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EFFECT OF PRE - EMERGENT HERBICIDES ON N - MINERALISATION AND MICROBIAL POPULATION

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Effect of pre-emergent herbicides Diuron and Oxyfluorfen on an ultisol was investigated by measuring ammonification, nitrification, microbial population and pH. It was found that soils treated with both herbicides had either the same or higher rates of N-mineralisation and microbial activity as the control soil over the total period although a temporary depressive effect was seen soon after application.

INTRODUCTION

Pre-emergent herbicides are widely used to control weeds in new clearings and pruned tea fields in the slopey terrains of Sri Lanka. However, there is a paucity of information on their persistence in the soil and on their effects on micro-organisms. Soil fertility depends to a considerable extent on the maintenance of an equilibrium between various components of complex populations of micro-organisms in the soil. The disturbance of this equilibrium by the gradual build up of persistent and toxic residues resulting from the continuous use of such herbicides may affect soil fertility adversely (Audus, 1964). Residual effects of these herbicides in the soil depends on (*a*) nature of herbicide, formulation and rate of application, (b) physico-chemical soil characteristics, (*c*) biological situation in the soil and activity of microorganisms, and (*d*) climatic influences and agricultural practices (Grossbard, 1976). The present study was undertaken to find out whether the commonly used pre-emergent herbicides on tea soils have any effect on mineralisation, nitrification and growth of micro-organisms in soil.

MATERIALS AND METHODS

Two experiments were conducted under (*a*) field and (*b*) laboratory conditions :

(*a*) Field experiment

The experiment was laid out in Field No. 4 of St. Coombs Estate (Lat 6.55 N ; Long 80.40 E ; 1382 m amsl) where tea was planted in June 1985, after uprooting Gautemala grass (*Tripsacum laxum*) grown for two years. The soil was an ultisol (great soil group), Mattakelle series.

Some important characteristics of the soil are given in Table 1.

TABLE 1—*Properties of the soil in Field No. 4, St. Coombs Estate*

1. Texture	Sand	(%)	—	49.8
	Silt	(%)	—	14.8
	Clay	(%)	—	35.4
2. Organic Carbon		(%)	—	3.3
3. pH (1 : 2.5 soil/water)			—	5.2

For this trial, 15 plots, each $16m^2$ in area were marked out and grouped into five blocks, each consisting of three plots. On December 11th, 1985 the following treatments were applied, after hand pulling the weeds :

Treatment—1 (T_1) Diuron (3 — (3, 4 — dichlorophenyl)—1, 1 — Dimethyl Urea)—active ingredient 80% (w/w) sprayed at a rate of 1.2 kg ha^{-1} in 560 l of water.

Treatment — 2 (T_2) — Goal — Oxyfluorfen (2 chloro — 1—(3 ethoxy—4 Nitro-phenoxy — 4 trifluro methyl benzene) — active ingredient 24% sprayed at a rate of 1.2 l ha^{-1} in 560 l of water.

Treatment—3 (T_3)—Control (weeds were hand pulled).

Herbicides were sprayed using a hand operated compressed air sprayer with brass flood-jet nozzle (0.4 l minute^{-1} 275 $kp_a{}^{-1}$ with orifice size of 062. Before imposing the herbicide treatments the young tea fertilizer mixture—T 200 (10.3% N ; 6.9% P_2O_5 ; 7.5% K_2O ; 3.0% MgO)—was broadcast on the surface at the rate of 320 g per plot. The design was of the randomized block type with treatments replicated thrice.

(*b*) Laboratory experiment

The soil from 0-15 cm depth in Field No. 4 of St. Coombs Estate was sieved (2 mm) at field moist condition for this study. This soil was mixed thoroughly with a solution containing young tea fertilizer mixture (T 200) at the rates recommended for field applications, on a sheet of clean polythene. Extra water was sprayed, so as to bring the soil to 50% water holding capacity. The soil was divided into 12 samples of one kg each and tied loosely in polythene bags. Treatments, similar to field study, were applied to the above soil, with the treatments replicated four times.. After imposing the treatments, the treated soil samples were incubated aerobically at 25° C. The design was of the randomised block type.

The following analyses were done by drawing soils from the field and laboratory incubation studies on day 1 and day 3 and then at weekly intervals up to the eighth week and thereafter at fortnightly intervals from the 8th to 16th week :

(*i*) Exchangeable NH_4^+—N (with 1N KCl extract using Indophenol blue method)

(*ii*) Extractable NO_3^-—N

(*iii*) pH (Soil : water—1 : 2.5)

Counting of bacterial and fungal colonies

Counting of the total number of bacterial and fungal colonies was carried out using soil solution and plate count methods (Johnson *et.al.*, 1959) using potato dextrose agar as the medium. The number of viable cells and mycelial fragments capable of growing in the agar medium were determined with the soil samples used in the laboratory incubation study at weekly intervals.

RESULTS AND DISCUSSION

Exchangeable Ammonium Nitrogen

Ammonium nitrogen content of the soil in all three treatments showed a similar pattern except during the first three weeks of study.

Under laboratory conditions NH_4^+ – N content of the control (T3) treatment was significantly higher than the other two during the first three weeks (Fig. 1A). However, under field conditions, the control treatment (T3) had a significantly higher value than the other two, only at the end of the first week (Fig. 1B). The exchangeable NH_4^+ – N in the soil after addition of fertilizer is due to (*a*) any free NH_4^+ which is not immobilised by microbial population and (*b*) NH_4^+ in the exchange sites of clay mineral. The NH_4^+ for the above two sources may come from (*a*) to a larger extent by added fertilizer and (*b*) to a lesser extent by mineralization of organic matter by microbial population.

Since, the added fertilizer NH_4^+ – N is the same for all three treatments, the differences in the early part of the study may be attributed to differences in the rates of immobilisation, mineralisation and nitrification by microbial populations in the soil. It was shown that fungal and bacterial populations which were responsible for mineralisation were initially inhibited by the use of substituted Urea herbicides (Grossbard and March, 1974) but showed a quick recovery to normal population after ten days. A similar inhibitory effect was observed with Oxyfluorfen in alfisol and oxisol when used at the rate of 0.5 l/ha (Chandralatha and Jayakody, 1986). Under field conditions, due to heavy rainfall experienced (50 mm) from the 5th to the 13th day the herbicides would have been diluted and leached out of the top 15 cm soil in addition to some mineralised ammonia. Hence the effect of herbicides would have diminished after the first week.

Unlike laboratory studies, where herbicides are thoroughly mixed with the soil, in the field studies herbicides come into contact with the top 1-2 cm of the soil when applied. This could be another reason for the low response observed in $NH_4^+ - N$ content under field conditions.

Nitrate - Nitrogen

Like $NH_4^+ - N$, nitrate nitrogen ($NO_3^- - N$) content of the soils in all three treatments showed a similar pattern and did not differ significantly throughout the study except during the first week under laboratory conditions (Fig. 1C, 1D). This may be due to the temporary inhibitory effect of herbicides used on nitrifiers like Nitrosolobus, Nitrosospira, and Nitrosovibrio in acid tea soils (Walker and Wickramasinghe, 1979). However, the inhibitory effect disappeared after the first week and nitrification rates of herbicide treated soil increased to that of control.

Most striking differences were found in the $NO_3^- - N$ content under laboratory and field conditions. Under laboratory conditions $NO_3^- - N$ content was found to increase up to a higher level (90 ppm) than under field conditions where it was maintained around 15 ppm. Such low levels may be due to leaching by continuous rainfall, plant uptake and denitrification.

pH

pH variation in all three treatments showed a similar trend throughout the period of study without any significant differences among the treatments (Fig. 1E, 1F). Though $NH_4^+ - N$ content and $NO_3^- - N$ content showed differences among treatments during the early part of study, this was not reflected in the pH. This may be due to a nullifying effect of NH_4^+ by NO_3^- under laboratory conditions. The pH of all the treatments at the end of the 8th week was lower than the initial value. This may be due to the greater extent of nitrification taking place under laboratory conditions. However, under field conditions, the pH rose slightly due to leaching of NO_3^- formed by nitrification.

Microbial population

Initially both fungal and bacterial population in treatments 1 and 2 showed a greater depressive effect than the control (Fig. 2A, 2B). However, at the end of the first week, they showed a quick recovery and at the end of second week, a stimulatory effect was observed. Initial depressive effect may be due to toxic activity of the two herbicides against the microbial population (Van Schreven, Lindenbergh and Koriden, 1970). Even though, herbicides were used at very low concentrations (0.8 $\mu g/g$ of soil) the uneven herbicide distribution may however result in relatively high concentration locally in the aqueous phase of the soil. This could be another reason for the initial toxic effect. However, at the end of the second week, the proliferation of microorganisms to the original level in treatments 1 and 2 may be due to degradation of added herbicides by the microbial population. It was shown that these herbicides could be easily utilised by many micro-organisms as sources of Carbon and Nitrogen (Abushady and Beih, 1984.) The initial depression of microbial population is consonant with the NH_4^+ – N and NO_3^- –N contents of herbicide treated soils under laboratory conditions. However, the stimulatory effect of the herbicides on micro-organism was observed only in NO_3^- – N content of the soil. Unfortunately, we have not isolated the microorganisms into various species. This could have given possible clues to explain the increase in NO_3^- – N content observed, in treatments 1 and 2.

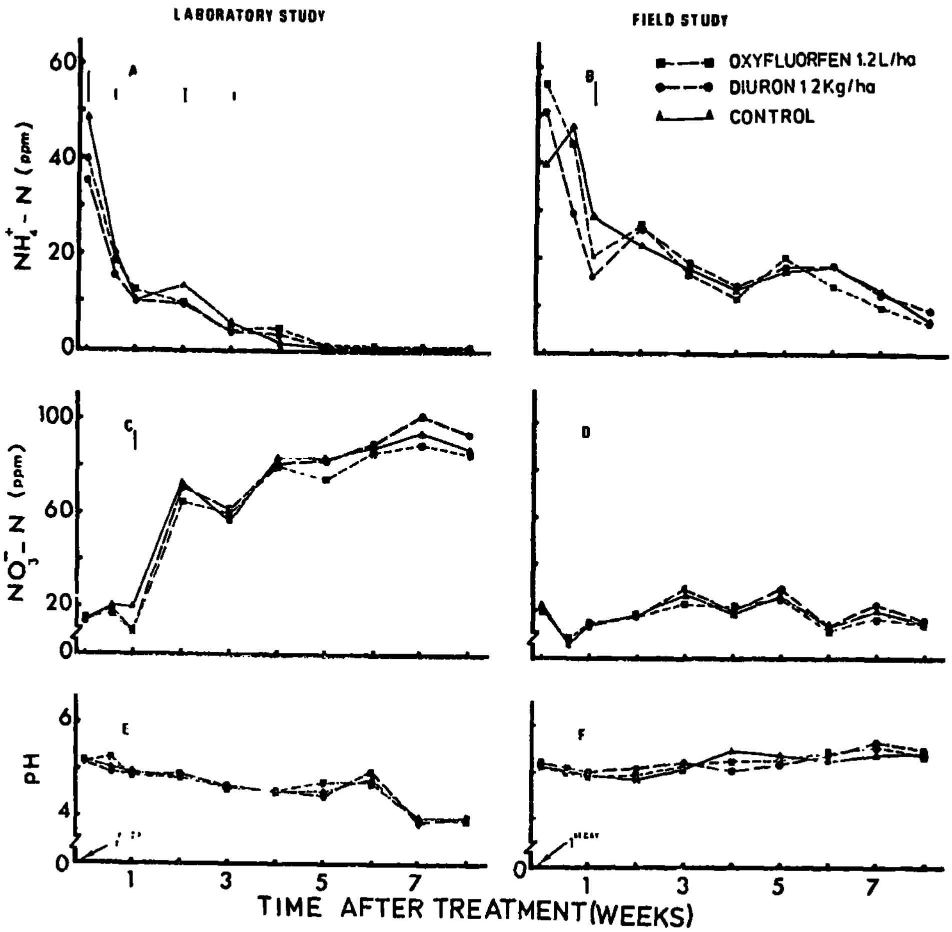

Fig. 1 — Effect of Oxyfluorfen and Diuron on ammonium N, nitrate N and pH of soil.

Both herbicides over a period had either the same or higher N mineralisation, although a temporary depressive effect was seen; soon after application. Thus, their use does not hinder the availability of soil N which determines the soil fertility through either increase in microbial population and or rapid breakdown of the herbicide molecule. The disadvantage, if any, is only immediate suppression of microbial population after the application.

Clearly, this suppression is not long lasting by any means and is only temporary since the population of both fungi and bacteria had come to normal levels by the end of the eighth week.

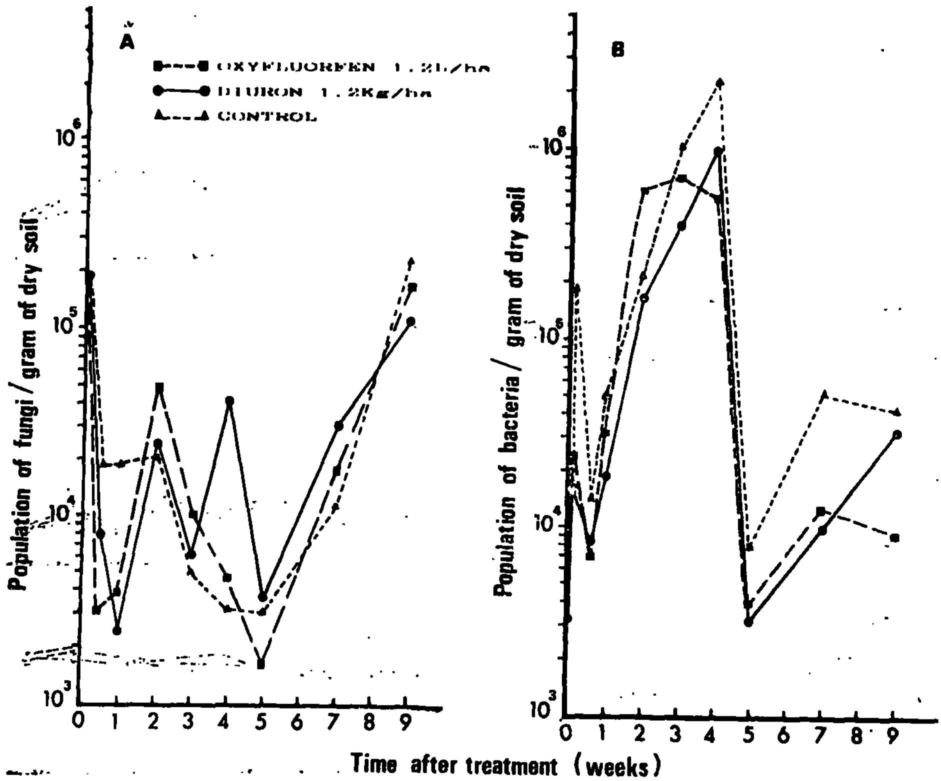

Fig. 2 — Effect of Oxyfluorfen and Diuron on population of (A) fungi and (B) bacteria.

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