Effect of pesticides and organic amendments on soil macrofauna and microbial respiration activities under rainfed tomato (*Solanum lycopersicum Linnaeus*).

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Introduction

In Africa, pesticide use accounts for 2–4% of the global pesticide (Agrow, 2006).Various active ingredients like organophosphates, carbamates, pyrethroids and organochlorins are commonly used in urban vegetable production (Cissé et al., 2002). In Burkina Faso, approximately one hundred active ingredients are used (Toé, 2003) and around 75% of these active ingredients are insecticides, acaricides or nematicides (Orou Guidou, 1998).
Numerous studies in Africa showed that pesticides are used incorrectly. Those studies revealed that famers use unauthorized or banned products and also inappropriate application and protection materials(Gomgnimbou et al., 2009); (Matthews et al., 2003). Inappropriate use of pesticides negatively impact on environment (Ahouangninou et al., 2011; Kishi, 2005).
The persistence of endosulfan, profenofos and others organo-chlorinated pesticides in the cotton fields in Burkina Faso was reported (Savadogo et al., 2006).
Soil amendment with animal manure or crop residues is a common soil management practice in agriculture in sub Saharan in Africa. This practice has beneficial effects on soil nutrient status and stimulate soil biology, particularly in degraded and arid environments (Ouédraogo et al., 2001 ; Ros et al., 2003).Organic amendments also play an important role on the fate of pesticide in soil (Kumar and Singh, 2013). (Savadogo et al., 2008), showed that manure at the rate of 3.33mg/kg of soil increased organochlorin pesticide degradation 1.5 time more than unamended soil from Burkina Faso.
In order to develop a strategy for bioremediation of soil polluted by pesticides, it was necessary to well know the effets of pesticides and organic amendments used by the famers on soil macrofauna.

Material and Methods

Study site

The study were carried out in cultivated (vegetable) fields located in Kamboinsé (12° 28 N; 1° 32 W) in Burkina Faso, West Africa. Soils in this area are mainly silty-sandy and clay-sandy.

Experimental design and layout

To evaluate the effect of pesticides and organic amendment on soil macraofauna and microorganism respiration, we used a factorial design with two main factors that were replicated four times:

1) Type of pesticides with three levels: i) lambdacyhalotrin, and ii) cholpyrifos ethyl iii) control without pesticide. All pesticides were applied at the recommended rate.
2) Type of organic amendment with four levels: i) no amedment application; ii) application of pig manure; iii) application cow manure and iv) application of compost. All organic amendment were apply at the recommended rate of 20t/ ha.

Macrofauna sampling

Monolith sampling of soil macrofauna was done according to the standard TSBF method (Andreson et Igram 2008). Sampling was conducted in May 2013, 8 weeks after crop planting. One soil monolith of 25cm×25cm×30cm depth was randomly excavated in each replicate plot using shovel and hoe. Termite specimens were preserved in 75% alcohol and earthworms in 75% alcohol + 4% formaldehyde before being transported in sealed vials to the laboratory for identification, enumeration (Bignell et al., 2008). Earthworm and termite parameters, including abundance (numbers of individuals per unit area), and taxonomic richness were calculated. Taxonomic richness (S) was calculated as the number of taxa per monolith (Magurran, 1988).

Soil sampling

Composite soil samples from five spots at 0-20 cm were taken from each plot after crop harvest using an auger. Samples were sieved through 2 mm mesh for respiration tests and chemical determinations.

Data analysis

Analysis of variance (ANOVA) was performed using a General Linear Model (GLM) implemented in Genstat Discovery Edition 4 statistical software for Windows. Differences were significant when $p<0.05$ according to Tukey's tests. Multivariate analysis (principal components analysis) was done by XLSTAT version 6.

Results and discussion

Physical and chemicals parameters have been mesure in this study and were pH was 6.18, organic matter (%) 1.259, total carbon (%) 0.730.

Macrofauna diversity and abundance

Organic amendment increased 69, 66% of the density of total macrofauna compared to the control (without organic amendment), the most dominant macrrofauna have been obtain in plots amendment with with pig manure (34% of total density) (fig1).the other group of macrofauna increased with organic amendment (fig2).The lowest density was obtained with the control without organic amendment. Many studies have reported that organic amendment have significant effect on soil total macrofauna density (Cluzeau et al., 2012; Ouédraogo et al., 2004; Traore et al., 2012). (Cluzeau et al., 2012) have showed that pesticide did not have any effect on soil total macrofauna density.

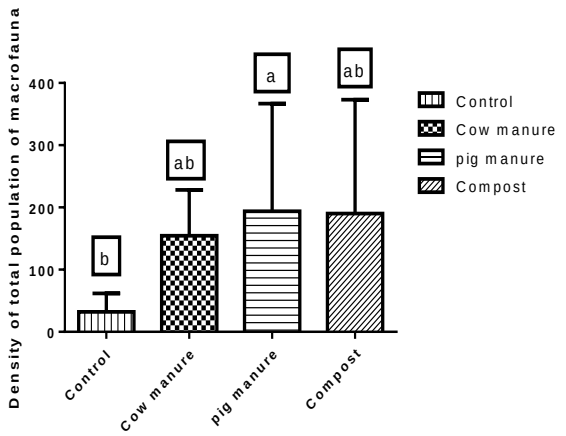

Fig 1. Organic amendment effect on soil total population of macrofauna

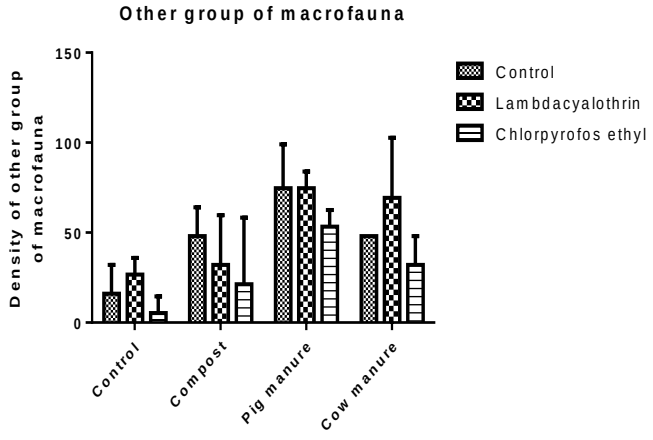

Fig 2. Organic amendment effect on soil other group of macrofauna

density). Furthermore, the pesticide treatment, organic amendment and their interaction had a significant effect (P <0.05) on earthworms density. The population density is zero with Lambdacyhalothrin without organic amendment. In this line, (Curry et al., 2002) reported that pesticide decreased earthworm abundance in soil. Indeed, Tejada et al., (2011) showed that chlorpyrifos-ethyl was adsorbed by soil organic matter, which makes pesticide less toxic. The total termite population was 939 individuals with 2 termites species (Table 1). These are *Odontotermes sp sp* Trinervitermes 1912 and *Holmgren*, Holmgren 1912. The best distribution of termite was obtained with chlorpyrifos ethyl and compost (E = 0.96). The termites were the dominant population represented by 55% of the total population. The *Odontotermes sp*, is the most abundant specie.
Compost has lead to the highest termite population (42% of total individuals / m^2). Howerver the density of termite is zero with lambdacyhalothrin and compost.

Table 1 : Earthworms and termites abundance

M0 : Control without organic amendment M1 :compost M2 : pig manure M3 : cow manure
P0 : Control without pesticide P1 : lambdacyhalotrin P2 : chloporyphos ethyl

Microorganisms respiration

		M0P0	M0P1	M0P2	M1P0	M1P1	M1P2	M2P0	M2P1	M2P2	M3P0	
Eartworm	*Dichogaster affinis*	5±9,23	0±0	5±9,23	21±9,23	37±18,47	5±9,23	5±9,23	11	37±18,47	11±9,23	2
	Millsonia inermis					5	6					
	S	0	0	0	0	0,364	0,689	0	0	0	0	
	E	0	0	0	0	0,52	0,99	0	0	0	0	
Termite	*Odontotermes sp, Trinervitermes sp,*	0	16	21	139	0	155	0	85	213	75	
		0	0				101	0		85	28	
	S	0	0	0	0	0	0,670	0	0	0,357	0,510	0
	E	0	0	0		0	0,96	0		0,515	0	0

The maximum respiration is influenced by organic amendments but pesticides did not have significant effect. Cattle manure decreased significantly the maximum respiration compared to the controls without organic amendment. Statistical analysis showed that the respiratory quotient that there is no significant difference between non-amended soils and amended soils. The lag time and the maximal respiration reflect the change or not of the physiology of the microbial population. The results obtained show that the applied pesticides have an effect on the physiology of soil microorganisms resulting in a long lag time compared to the control. However, chlorpyrifos-ethyl had more depressive effect than lambdacyhalothrin. Martins et al. (2003), Schnurer (2006), Nare et al. (2010) have shown that the lag time increases with pesticides residues and toxicity. This suggests that pesticides are toxic to soil microorganisms but more toxic with chlorpyrifos-ethyl than lambdacyhalothrin. Indeed, Tejada et al. (2011) showed that chlorpyrifos-ethyl reduced dehydrogenase activity which is correlated with the biological activity of the soil microbial population (Garcia et al. 2000).

Table 2: organic amendment effect on Maximale respiration and respiratory quotient

Table 2: organic amendment effect on Maximale time and lag time

Pesticides	Tmax(h)	Lag time (h)
Chlorpyrifos-éthyl	59,33[b] ±8,9	30,33[a] ±1,30
lambdacyhalothrine	59,92[b] ± 8,71	29,25[b] ±4,71
Control	67,25[a] ±6,16	27,50[c] ±3,68

Organic amer

Compos

Cow manure	0,351[b] ±0,041	0,8965[b]±0,11
Pig manure	0,568[a]±0,188	0,9321[b] ±0,07
Control	0,602[a] ±0,030	0,8056[ab]±0,14

Multivariate analysis (principal components analysis)

The first axis was positively correlate with all the parameters (macrofauna total population, termite, earthworms, and microorganisms respiration). The second axis was positively correlated with termite and earthworms and negatively with soil respiration and macrofauna total population. According to individual, M0 and M1 contribute to increased termite population, but M2 and M3 for earthworms, respiration and macrofauna total population.

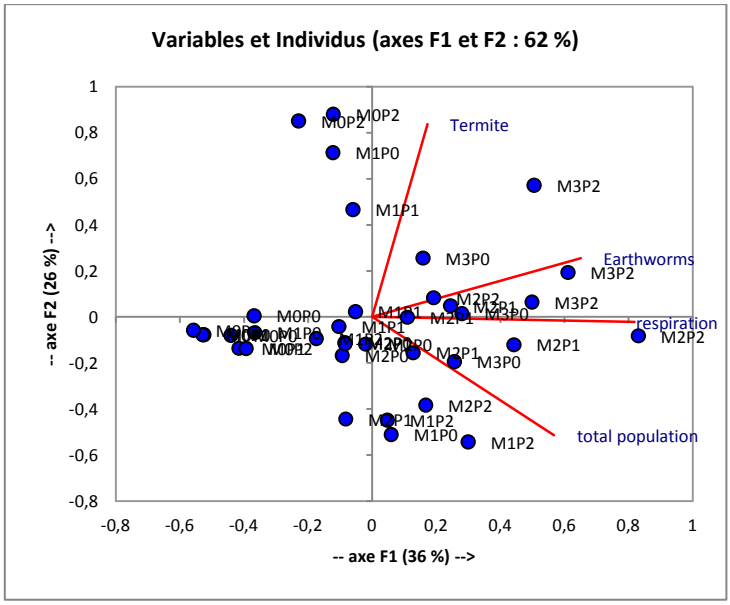

Fig 3: Multivariate analysis (principal components analysis)

Conclusion

In general pesticides used in this study, had no effect on the total density of the soil macrofauna. Organic amendment increased macrofauna population density. Pesticides, organic amendment and their interaction had an effects on soil earthworms and termites. The pesticides had an negative effect on the physiology of soil microorganisms.

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