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Influence of pesticides and alfalfa on soil biological properties

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Abstract—Several biochemical parameters, such as respiration rate (RIP), biomass-C oxygen demand, and ATP reflecting microorganism biomass and activities were determined. All soil samples were incubated at 22℃, 14.5℃ for 60, 192 and 480h, respectively. All these parameters were significantly influenced by the contents of alfalfa w(alfalfa)/w(soil). The differentiation between biomasses of different treatments, 1%, 3% of alfalfa and control were found to be the $P<0.05$, $P<0.01$, respectively. The correlation coefficients between CO_2 rate, biomass-C and ATP were from 0.64 to 0.94. Biomass-C, rate of CO_2, oxygen demand and ATP are shown to be no significant differences for control samples No. 7 and No. 11 with different treatments. Successive applications of the pesticides caused only slight side-effects on the soil microflora under normal field rates and amounts.

Keywords: alfalfa pieces; pesticides; soil microbial biomass.

1 Introduction

Soil microorganisms are playing an important role in regulating nutrient cycling and availability of nutrient in agricultural system (Wardre, 1992). In modern agriculture, however, the use of pesticides has become an integrally and economically essential part. Pesticides are often applied several times during one growing season (Schuster, 1990). Whether successive application of various pesticides can affect the biomass and activity of the soil microorganisms? Microbial biomass and activity were also effected by quality and quantity of organic matter in soil. Jenkinson and Jansson (Jenkinson, 1985; Jansson, 1958) suggested that soil organic matter is provided by plant residues in soil. The objectives of this study was to verity whether successive application of various pesticides can affect the biomass and activity of the soil microorganisms, and to investigate the decomposition of alfalfa in soil treated with pesticides.

2 Materials and methods

2.1 Soil samples

Top soil samples (0—5cm) were collected from a field of Scheyern farm, early of March 1992. The soil was kept in plastic bags and stored at 4℃. Two days before the experiment began

the soil samples were sieved(<2mm), and measured for water content water holding capacity at room temperature. Soil samples were thoroughly mixed and allowed to adapt to laboratory conditions for next week. The sample No. 7 was collected from a plot without pesticides, and soil sample No. 11 was collected from a plot with application of pesticides. Each soil samples was a mixture of soils taken from 10 sampling point of soil. The data of two samples are listed in Table 1.

Table 1 Property of soil samples

Soil No.	Pesti-cides	pH	Total C, %	Total N, %	Density, g/cm³	Clay, %	Silt, %	Sand, %	Capacity of water	Crop 1991
7	Unused	5.72	1.23	0.14	1.5	22	61	16	52.5	wheat
11	used	5.91	1.43	0.157	1.4	21	60	19	54.68	wheat

In our experiment two different amounts of alfalfa (1% and 3% alfalfa pieces of soil weight) were mixed into two soil respectively, before experiment beginning. Each treatments were carried out (control, with pesticides and without pesticides, 1%, 3% of alfalfa pieces) with 4 replications. The samples were incubated at 14.5℃ for measurement of respiration rate for 24, 48, 60, 96, 148, 216, 288, 336, 480h, respectively, and incubated at 22℃ for determination of oxygen demand, ATP and biomass-C. Oxygen demand was measured for a period of 0 to 60 h. ATP was analyzed in 24, 48, 72, 96, 144, 192h, biomass-C was determined after incubation 24, 72, 144, 288, 336, 480h, respectively.

2.2 History of application of pesticides

Pesticides were applied typically for more than 10 years. These included diquat concentration ammonia, cimoxanyl, dithianon, pyrethrods, carbamates organic phosphor, endosulfane and so on.

2.3 Analytical methods

Analytical method of biomass-C was according to Heilmann and Beese(Heilmann, 1992). The amount of carbon in the physiologically-active microbial biomass was determined. It was found that 600 mg glucose/100g soil was needed for biomass-C measurements. This quantity of glucose was thoroughly mixed into the soil, incubation was at 22℃ for a maximum of 4 h. Initially the maximum rate of respiration was determined and the values obtained into the equation.

$$X = 40.04Y + 0.37,$$

where, X is biomass-C[mg/(100g dry wt.)]; Y is CO_2[ml/(100g dry wt.)·h].

Measurement method for respiration rate was by Anderson *et al.* (Anderson, 1978a). Oxygen demand and ATP were measured according to Bai *et al.* (Bai, 1989).

3 Results and discussion

3.1 Biomass-C measurements

The microbial biomass-C in control samples No. 7 and No. 11 were determined to be 49.92 and 40.21 mg/100g dry soil respectively. After 3 days incubation, the biomass-C in control samples No. 7 and No. 11 were 56.4 and 43.81 mg/100g dry soil respectively. A detailed de-

scription is given in Fig. 1.

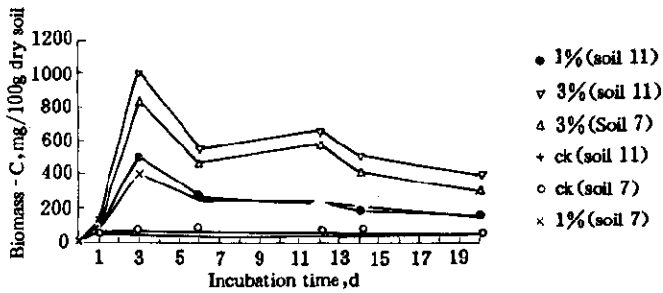

Fig. 1 Dynamics of microbial biomass - C in soil No. 7 and No. 11 with incubation time (day) of different treatment

The biomass - C in both of control samples was similar. The results show that the influence by pesticides were very weak. The biomass - C increased very quickly in soil with alfalfa after 3 days of incubation. Microbial biomass - C was found to increase 359. 4% and 902. 8% for soil No. 7 with 1% and 3% of alfalfa, respectively, to increase 381. 7%, 799. 8% for soil No. 11 with 1% and 3% of alfalfa, respectively.

3. 2 Rate of CO_2 production

Respiration rate of control samples of No. 7 and No. 11 were always much lower than those with alfalfa treatment. After incubation 2. 5 days, CO_2 rate was 0. 07, 4. 07, 14. 94, 0. 07, 4. 7, 13. 96 ml/h. 100g dry soil, in control, 1% and 3% of alfalfa of soil No. 7 and soil No. 11 respectively (Fig. 2). There was a sharp increase up to day 2. 5 and no effects of pesticides on the CO_2 release could be proved.

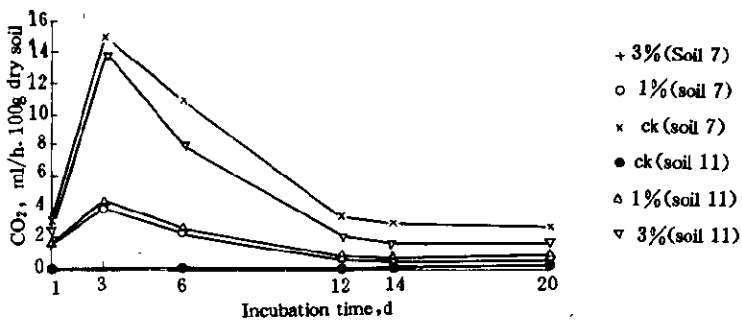

Fig. 2 CO_2 rate in soil No. 7 and No. 11

Oxygen demand was 36. 50, 1146. 75, 3139. 0, 32. 00, 1147. 75, 3115. 25 mg O_2/L in

control, 1%, 3% of alfalfa treatment of soil No. 7 and soil No. 11 respectively. Oxygen demand curves of soil No. 7 and soil No. 11 was always similar with duration of the incubation. Again there was no difference between the soil with and without pesticides.

3.4 Measurement of ATP

No effects of pesticides on the ATP contents in the studied soil were observed. A striking correlation also was found between different contents of alfalfa and ATP contents(Fig. 4).

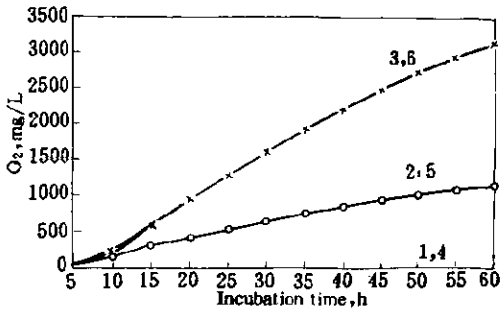

Fig. 3 Oxygen demand in soil No. 7 and No. 11
1:ck(soil 7); 2:1%(soil 7); 3:3%(soil 7);
4:ck(soil 11); 5:1%(soil 11); 6:3%(soil 11)

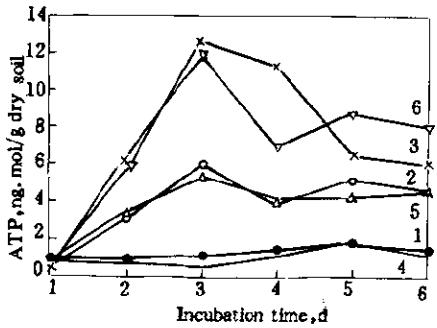

Fig. 4 ATP contents in soil No. 7 and No. 11
1:ck(soil 7); 2:1%(soil 7); 3:3%(soil 7);
4:ck(soil 11); 5:1%(soil 11); 6:3%(soil 11)

The results showed that the concentrations of the ATP were 1.05, 5.82, 12.52 and 0.56, 5.38, 11.68 ng mol/g dry soil in control, 1%, 3% of alfalfa treatment of soil No. 7, No. 11 respectively after 3 days incubation. The ATP values were generally higher in the 3% and 1% of alfalfa treatment than in the control in both soil. The peak value of ATP occured after 3 days, except control, and the peak of ATP was 5 days and ATP was increased much slower for control.

Table 2 Increasements times of microbial biomass with and without alfalfa

Alfalfa, %	Soil No. 7				Soil No. 11			
	Biomass - C	CO_2 rate	ATP	Oxygen demand	Biomass - C	CO_2 rate	ATP	Oxygen demand
0(control)	1	1	1	1	1	1	1	1
1	7.1	58.14	5.54		12.29	67.14	9.61	35.87
3	15	213.43	11.92	86	25	199.43	20.86	97.35

Following addition of alfalfa powder(1%, 3% w/w) to the soil No. 7 and No. 11, there was a very large and rapid increase in the amount of the robial biomass - C. The biomass - C was in-

creased by 7.10, 15.00, 67.14, 199.43 times in 1%, 3% of alfalfa treatment as compared with control in soil No. 7 and No. 11 after 3 days of incubation, respectively. ATP, CO_2 rate, and cumulative values of oxygen uptake were also increased.

A significant difference between 1%, 3% alfalfa treatment and control was observed. The results of biomass - C, CO_2 rate, ATP and oxygen demand are given in detail in Table 3.

Table 3 Differentiation in terms of CO_2 rate, biomass - C, ATP and oxygen demand among the soil with different treatment

				Soil No. 7		Soil No. 11	
	n	P0.05	P0.01	T1	T2	T1	T2
CO_2 rate	10	2.262	3.25	5.12	5.04	4.97	4.3
Biomass - C	6	2.447	3.707	3.08	4.29	3.63	4.2
ATP	6	2.447	3.707	3.42	3.25	4.39	3.94
Oxygen demand	12	2.179	3.055	11.6	5.42	8.68	5.36

Table 3 shows that all of results were $P<0.05$ CO_2 rate and oxygen uptake were $P<0.01$ in 1% of alfalfa of soil No. 7. CO_2 rate, biomass - C, oxygen demand were $P<0.01$ in 3% of alfalfa of soil No. 7. All of results were $P<0.01$ in soil No. 11. The correlation coefficients between CO_2 rate and biomass - C and between CO_2 rate and ATP are given in Table 4.

Table 4 Correlation coefficients(r)

	Soil No. 7			Soil No. 11	
Control	1%	3%	Control	1%	3%
	(Alfalfa)			(Alfalfa)	
A 0.71	0.64	0.74		0.86	0.76
B 0.69	0.79	0.85	0.88	0.89	0.94

Notes: A is between CO_2 rate and biomass - C; B is between CO_2 rate and ATP

Correlation coefficients were 0.64 to 0.94, except the control of soil No. 11. Our present work shows that fungal growth is in abundance after 2—3 days incubation with 1% and 3% of alfalfa treatment. It showed that CO_2 rate, biomass - C, oxygen demand and ATP were increased markedly. In conclusion, microbial biomass was sensitive to different amounts of alfalfa in soil and to the changes occurring during decomposition. The results from these experimental suggested that biomass generally increased with easy decomposable organic matter content in soil, when alfalfa was added in soil, it was easily decomposed and the amendment show introduce CA. 100 mg nitrogen/kg(dry weight). A large proportion of the N required by the rapidly increasing microbial population comes directly from the alfalfa. Some studies have also reported that decomposition rate of plant residues was an important (Constance, 1991; Hendrix, 1986; Swift, 1976; Coleman, 1987) for microbial biomass of soil, and a close relationships between residues

decomposition and microbial abundance(Flanagan, 1981; 1983). In our investigation, influence of pesticides was very slight on the soil microbial biomass, when pesticides were applied into the soil, at normal field application rates. The pesticides were degraded, the microflora always recovery quickly. Therefore, side - effects usually already disappear before the next pesticides treatment being carried out(Schuster, 1990). Furthermore, repeated applications of pesticides, especially identical pesticides can enhance adaptation and degradation of soil microbial. In Dhanaraj's review paper(Dhanaraj, 1988) also concluded when pesticides applied at normal field rates had no adverse effects on nitrifies. Biederberk *et al.* (Biederberk, 1987) observed that 2, 4- D slightly increased carbon mineralization for a short period(2wk).

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