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ORIGINAL PAPER

Soil fauna and organic amendment interactions affect soil carbon and crop performance in semi-arid West Africa

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Abstract A field experiment was conducted at Kaibo in southern Burkina Faso on an Eutric Cambisol during the 2000 rainy season to assess the interaction of organic amendment quality and soil fauna, affecting soil organic carbon and sorghum (*Sorghum bicolor* L. Moench) performance. Plots were treated with the pesticides Dursban and Endosulfan to exclude soil fauna or left untreated. Sub-treatments consisted of surface-placed maize straw (C/N ratio=58), *Andropogon* straw (C/N ratio=153), cattle dung (C/N ratio=40), sheep dung (C/N ratio=17) or compost (C/N ratio=10) and the control. Organic amendments were applied at a dose equivalent to the application of 40 kg N ha^{-1}. The presence of soil fauna increased soil total carbon by 32% and grain yield production by 50%. The interaction between high C/N ratio organic amendment, *Andropogon* straw (SA), and soil fauna reduced soil carbon build-up. We suggest that this is due to a priming effect of SA on soil organic matter in the presence of soil fauna. We also suggest that the interaction between soil fauna and easily decomposable organic amendment led to the smallest decrease in soil carbon build-up. It is concluded that in semi-arid West Africa, in the presence of soil fauna, soil carbon build-up is more affected by the quality of organic amendments than the quantity of carbon inputs. Sorghum grain yield production was significantly reduced in the absence of soil fauna. High C/N ratio organic amendment interacted negatively with soil fauna in its effects on crop performance. We propose that the effect of soil fauna on soil carbon build-up and crop performance can be optimised by using high quality organic matter or supplementing low-quality organic matter with inorganic nitrogen in semi-arid West Africa.

Keywords Crop production · Organic amendments · Soil fauna · Priming effect · Soil carbon · West Africa

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Introduction

It has become increasingly recognised that soil fauna have a significant role in soil processes affecting soil carbon dynamics, nutrient availability and primary production (Brussaard and Juma 1996; Mando 1998; Brussaard 1999; Lavelle et al. 1999). While fungi and bacteria are responsible for the major chemical transformations during the decomposition of organic amendments, soil fauna plays a key role in comminution (physical breakdown; Ouédraogo et al. 2004) and catabolism and significantly affect soil physical properties (Swift et al. 1979; Tian et al. 1997; Mando et al. 1996).

Indeed, it is well known that plant litter is colonised by saprophytic microorganisms whose degradation of plant structural polysaccharides is an essential prelude to feeding by soil invertebrates. Invertebrate faeces and litter fragments are incorporated into the soil where further microbial action results in the formation of humus (Collins 1981).

Various soil fauna have important direct effects on soil properties by being able to dig into, ingest and/or transport soil materials. They affect the dynamics of soil organic matter through the effects of the structures that they create (mounds, casts, burrows, etc.) or from their impact on the population dynamics of other decomposer biota (Ouédraogo et al. 2006a).

Ouédraogo et al. (2004) showed that in the savannah ecosystem of Kaibo (Burkina Faso), up to 99 % of recalcitrant organic amendment remained undecomposed 3 months after their application against only less than 20% when soil fauna are not excluded. An assessment of the composition of soil macrofauna in the study site showed that numerically, the soil macrofauna mainly consisted of termites (78%), ants, Coleoptera, Myriapoda, Arachnida, Dermaptera and earthworms. What is less clear is how these soil fauna and organic amendment quality interact in their effects on the incorporation of organic matter into soil and nutrient release for crop production. The hypothesis tested in this paper is that soil carbon and crop performance will be reduced in the absence of soil fauna. We also hypothesised that soil carbon build-up in the presence of soil fauna is more affected by the quality of organic amendments than the quantity of carbon inputs.

Table 1 Characteristics of the top soil (0–10 cm; Eutric Cambisol, Kaibo, southern Burkina Faso)

Parameters	Values
Clay (%)	15±2
Silt (%)	33±4
Sand (%)	51±5
Carbon (%)	0.83±0.14
Nitrogen (%)	0.05±0.01
Phosphorus (%)	0.017±0.003
Potassium (%)	0.063±0.012
Exchangeable calcium (cmol kg^{-1})	5.0±1.0
Exchangeable magnesium (cmol kg^{-1})	1.4±0.3
Exchangeable potassium (cmol kg^{-1})	0.2±0.06
Exchangeable sodium (cmol kg^{-1})	0.1±0.02
pH (H_2O)	7.0±0.4
pH (KCl)	5.3±0.4

± Standard deviation

Materials and methods

Site description

The study was conducted in 2000 at Kaibo (11–12°N) in southern Burkina Faso, located in the north Soudanian climatic zone with a mean temperature of 28°C. Annual rainfall ranges from 750 to 1,000 mm with an average rainfall of 935 mm. The cropping season lasts from June to October. Leptosols, Vertisols, Fluvisols, Regosols, Luvisols, Lixisols and Cambisols are the most dominant soil types (BUNASOL 1989; Mulders and Zerbo 1997). The experiment was laid out on an Eutric Cambisol. The top soil (0–10 cm) characteristics are shown in Table 1. Nutrient depletion and water erosion are the main land degradation forms.

Experimental design

A split plot design with four replications was laid out before the 2000 rainy season. The site was previously under fallow for 6 years. The main treatment was the use of insecticides to establish plots without fauna (treated) next to plots with fauna (non-treated). Dursban with chloropyrifos (organophosphate termiticide and insecticide) as active ingredient (480 g per litre of commercial product) applied at the rate of 400 g a.i ha^{-1} and Endocoton with endosulfan (organochlorine insecticide and acaricide) as active ingredient (500 g per litre of commercial product) and applied at the rate of 450 g a.i ha^{-1} were applied four times (just before the set up of the experiment and 3, 6 and 10 weeks after the organic amendment application and sowing). Assessment of the impact of pesticides on soil macrofauna has been done by Ouédraogo et al. (2004) using the litterbag technique. The results showed that termite, earthworm, ant, Coleoptera and Myriapoda are the main soil fauna groups and were reduced respectively by 99.6, 100, and 96.3, 83 and 82 % compared to the untreated plots. The impact of applied pesticides on non-targeted soil organisms such as soil microorganisms and the incidence of additive products to the active ingredient have been the concern of the experimental design. Although data on the impact of organochlorine and organophosphate on soil microorganisms are scarce in semi-arid West Africa, as studies are mainly focussed on the capacity of soil microorganisms to degrade pesticides in soil, recent data collected by Coulibaly (2006) from experiments done at Kaïbo on a Eutric Cambisol using incubation techniques showed that pesticide such as commercial endosulfan applied at an equivalent dose of 2,400 g a.i ha^{-1} soil have no significant impact on soil microbial activities. The doses applied in our study were five times lower than those applied by Coulibaly (2006).

The plots were 24×20 m in size and 10 m apart. Subtreatments consisted of addition of maize straw (SM), *Andropogon* straw (SA), cattle dung (CD), sheep dung (SD) or compost (CO). Therefore, in this paper, "treated and non-treated" will refer to the main treatment and "amendment" will refer to sub-treatments. The size of sub-plots was 10×5 m separated by guard rows of 2.5×2 m. The blocks were separated by an alley of 4 m. All organic amendments were applied at the same time before sowing at doses equivalent to the application of 40 kg N ha^{-1}. The chemical properties of organic amendments applied are shown in Table 2.

Crop and soil management

The plots were tilled manually to minimise soil disturbance that can affect the activities of soil fauna. Sorghum SARIASO14 variety (*Sorghum bicolor* L. Moench) was used as plant material and sown at the rate of 31,250 seeds ha^{-1} on 25 July. During the growing season, the field was weeded twice using hoes. Crop was harvested 4 months after sowing.

Sampling and analysis

Soil samples (0–10 cm) were taken at flowering 2 months after organic amendment application and at harvest to measure soil total carbon and nitrogen concentration. Three samples were taken in each plot and mixed to make one composite sample. Soil carbon was determined using the Walkley–Black method. Total and mineral nitrogen were measured by colorometry after digestion (Kjeldhal; Houba et al. 1989). Sorghum dry matter and grain yield data were obtained by sun drying and weighing with an electronic balance. To take into account the impact of soil fauna on soil physical properties, soil data have been expressed in g dm^{-3}.

The experimental design allows simple calculation on the different factors' impact on soil carbon build-up.

The effect of organic amendment and soil fauna on soil carbon concentration in non-treated plots in amendment (i) was calculated as:

$$\Delta C_{\mathrm{NT(i)}} = \mathrm{Ai} + \mathrm{Bj} + \mathrm{Eij} \quad (1)$$

where Ai is the effect of organic amendment, Bj is the effect of soil fauna and Eij is the interaction between organic amendment and soil fauna.

Organic amendment contribution to soil carbon build-up (Ai) is calculated as the difference between soil carbon concentration in treated plots in the amendment (i) ($C_{\mathrm{T(i)}}$) minus soil carbon concentration in the treated plots in the control ($C_{\mathrm{T\ control}}$).

$$\mathrm{Ai} = C_{\mathrm{T}(i)} - C_{\mathrm{T\ control}} \quad (2)$$

Soil fauna contribution to soil carbon build-up (Bj) is calculated as the difference between soil carbon concentration in the non-treated plots in the control ($C_{\mathrm{NT\ control}}$) minus soil carbon in treated plots in the control ($C_{\mathrm{T\ control}}$).

$$\mathrm{Bj} = C_{\mathrm{NT\ control}} - C_{\mathrm{T\ control}} \quad (3)$$

$\Delta C_{\mathrm{NT(i)}}$ can also be calculated as soil carbon concentration in non-treated plots in the amendment (i) ($C_{\mathrm{NT(i)}}$) minus soil carbon concentration in treated plots in the control ($C_{\mathrm{T\ control}}$).

$$\Delta C_{\mathrm{NT\ (i)}} = C_{\mathrm{NT\ (i)}} - C_{\mathrm{T\ control}} \quad (4)$$

Replacing $\Delta C_{\mathrm{NT(i)}}$, Ai, Bj, by their respective value from Eqs. 2, 3 and 4 in Eq. 1 yields interaction effects (Eij), which finally is equal to the difference in soil carbon concentration in the amendment (i) between non-treated and treated plots ($C_{\mathrm{NT(i)}} - C_{\mathrm{T(i)}}$) minus the difference in soil carbon concentration in the control between non-treated and treated plots ($C_{\mathrm{NT\ control}} - C_{\mathrm{T\ control}}$).

$$\mathrm{Eij} = \left(C_{\mathrm{NT\ (i)}} - C_{\mathrm{T\ (i)}}\right) - \left(C_{\mathrm{NT\ control}} - C_{\mathrm{T\ control}}\right) \quad (5)$$

The same formula was applied to soil nitrogen and crop performance data.

All data were subjected to ANOVA using Genstat software.

Results

Soil carbon concentration

Two months after sowing, soil carbon concentration was significantly higher in non-treated than treated plots in the CO, whereas in SA, soil carbon concentration was significantly higher in treated plots than non-treated plots

Table 2 Chemical properties and application rate of organic amendments

Organic amendments	*Andropogon* straw	Cattle dung	Maize straw	Compost	Sheep dung
Total quantity (kg ha^{-1})	12,500	4,211	5,195	4,819	2,614
Carbon (C) (kg ha^{-1})	6,125	1,600	2,343	415	659
Nitrogen (N) (kg ha^{-1})	40	40	40	40	40
Phosphorus (P) (%)	0.03	1.06	0.18	0.18	0.33
Potassium (K) (%)	0.24	0.36	1.20	0.73	1.20
Lignin (L) (%)	0.13	0.49	0.16	0.91	0.16
C/N Ratio	153	40	59	10	17
L/N Ratio	0.4	0.5	0.2	1.1	0.1

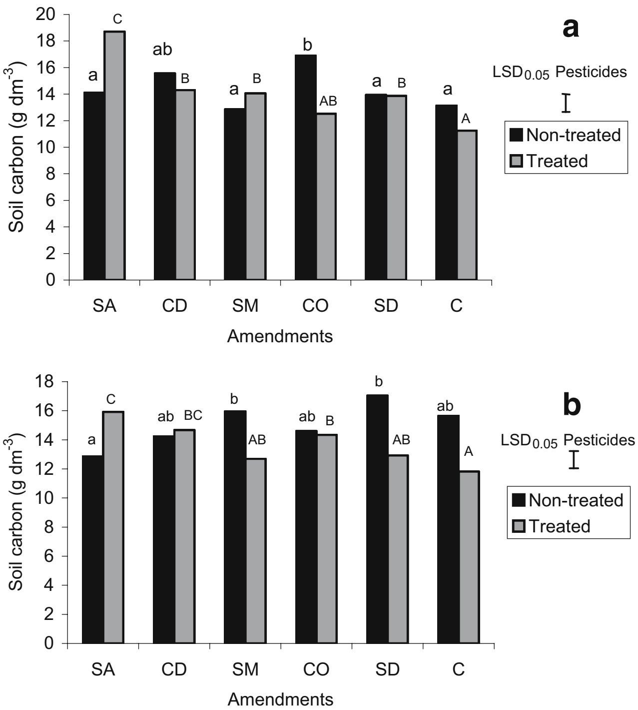

Fig. 1 Soil carbon concentration at 2 months after sowing (**a**) and at harvest (**b**) in 2000 at Kaibo, Burkina Faso. *LSD0.05* Least significant difference at a level of 5%. *Lower case* compares amendments in non-treated plots and *upper case* amendments in treated plots. *SA Andropogon* straw, *CD* cattle dung, *SM* maize straw, *CO* compost, *SD* sheep dung, *C* control

(Fig. 1a). No significant differences were noted between non-treated and treated plots in the other amendments. In the non-treated plots, soil carbon concentration was significantly higher in CO than other amendments but did not differ significantly from CD. No significant differences were observed among the other amendments. In the treated plots, the lowest soil carbon concentration was noted in the control, significantly different from SA, SD, SM and CD but not from CO. The highest soil carbon concentration was noted in SA, significantly different from other amendments.

At harvest, soil carbon concentration was significantly higher in non-treated plots than treated plots in SM, SD and the control plots, whereas it was higher in treated plots than in non-treated plots in SA (Fig. 1b). In the non-treated plots, the highest soil carbon concentrations were observed in SD and SM, but they did not differ significantly from CO, CD and the control. No significant differences were observed among the other amendments. In treated plots, soil carbon concentration was the lowest in the control, significantly different from CO, CD and SA but not from SD and SM. The highest soil carbon concentration was observed in SA, but it did not significantly differ from CD and CO. In the non-treated plots, soil carbon increased from 2 months to harvest in the control, SD and SM, whereas it decreased in CO. ANOVA shows that pesticides ($P<0.05$) and organic amendment ($P<0.05$) had a significant impact on soil carbon concentration (Table 3). Organic amendment and pesticides also interacted significantly in their effects on soil carbon concentration ($P<0.01$).

Organic amendment, soil fauna and their interaction effects on soil carbon concentration

Figure 2a shows soil carbon change due to soil fauna, organic amendment and their interactions 2 months after sowing. Soil fauna contributed positively to soil carbon build-up by an average of 1.82 g dm^{-3}. Organic amendment contributed positively to soil carbon build-up and was significantly higher in SA than CO. Other organic amendments did not significantly contribute to soil carbon build-up. Except in CO, the interaction between soil fauna and organic amendment reduced soil carbon build-up with the highest negative impact in SA, which differ significantly from CD and CO but not from SM and SD.

At harvest, the contribution of soil fauna was on average +3.82 g dm^{-3}. No significant differences were observed between the contributions of the different organic amendments. The interaction between organic amendment and soil fauna led to a significant decrease in soil carbon concentration in SA and CD compared to SM and SD but not compared to CO (Fig. 2b).

Soil total nitrogen concentration

Two months after sowing, in non-treated plots, soil total nitrogen concentration was significantly higher in CO than in the other amendments except CD (Fig. 3a). In treated

Table 3 Probability of effects of pesticides, organic amendments and sampling period on soil carbon, nitrogen and crop performance

Source of variation	Soil carbon	Total N	Grain yield	Straw yield	Harvest index
Pesticide	0.025	0.065	<0.001	0.794	<0.001
Organic amendment	0.002	0.032	0.012	0.006	0.016
Sampling period	0.691	<0.001	–	–	–
Pesticide x organic amendment	<0.001	0.851	0.003	0.016	0.009
Pesticide x sampling period	0.190	0.001	–	–	–
Organic amendment x sampling period	0.072	0.088	–	–	–
Pesticide x organic amendment x sampling period	<0.001	0.992	–	–	–

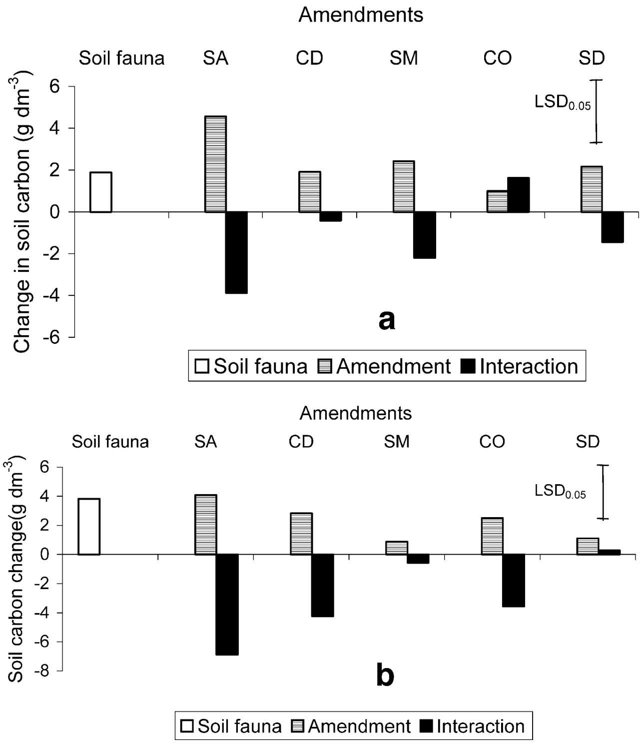

Fig. 2 Change in soil carbon due to soil fauna, organic resource and their interactions at 2 months after sowing (**a**) and at harvest (**b**) in 2000, at Kaibo Burkina Faso. *LSD0.05* Least significant difference between amendments at a level of 5%. *SA Andropogon* straw, *CD* cattle dung, *SM* maize straw, *CO* compost, *SD* sheep dung, *C* control

plots, soil total nitrogen was significantly higher in SA than the other amendments except CO.

At harvest, in non-treated plots, soil total nitrogen concentration was higher in CD and significantly different from the other amendments (Fig. 3b). No significant differences were observed among the other amendments. In the treated plots, the highest soil total nitrogen concentration was noted in CD with a significant difference from all other amendments. In non-treated plots, soil total N concentration was in general higher at harvest than at 2 months after sowing, whereas in treated plots, the trend was a decrease in soil total N concentration from 2 months after sowing to harvest. The sampling period significantly affected total N ($P<0.001$), while the interaction between pesticide and sampling period ($P=0.001$) also was significant (Table 3).

Soil fauna, organic amendment and their interactions affecting soil total N concentration

At 2 months after sowing, soil fauna had decreased soil total N concentration (Fig. 4a). Organic amendment contribution was the lowest in CD, SM and SD and different from SA but not from CO. The interaction between soil fauna and organic amendment was positive in all amendments except in SA.

In contrast to the sampling date 2 months after sowing, soil fauna had increased soil total N concentration at harvest (Fig. 4b). Organic amendment had also increased soil total N concentration and was the highest in CD, but it did not significantly differ from other amendments. The interaction between soil fauna and organic amendment decreased soil total N in CO, but no significant differences were noted compared to other amendments.

Crop performance

Sorghum grain yield was higher in treated plots compared to non-treated plots in SA and CD, but the difference was only significant in SA (Fig. 5a). In the non-treated plots, sorghum grain yield was significantly higher in CO, SD, SM and the control than in the other amendments. CD sorghum grain yield was significantly higher than any other amendments in treated plots. No significant differences were observed among the other amendments in treated plots.

In the non-treated plots, the highest sorghum straw yield was observed in SA and SM, significantly different from CD but not from CO, SD and the control (Fig. 5b). In the treated plots, sorghum straw yield was the highest in SM

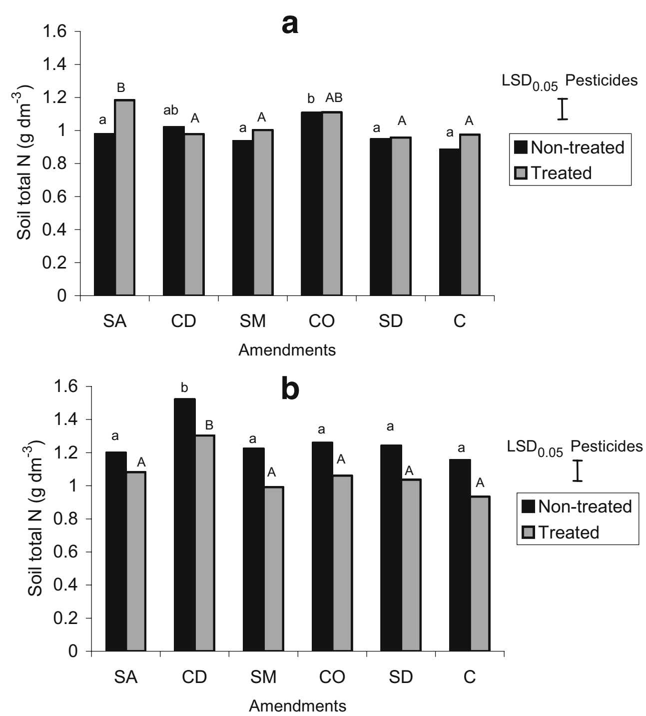

Fig. 3 Soil total nitrogen concentration at 2 months after sowing (**a**) and at harvest (**b**) in 2000 at Kaibo, Burkina Faso. *Lower case* compares amendments in non-treated plots and *upper case* amendments in treated plots. *LSD0.05* Least significant difference at a level of 5%. *SA Andropogon* straw, *CD* cattle dung, *SM* maize straw, *CO* compost, *SD* sheep dung, *C* control

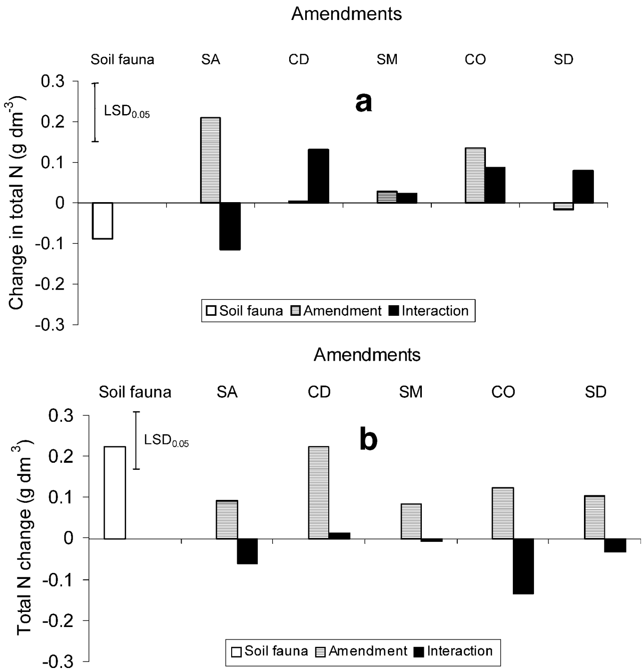

Fig. 4 Change in soil total N due to soil fauna, organic resource and their interactions at 2 months after sowing (**a**) and at harvest (**b**) in 2000, at Kaibo Burkina Faso. *LSD0.05* Least significant difference at a level of 5%. *SA Andropogon* straw, *CD* cattle dung, *SM* maize straw, *CO* compost, *SD* sheep dung, *C* control

with significant differences compared to other amendments except SA. No significant differences were observed among the other amendments.

The harvest index (grain yield/straw yield ratio) was significantly higher in non-treated plots compared to treated plots except in SA and CD where the harvest index was significantly higher in non-treated plots compared to treated plots (Fig. 5c). In the non-treated plots, sorghum harvest index was significantly higher in CO and SD than SA, CD and SM but did not differ from the control. The lowest harvest index was measured in SA. In treated plots the highest harvest index was noted in CD, which differed significantly from the other amendments. No significant differences were observed among the other amendments in treated plots.

Sorghum grain yield change due to soil fauna was about +400 kg ha^{-1} (Fig. 6a). The highest grain yield change due to organic amendment was noted in CD, but it did not significantly differ from other amendments. Soil fauna and organic amendment interaction significantly reduced crop production in SA and CD. The change in the harvest index (Fig. 6b) due to interaction between soil fauna and organic amendment followed the same trend as for grain yield. Change in harvest index due to organic amendment was significantly higher in CD than other amendments but did not differ from the change due to soil fauna. Organic amendment, pesticides and their interaction significantly affected sorghum grain yield ($P<0.01$). Organic amendment and pesticides also interacted in their effect on sorghum straw yield (Table 3).

Discussion

Soil fauna, organic amendment quality and soil carbon concentration

The average contribution of soil fauna to soil carbon build-up was 3.82 g dm^{-3} at harvest which account for about 32% of soil total carbon concentration. This may be attributed to an enhanced root production in the presence of soil fauna (as soil carbon concentration increased within 2 months to

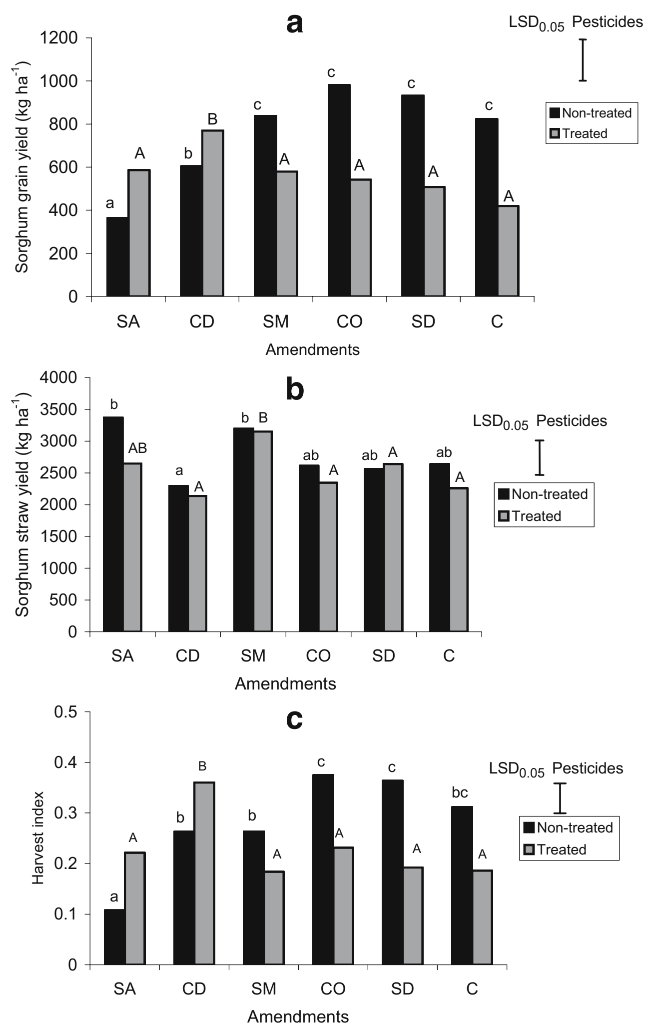

Fig. 5 Sorghum grain yield (**a**), straw yield (**b**) and harvest index (**c**) in 2000 at Kaibo, Burkina Faso. *Lower cases* compare amendments in non-treated plots and *upper case* amendments in treated plots. *LSD0.05* Least significant difference at a level of 5%. *SA Andropogon* straw, *CD* cattle dung, *SM* maize straw, *CO* compost, *SD* sheep dung, *C* control

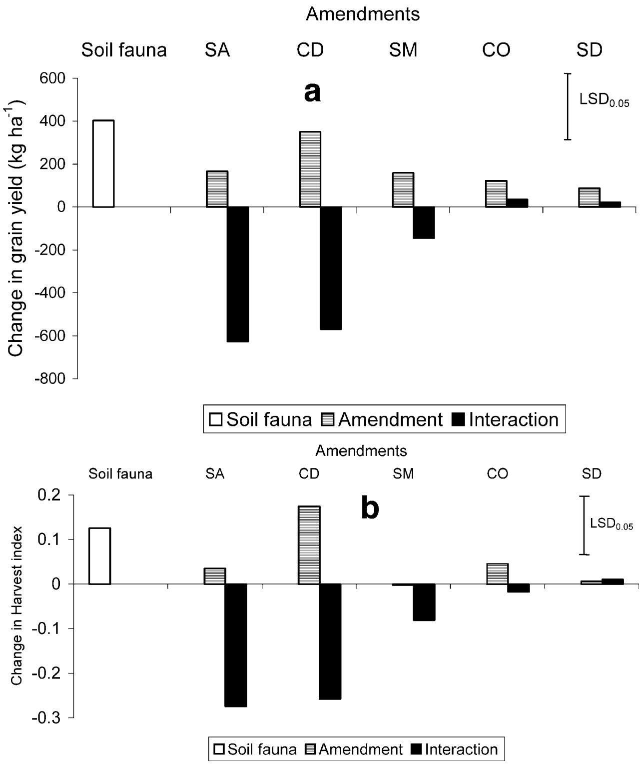

Fig. 6 Change in grain yield production (**a**) and harvest index (**b**) due to soil fauna, organic resource and their interactions in 2000, at Kaibo Burkina Faso. *LSD0.05* Least significant difference at a level of 5%. *SA Andropogon* straw, *CD* cattle dung, *SM* maize straw, *CO* compost, *SD* sheep dung, *C* control

harvest), likely due to an improved soil physical properties (Ouédraogo et al. 2006a). Moreover, many studies report that the excrements dejected by soil fauna are remarkably higher in soil organic matter concentration than the surrounding soil (Lavelle et al. 1994; Henrot and Brussaard 1997). Brussaard and Juma (1996) summarised the role of soil fauna in soil organic matter build-up as the result of (1) comminution of plant residues, (2) coarse mixing of plant residues and (3) fine mixing of organic and mineral particles.

The results showed that soil carbon concentration at harvest was lowest in SA and did not significantly differ from the control. It may be hypothesised that compared to other amendments, it takes time for the comminuted *Andropogon* straw to be incorporated into soil organic matter. However, previous study showed that at harvest, less than 5% of *Andropogon* straw remained undecomposed (Ouédraogo et al. 2004). Moreover, soil carbon concentration measured in the next year (2001) was not significantly different from the control plot (data not shown). Furthermore, the interaction between *Andropogon* straw and soil fauna has led to decreased soil carbon. We suggest that stimulation of microbial activity by soil fauna as demonstrated by Brussaard and Juma (1996) and Bardgett et al. (1998) will enhance priming effect on SOC, which will be higher, the lower the quality of the organic amendment because of N unavailability. Indeed, Brussaard and Juma (1996) indicated that soil fauna contribution to soil carbon build-up relies on its role in stimulating microbial activity, inoculation of microbes to organic substrates in the litter or in the animal gut. Furthermore, Bardgett et al. (1998) demonstrated that the presence of soil fauna significantly increased soil microbial biomass in a microcosm experiment. Field experiment indicated that the presence of soil fauna may increase soil microbial biomass by 62% (Bardgett and Chan 1999). Nutrient-rich casts produced by earthworms induce high densities of microbial populations compared to surrounding soil (Cortez and Bouche 1998; Lavelle et al. 1999).

Moreover, the results showed that in the presence of soil fauna, the application of 6,125 kg C ha^{-1} trough *Andropogon* straw reduced soil carbon concentration than the application of 659 kg C ha^{-1} through sheep dung, which tended to increased soil carbon concentration. This confirms the hypothesis that in semi-arid West Africa, soil carbon build-up is more affected by the quality of organic amendments than the quantity of carbon inputs (Ouédraogo et al. 2006b).

In addition, Tian et al. (1997) reported also that the effect of mulching on the microclimate contribute to enhance the decomposition of low quality mulches. They showed that a combination of lower temperature and higher moisture (typical under low quality mulch) resulted in more rapid decomposition of the material, which in the case of our study, may have contributed to enhance the priming effect not observed with the use of high quality amendment (sheep dung). This implies that the incorporation of the comminuted organic amendment by soil fauna into soil organic matter may be directly or indirectly affected by its quality.

The higher positive change in soil carbon in SA in the absence of soil fauna may be interpreted either by an increase in soil carbon or a reduced soil carbon mineralisation in the absence of soil fauna. However, close comparison between soil carbon in SA and at the beginning of the experiment showed no significant difference (16.2 g dm^{-3}). This suggests that low stimulation of soil microorganisms occurred in the absence of soil fauna reducing the priming effect after the incorporation of low quality organic amendments. This area needs more investigations.

Therefore, we propose that the effect of soil fauna on soil carbon concentration can be optimised by using high quality organic amendment or supplementing low quality organic matter with inorganic nitrogen. Moreover, in the traditional application of mulch, organic amendments are applied 2 or 3 months before sowing and likely aims to reduce the priming effect due to low quality organic amendment application.

Effects of interactions between organic amendment and soil fauna on crop performance

The presence of soil fauna at the end of the trial accounted for almost 50% of the mean grain yield production and positively contributed to efficient nutrient utilisation by the crop (positive contribution to harvest index). This may be due to the positive impact of soil fauna on nutrient release and soil physical properties (Ouédraogo et al. 2006a). In the semi-arid area, soil fauna continuously open voids and thus counteract the destruction of voids, which significantly improved soil water availability to the crop (Mando and Miedema 1997).

In the treated plots, the lowest grain yield and harvest index in SM, CO, SD and the control indicates that nutrients were not efficiently used. A possible decrease in soil microbial activity in the absence of soil fauna may have reduced nutrient use by crop and enhanced nutrient losses from easily decomposable organic amendment. The negative effect of the interaction between soil fauna and low quality organic amendment (SA, CD) suggests that the optimisation of soil carbon build-up and crop production with the application of high C/N ratio organic amendment requires addition of inorganic nitrogen. Low CD quality in this study may be due to the fact that dungs were collected at the end of the dry season, a period where forage is scarce with low quality, and only high lignified forage remained in the pastures.

In SA, the negative effect of the interaction with soil fauna was not compensated with high grain yield production but with high straw production, which induced a lowest harvest index indicating low nutrient utilisation efficiency. This implies that temporal nitrogen immobilisation has occurred leading to a reduced crop performance.

Conclusions

The main conclusions of this study are:

1. Soil fauna enhance soil carbon build-up (+32%), and the improvement of crop performance may be up to +50% in low-input agricultural systems in semi-arid West Africa.
2. High C/N ratio organic amendment and soil fauna interact negatively in their effects on soil carbon build-up, whereas in the absence of soil fauna, soil carbon mineralisation was reduced.
3. Crop performance was significantly reduced in the absence of soil fauna, and high C/N ratio organic amendment and soil fauna interact negatively in their effect on crop performance. We propose that the effect of soil fauna on soil carbon concentration can be optimised by using high quality organic amendment or supplementing low quality organic matter with inorganic nitrogen in semi-arid West Africa.
4. Further investigations are needed to highlight the direct impact of soil fauna-microbial interactions in semi-arid West Africa conditions.

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