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Influence of the Herbicide Alachlor on Soil Microorganisms and Carbon dioxide Production

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Effect of alachlor, 2-chloro-2', 6'-dimethyl-N (methoxy methyl) acetanilide (1.5, 7.5, 15 and 30 ppm), was studied on the population of different groups of soil microbes. Normal dosage of the chemical (1.5 ppm) does not produce detrimental effects on soil fungi, actinomycetes and bacteria. The toxicant stimulated soil respiration for first 20 days.

Introduction

Application of herbicides has become an efficient method for controlling weeds of crops in recent years (Joshi 1974). However, interaction of herbicides with soil micro-organisms has been overlooked for a long time. Reviews by Bollen (1961) Martin (1963) and Audus (1964) clearly indicate that soil application of herbicides does produce conspicuous fluctuations in the population of soil microbes, particularly at higher concentrations.

This communication reports the results of soil application of alachlor on microbes (fungi, bacteria and actinomycetes) and its effect on soil respiration.

Materials and Methods

Composite soil samples were collected from a depth of 15 cm from a sugarbeet field. Based on active ingredient, alachlor (2-chloro-2',-6'-diethyl-N-(methoxymethyl),acetanilide) was applied to 500 g soil on oven-dried-basis (o.d.b.) @ 1.5, 7.5, 15.0 and 30.0 ppm. i.e. approx. 3, 15, 30 and 60 kg/ha. The soil moisture was adjusted and maintained at 60% water-holding capacity (w.h.c.). The containers were incubated at 28±1°C and each treatment was replicated thrice.

Microbial studies

The dilution plate technique was used for estimating different microbial populations. Fungi were assessed on peptone-rose-bengal agar medium (Martin 1950), *Fusaria* on Nash and Snyder's medium (Nash & Snyder 1962) and *Azotobacter* on Jensen's agar medium (Jensen 1951). Total bacteria were assessed on Thornton's medium, as modified by Agnihotri (1971) by adding 50 mg pentachloronitrobenzene, 40 mg actidione and 35 mg pimaricin. Actinomycetes were estimated on water agar medium (Lingappa & Lockwood 1962). To this medium, 40 mg actidone and 20mg pimaricin(Agnihotri 1971)

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were added to prevent the development of unwanted fungal colonies. The data on microbial population were recorded on 0, 7th, 15th, 30th and 45th days after applying the toxicant in soil.

Carbon dioxide production

The apparatus designed by Peterson (1926) was employed for studying soil respiration. Evolved CO_2 was estimated at an interval of 4 days by the method of Pramer and Schmidt (1964).

Results and Discussion

Data on fungal population were recorded on Martin's medium which does not support the growth of Pythiaceous fungi, *Mortierella* species, and members of Basidiomycetes. In soils amended with alachlor, the population of fungi decreased and reduction depended on the quantity of the chemical initially applied. Significant reduction in the fungal population lasted for 30 days (table 1). Similar inhibitory effects of several other herbicides have been reported by Chappell and Miller (1956) and Singh (1971). It was interesting to note that alachlor neither stimulated nor inhibited the fusarial population in soil (table 2). Three species of *Fusarium*, namely, *F. moniliforme*, *F. oxysporum* and *F. solani*, were isolated and identified. Of these, *F. moniliforme* always outnumbered the other two species.

Table 1 *Effect of alachlor on the population of fungi in soil*

Treatments (ppm)	Number X 10^4/g soil on dryweight basis*			
	Days of incubation			
	7**	15	30	45
0.0	18.0	21.0	15.8	13.0
1.5	16.4	18.6	14.9	12.2
7.5	13.2	14.9	12.6	13.4
15.0	12.4	14.3	11.0	12.7
30.0	10.5	13.6	12.2	16.0
C.D. at 5%	2.7	3.5	3.0	—
	Sig.	Sig.	Sig.	N. Sig.

* Mean of three replications
** Initial population 16×10^4/g soil
Sig., Significant
N. Sing., Non-Significant

Table 2 *Effect of alachlor on the population of fusaria in soil*

Treatments (ppm)	Number $\times 10^3$/g soil on dry weight basis*			
	Days of incubation			
	7**	15	30	45
0.0	11.1	12.2	12.8	13.1
1.5	10.3	11.2	11.9	11.8
7.5	9.8	10.1	10.4	11.0
15.0	10.7	9.0	9.5	10.0
30.0	8.7	9.8	8.5	8.6
C.D. at 5%	—	—	—	—
	N. Sig.	N. Sig.	N. Sig.	N. Sig.

* Mean of three repllcations
** Initial population 10.8×10^3/g soil
N. Sig., Non-significant

Data (table 3) indicate that alachlor produced stimulatory effect on the bacterial population for first 15 days and thereafter there was no significant effect. The stimulatory effect of the chemical in the beginning might be either due to the utilization of the chemical and/or its degradation products as an energy sources or due to its hormone like-action. Beck (1970) also reported increased bacterial population in soil amended with high concentration of monolinuron. The population of *Azotobacter* in alachlor-amended soils was not significantly altered (table 4).

Table 3 *Effect of alachlor on the population o bacteria in soil*

Treatments (ppm)	Number × 10^6/g soil on dry weight basis*			
	Days of incubation			
	7**	15	30	45
0.0	33.0	37.0	32.4	30.7
1.5	30.8	42.0	38.4	32.8
7.5	34.0	48.0	42.0	35.0
15.0	40.5	54.2	47.0	39.0
30.0	50.0	60.0	44.7	42.2
C.D. at 5%	8.1	10.5	—	—
	Sig.	Sig	N. Sig.	N. Sig.

* Mean of three replications
** Initial population 25.7 × 10^6/g soil
Sig., Significant
N. Sig., Non-Significant

Table 4 *Effect of alachlor on the population of Azotobacter in soil*

Treatments (ppm)	Number × 10^3/g soil on dry weight basis*			
	Days of incubation			
	7**	15	30	45
0.0	28.3	32.0	30.5	26.3
1.5	29.5	32.5	29.5	27.2
7.5	27.5	28.3	24.0	22.9
15.0	26.1	29.5	25.5	27.8
30 0	22.7	26.0	27.0	28.9
C.D. at 5%	—	—	—	—
	N. Sig.	N. Sig.	N. Sig.	N. Sig.

* Mean of three replications
** Initial population 27.3 × 10^3/g soil
N. Sig., Non-significant

Higher concentrations of alachlor (7.5, 15 and 30 ppm) drastically reduced the population of actinomycetes by the 7th day (table 5). Thereafter significant differences did not occur up to 30th day but by 45th day increase in population over check was again significant. The increase in population in the later part of the experiment may be due to the utilization of degradation product (s) of the chemical or the cell material of dead micro-organisms providing readily available energy source for surviving actinomycete population.

Table 5 *Effect of alachlor on the population of actinomycete in soil*

Treatments (ppm)	Number × 10^6/g soil on dry weight basis*			
	Days of incubation			
	7**	15	30	45
0.0	26.0	31.1	28.4	18.2
1.5	21.2	26.0	25.0	18.9
7.5	16.8	25.7	27.2	25.0
15.0	14.4	27.2	30.4	40.3
30.0	10.3	23.9	32.3	49.5
C.D. at 5%	5.9	—	—	9.2
	Sig.	N. Sig.	N. Sig.	Sig.

* Mean of three replications
** Initial population 19.9 × 10^6/g soil
Sig., Significant
N. Sig., Non-significant

Alachlor showed better CO_2 production for first 20 days (table 6) indicating quick proliferation of bacteria in soils amended with alachlor (table 3). As compared to amended soils, the production of CO_2 in the check soil decreased by the 4th day, suggesting depletion of food material necessary for the growth and reproduction of micro-organisms.

The results of the present investigation clearly indicate that alachlor at the recommended rate (1.5 ppm) will not change the population of micro-organisms in soil and their general biological activity as adjudged by CO_2 studies.

Table 6 *Effect of alachlor on CD_2 evolution in soil*

Treatments (ppm)	CD_2 (mg) evolved/100 g soil on dry weight basis*									
	Day of incubation									
	4	8	12	16	20	24	28	32	36	40
0.0	31,6	24.0	19.1	15.2	10.9	9.0	7.6	6.9	5.4	4.9
1.5	32.7	24.6	19.6	15.6	11.7	9.7	7.5	6.6	5.3	4.8
7.5	33.9	25.5	20.3	16.2	12.8	10.0	7.5	6.3	5.0	4.7
15.0	34.1	25.9	20.6	16.4	13.4	9.7	7.8	6.3	4.9	4.7
30.0	36.7	27.6	22.0	17.5	12.7	10.6	6.5	7.1	5.3	4.7
C.D. at 5%	1.1	0.5	1.4	0.9	1.1	—	—	—	—	—
	Sig.	Sig.	Sig.	Sig.	Sig.	N Sig.	N. Sig.	N. Sig	N. Sig.	N. Sig.

* Mean of three replications
Sig., Significant
N. Sig., Non-significant

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