Bull. Environ. Contam. Toxicol. (1984) 33:241-245

Environmental Contamination and Toxicology

Effect of Insecticides on Soil Algal Population

P. V. G. Muralikrishna and K. Venkateswarlu*

Department of Botany, Nagarjuna University, NAGARJUNA NAGAR, Andhra Pradesh, India 522510

Soil algae, particularly blue-greens, have been implicated in the enrichment of soil due to their ability to fix nitrogen. The intensive and indiscriminate use of pesticides such as parathion, carbaryl and endosulfan against many insect pests of rice, cotton, tobacco and other crops might be harmful to the native algal population in soil. Toxicity of certain of these agrochemicals to algae was studied mainly in pure cultures (Singh 1973, Das and Singh 1977, Kar and Singh 1978). The impact of pesticides on the native algal flora in soil has not been investigated. This paper presents the effect of three commonly used insecticides viz., parathion [O,O-diethyl O-(p-nitrophenyl) phosphorothioate], carbaryl (1-Naphthyl N-methylcarbamate) and endosulfan (6,7,8,9,10,10-Hexachloro-1,5,5a,6,9,9a-hexahydro-6,9-methano-2,4,3-benzodioxathiepin-3-oxide), on the algal population in a lateritic soil under two moisture levels.

MATERIALS AND METHODS

Red laterite soil (organic carbon, 1.2%; total nitrogen, 0.12%; pH, 8.1) from the university botanical garden was collected to a depth of 8 cm with a sterilized spatula, after removing the algal crust. It was mixed thoroughly, air-dried and passed through a 2 mm sieve. From this composite sample, 10 g portions, taken in test tubes were treated with each selected insecticide to give 0, 5, 10, 25, 50, 100 µg a.i./g soil. For each treatment, one set of tubes was maintained at 50% water-holding capacity (WHC) to provide nonflooded conditions while another set was flooded with distilled water to provide 1:1.25 soil to water ratio. Commercial formulations of three pesticides viz., parathion 50% EC (emulsifiable concentrate), carbaryl 50% WP (wettable powder) and endosulfan 50% EC, were used. The tubes were incubated at room temperature (27 ± 4°C).

*Author to whom correspondence should be made.

At the end of appropriate periods of incubation, based on the persistence values of the selected pesticides, the algal population in each soil sample was estimated by the technique of enrichment culture using Bold's basal medium (Bischoff and Bold 1963). The culture tubes having 4 mL of the mineral salts medium and 1 mL aliquots of the soil suspension prepared by 2-fold serial dilutions were incubated under continuous illumination. Prior to the preparation of serial dilutions, the nonflooded soil samples were also flooded with distilled water to provide 1:1.25 soil to water ratio. Five replicate tubes were maintained for each dilution. After 21 days of incubation, when the phototactic rings and surface films of algae appeared, the total algal population was determined by the 'most probable number' (MPN) method, referring to the tables of Fisher and Yates (1963). The algal colonies were also observed microscopically for characterization.

RESULTS AND DISCUSSION

The short-term effect of parathion, carbaryl and endosulfan on the algal populations was studied under nonflooded and flooded soil conditions (Table 1). Prior to the enumeration of the algal populations, the soil samples were incubated for different periods of time keeping in view the approximate persistence values of these insecticides in flooded soil so that the incubation period is very close to the half-life period of the pesticide concerned.

In general, the algal population was more in nonflooded soil samples than in waterlogged samples. As moisture is an important factor for algae, the soil samples maintained at 50% WHC could provide adequate water with the resultant supply of dissolved nutrients to facilitate good growth and multiplication of algae during incubation. In the soil kept under flooded conditions for a maximum of 20 days, the algal populations might not have been in a vigorous metabolic state because of complete saturation of water (Fogg et al. 1973). The variations in the populations of algae among the controls maintained for the three pesticides were probably due to the fluctuations in the environmental factors as this study was performed over a period of four months. In the soil sample where no insecticide was added, the most ubiquitous algae were Chlorococcum, Chlorella, Scenedesmus, Oscillatoria, three other unicellular forms of Cyanophyceae, besides an unidentified, predominant member of colonial Nostocaceae.

The application of parathion at higher levels (10 to 100 ppm) to soil under flooded and nonflooded conditions greatly reduced the populations of algae. Its inhibitory effect, however, was more pronounced under nonflooded

Table 1. Effect of parathion, carbaryl and endosulfan on algal flora of the soil maintained under two water regimes.

Pesticide (ppm)	Algal population, 10^3/g soil[a]	
	Nonflooded	Flooded
	Parathion[b]	
0	74.04	28.75
5	86.16	18.20
10	29.71	14.92
25	29.71	12.38
50	12.80	11.74
100	ND	7.41
	Carbaryl[c]	
0	75.12	22.50
5	114.96	14.92
10	90.24	11.74
25	90.24	10.11
50	41.44	3.10
100	32.51	3.10
	Endosulfan[d]	
0	98.20	47.09
5	118.64	22.50
10	107.13	28.76
25	107.13	38.38
50	86.16	14.92
100	47.09	2.94

[a]Initial population in the soil was 90.24 x 10^3/g.

[b]Soil was incubated for 10 days.

[c]Soil was incubated for 15 days.

[d]Soil was incubated for 20 days.

ND = Not determined.

conditions (50% WHC). On the contrary, Naumann (1970) observed no effect on algae when methyl parathion was applied at rates up to 300 Kg a.i./ha to a loam soil with pH 7.2. Thus, the adverse effect on algae with the application of parathion in the present study might be due to the involvement of its hydrolysis product, p-nitrophenol, associated with the alkaline reaction of the soil (Sethunathan et al. 1977). An overall reduction in the frequency of unidentified unicellular forms was observed with parathion added to nonflooded soil, whereas no such

reduction was evident under flooded conditions. There was no change in the occurrence of the other algal forms. Of special interest was its stimulatory effect in non-flooded soil at the low rate (5 ppm) which is very close to the level of field application.

The application of Sevin, a commercial formulation of carbaryl, also resulted in a similar trend under flooded condition; but there was no reduction in population up to 25 ppm under nonflooded condition. In addition, the development of unidentified unicellular forms was totally restricted with the addition of carbaryl to soils. There was considerable stimulation of algal populations at 5 ppm level under nonflooded conditions. This observation would probably support the reported enhancement in survival, growth and nitrogen fixation by a blue-green alga, Nostoc muscorum, when carbofuran, another closely related methylcarbamate, was added at 25 ppm in culture medium (Kar and Singh 1978).

On the otherhand, Thiodan, a commercial formulation of endosulfan, had very little effect in limiting the density and frequency of the different algal forms under both water regimes, up to 25 ppm. As with the other two pesticides, the total algal population increased in nonflooded soil when endosulfan was applied at the rate close to that of field application.

The results obtained in the present study clearly show that the three insecticides viz., parathion, carbaryl and endosulfan, when applied at the recommended levels of field application (5 to 10 ppm), are not harmful to the soil algal population, which contribute much to the soil fertility. The application of these pesticides to nonflooded soils at 5 ppm level slightly enhanced the population of algae while higher concentrations resulted in gradual inhibition, especially under flooded conditions. Parathion caused greater inhibition than the other two. The frequency of the algal forms, however, was not changed due to the application of these chemicals excepting the inhibition of certain unicellular forms with the addition of parathion to nonflooded soil.

Acknowledgments. The authors are extremely grateful to Prof. A.S. Rao, Head of the department of Botany, for his keen interest in this study and for critically reading the manuscript.

REFERENCES

Bischoff HN, Bold HC (1963) Phycological studies IV. Some soil algae from enchanted rock and related algal species. Univ Texas Publ No. 6318, Austin, Texas

Das B, Singh PK (1977) Effect of weedicide 2,4-dichlorophenoxy acetic acid on growth and nitrogen fixation of blue-green alga Anabaenopsis raciborskii. Arch Environ Contam Toxicol 5: 437-445

Fisher RA, Yates F (1963) Statistical tables for biological, agricultural and medical research. Oliver & Boyd, Edinburgh and London

Fogg GE, Stewart WDP, Fay P, Walsby AE (1973) The blue-green algae. Academic Press, London

Kar S, Singh PK (1978) Toxicity of carbofuran to blue-green alga Nostoc muscorum. Bull Environ Contam Toxicol 20: 707-714

Naumann K (1970) Zur Dynamik der Bodenmikroflora nach Anwending von Pflanzenschutzmitteln II. Die Reaktion verschiedener physiologischer Gruppen von Bodenbakterien auf den Einsatz von Parathion-methyl im Freiland. Zbl Bakt Abt II 124: 755-765

Sethunathan N, Siddaramappa R, Rajaram KP, Barik S, Wahid PA (1977) Parathion:Residues in soil and water. Residue Rev 68: 91-122

Singh PK (1973) Effect of pesticides on blue-green algae. Arch Mikrobiol 89: 317-320

Received November 21, 1983; accepted December 1, 1983.