

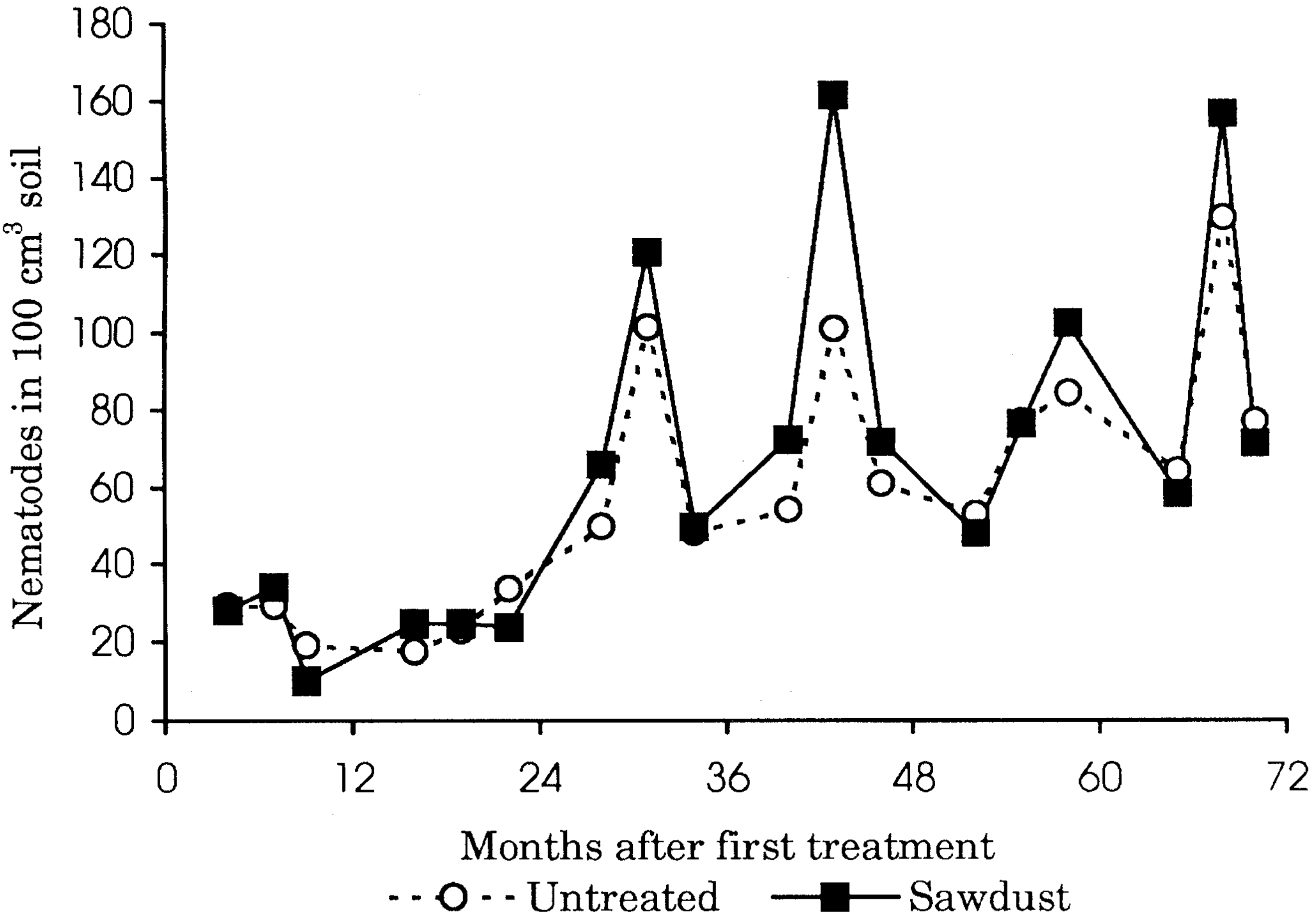

Fig. 7 - Effect of soil amendment with coniferous sawdust on density of K-strategists.

same time the ability of capillary binding of water increased 9% in the treated soil. The reported changes in the physical soil properties are not large in this soil, but increase of soil water capacity is of importance in central Poland, where few heavy rains prevail during the growing season and water should be saved for good growth of plants.

The studies undertaken show the beneficial effects of coniferous sawdust treatment of soil in increasing the biological potential and physical properties, providing the treatment is repeated in consecutive years.

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