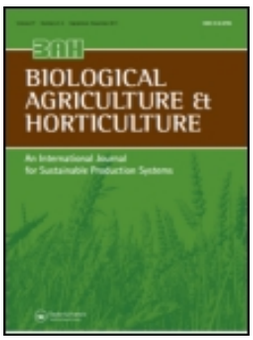

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Biological Agriculture & Horticulture

An International Journal for Sustainable Production Systems

ISSN: 0144-8765 (Print) 2165-0616 (Online) Journal homepage: http://www.tandfonline.com/loi/tbah20

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To cite this article: G. H. Pfotzer & C. Schüler (1997) Effects of Different Compost Amendments on Soil Biotic and Faunal Feeding Activity in an Organic Farming System, Biological Agriculture & Horticulture, 15:1-4, 177-183, DOI: 10.1080/01448765.1997.9755192

To link to this article: https://doi.org/10.1080/01448765.1997.9755192

Entomological Research in Organic Agriculture, pp. 177–183

Printed in Great Britain

Effects of Different Compost Amendments on Soil Biotic and Faunal Feeding Activity in an Organic Farming System

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ABSTRACT

Soil biological activity was measured after the application of different composts to potatoes in a field trial. The study is part of a project designed to evaluate the long-term effects of compost application on soil properties. Microbial activity was measured using the fluorescein diacetate (FDA) hydrolysis and faunal feeding activity was estimated with the bait-lamina test according to von Törne (1990). Data were compared with results of collembola and acari population densities obtained in earlier studies in the same field trial. The treatments were composted farmyard manure with and without hornmeal supplementation, biogenic waste compost and mineral fertilizer. The soil microbial and faunal feeding activity responded to the compost amendment with higher activity rates than with mineral fertilization. Highest values of both were found after application of biogenic waste compost. However, additional application of hornmeal in the farmyard compost treatment did not result in higher activity rates throughout the year.

INTRODUCTION

Soil biological activity refers to microbial and faunal turnover and is commonly related to biomass and population density. Organic fertilization accelerates biological activity and as a consequence mostly increases abundance of organisms. This has been shown for different cropping systems by Karg (1969), Lagerlöf & Andrén (1988), Mäder *et al.* (1993) and others. Most of the studies compared different management practices and the use of farmyard manure. Little information is available on the long-term effects of different compost amendment on soil organisms including microflora and mesofauna under organic farming conditions. In Germany there is a controversial debate about the use of biogenic waste compost in organic farming. However, our background

knowledge about the ecosystematical effects is rare. The presented results are based on experiments conducted within a field trial, designed to evaluate the long-term effects of compost application on soil properties. This trial was established in 1986 and is currently in the second crop rotation period.

MATERIAL AND METHODS

The following organically fertilized treatments were compared with a minerally fertilized control treatment *(Mineral F.):* (i) composted farmyard manure *(Farmy. Comp.),* (ii) composted farmyard manure plus hornmeal *(Farmy. Comp. + Org. F.)* and (iii) composted source-separated organic household waste *(Bio. Waste Comp.).* Composts were applied in an amount of 60 Mg fresh matter ha^{-1}, hornmeal application consisted of 0.6 Mg ha^{-1}.

The soil biological activity was measured with the bait-lamina test described by von Törne (1990) and the rate of fluorescein diacetate (FDA) hydrolysis according to Schnürer & Rosswall (1982). The first mentioned method provides an overview of the feeding activity of the soil mesofauna measured by the number of perforated baits. It shows the absolute activity found in a treatment as well as the vertical distribution of the feeding activity. The rate of FDA hydrolysis represents the microbial activity and is correlated with soil respiration (Schnürer & Rosswall, 1982). All plots were sampled four times in 1994.

As bait material in the bait-lamina test, a mixture of cellulose (79%), agar-agar (20%) and glucose (1%) was used. The laminae were inserted into the soil, using a knife to form a slit. One file (16 laminae) was exposed in each of the four field replicates. The time of exposure depended on the overall feeding activity. Laminae were collected when 40 to 50% of the baits of control laminae were perforated. Statistical analysis was done using Kruskal-Wallis H oneway anova. If the results were significant at $p \leq 0.05$, an LSD-test was applied to calculate post-hoc contrasts.

The microbial activity was measured by the rate of fluorescein diacetate hydrolysis. The topsoil (0–10 cm) was collected and freshly analysed at field conditions. An extraction ratio of 1:8 was used and incubation for 20 min at 25°C. Results were analysed by anova and LSD-test.

The population density of collembola and mites was measured in 13 samplings between 1989 and 1992 (Schüler & Pfotzer, 1993) using a modified Kempson extractor. Taxonomical analysis was based on family range (collembola) and orders/suborders (acari). These data were used to compute cluster analysis applying Ward's method and euclidean distances. The results for different treatments of compost application were compared with bait-lamina test and the rate of FDA hydrolysis to determine similarities in the response to fertilization.

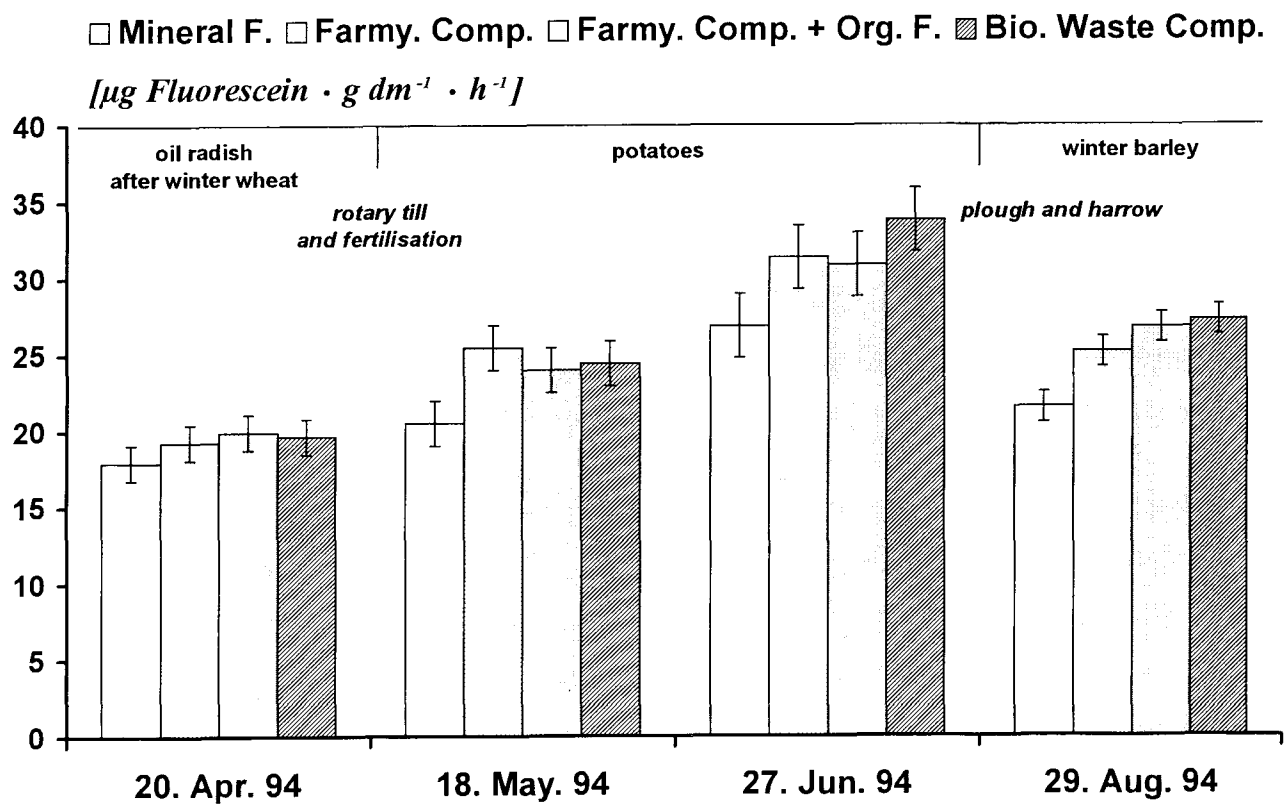

FIGURE 1. Soil microbial activity (rate of FDA-hydrolysis) after compost amendment. Overlapping error bars are not significantly different at the $p \leq 0.05$ level (LSD-Test)

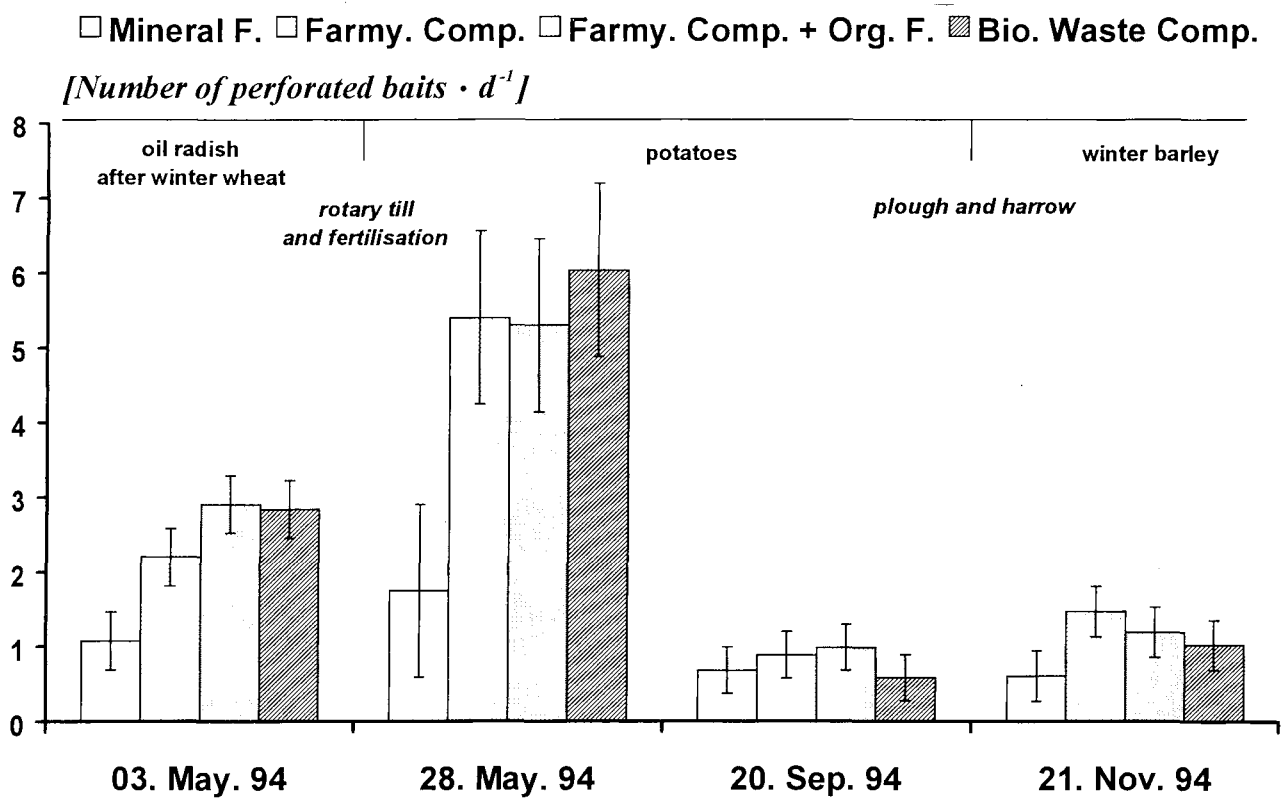

FIGURE 2. Soil faunal feeding activity after compost amendment in the field trial. Overlapping error bars are not significantly different at the $p \leq 0.05$ level (LSD-Test).

RESULTS

The soil microbial activity in the different fertilization treatments is shown in Figure 1. The lowest values were found in April with no significant difference between the fertilization treatments. After soil cultivation, fertilization and potato planting, the FDA activity was significantly higher in the compost application treatments than with mineral fertilization. Highest values were found in plots supplied with biogenic waste compost. Microbial activity was not affected by hornmeal application.

The feeding activity of the soil fauna, mostly microarthropods (Larink & Kratz, 1994), responded to compost amendment in a similar way as microbial activity. Figure 2 shows the results of the bait-lamina tests as activity rate (number of perforated baits day^{-1}) to make results of different sampling periods comparable, since the time of exposure varied in a range from 18 to 72 days (3 May: 35 days, 28 May: 18 days, 20 September: 72 days and 21 November: 32 days). Compost application enhanced the activity significantly compared with the mineral fertilization treatment. The highest activity rates could be found after application of biogenic waste compost in May.

The result of the cluster analysis for all parameters is shown in Figure 3. The strong relation of farmyard manure compost application and hornmeal supplementation is indicated by the shortest distance in the dendrograms. Biogenic waste compost was combined into the same cluster as both farmyard manure compost treatments but varied in a range between 5 (FDA-hydrolysis) and 17 (population density of Collembola) in the rescaled cluster distance. This cluster is markedly differing from the mineral fertilizer cluster in microbial and faunal feeding activity as well as in the abundance of collembola and mites.

DISCUSSION

The results of the bait-lamina test seem to be considerably influenced by climatic conditions and soil cultivation. Summer drought and ploughing before barley sowing reduced the feeding activity significantly. The time of exposure in September (72 days) was too long due to summer drought and must be regarded as not being representative. In this case perforation of the laminae also could have been caused by microbial decomposition as well as by physical effects like wetting and drying. The feeding activity typically decreases with soil depth (von Törne, 1990). This was not the case when potatoes were grown, since dam cultivation probably disturbs vertical population distribution of the soil fauna and hence the activity distribution pattern. The different fertilization treatments did not influence these activity patterns.

The cluster analysis for the rate of FDA hydrolysis, the bait-lamina test and the population densities of collembola and mites showed a matching pattern for

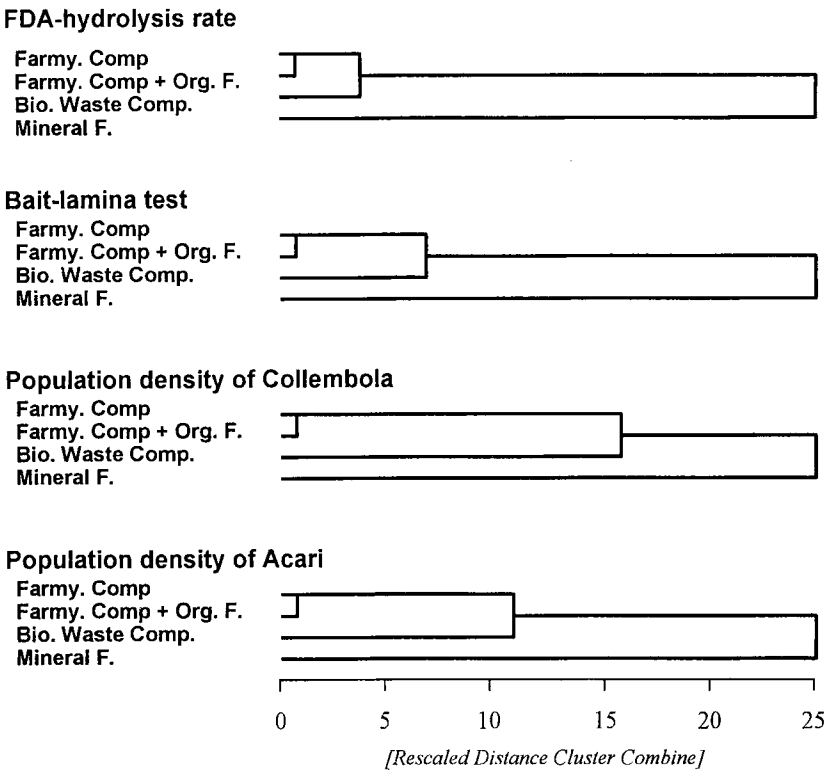

FIGURE 3. Dendrograms of cluster analysis for microbial activity (FDA-hydrolysis rate), faunal feeding activity (bait-lamina test) and abundance of Collembola and Acari.

the various treatments and measurements. This result leads to the conclusion that compost amendment has a comparable impact on the microbial as well as on the faunal activity in the soil. With regard to the mineral fertilization treatment, the application of compost accelerates the biological activity in the soil.

The similar effects on population density of collembola and mites as well as on microbial and faunal activity further supports the theory of a positive correlation between microbial biomass and abundance of the soil mesofauna in terms of a food chain as described by Anderson & Ineson (1984).

ACKNOWLEDGMENTS

This project is supported by the Deutsche Forschungsgemeinschaft (DFG). The long-term field trial was funded by the Hessisches Ministerium für Wissenschaft und Kunst.

References

Anderson, J.M. & Ineson, P. (1984). Interactions between microorganisms and soil invertebrates in nutrient flux pathways of forest ecosystems. In *Invertebrate-Microbial Interactions* (J.M. Anderson, H.D.M. Rayner & D.W. Walton, eds.), pp. 65–88. British Mycological Society, British Ecological Society, Cambridge University Press; Cambridge.

Karg, W. (1969). Der Einfluß verschiedener Fruchtfolgen, insbesondere mit mehrjährigem Kleegras, auf schädliche und nützliche Mikroarthropoden im Boden. *Archiv für Pflanzenschutz*, **5**, 347–371.

Lagerlöf, J. & Andrén, O. (1988). Abundance and activity of soil mites (Acari) in four cropping systems. *Pedobiologia*, **32**, 129–145.

Larink, O. & Kratz, W. (1994). Ködderstreifen-Workshop in Braunschweig—ein Resümee. *Braunschweiger naturkundliche Schriften*, **4**, 647–651.

Mäder, P., Pfiffner, L., Jäggi, W., Wiemken, A., Niggli, U. & Besson, J.-M. (1993). DOK-Versuch: Vergleichende Langzeit-Untersuchungen in den drei Anbausystemen biologisch Dynamisch, Organisch-biologisch und Konventionell. III. Boden: Mikrobiologische Untersuchungen. *Schweizerische Landwirtschaftliche Forschung*, **32**, 509–545.

Schnürer, J. & Rosswall, T. (1982). Fluorescein diacetate hydrolysis as measure of total microbial activity in soil and litter. *Applied Environmental Microbiology*, **43**, 1256–1261.

Schüler, C. & Pfotzer, G.H. (1993). Zur Populationsentwicklung der Collembolen- und Milbenfauna eines Ackerbodens unter dem Einfluß verschiedener Kompostdüngung. *VDLUFA Schriftenreihe*, **37**, 473–476.

Törne, E. von (1990). Assessing feeding activities of soil-living animals. I. Bait-lamina-tests. *Pedobiologia*, **34**, 89–101.