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EFFECT OF PESTICIDES ON ENZYMATIC ACTIVITIES AND NITROGEN MINERALIZATION IN SOILS

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ABSTRACT

The activities of soil enzymes *viz.* urease, acid phosphatase and dehydrogenase were significantly inhibited (4.00 to 25.21%) by pesticides i.e.captafol, carbofuran and butachlor and it was comparatively higher in salt affected soil. The urea N-mineralization was significantly inhibited (4.00 to 25.03%) by the application of pesticides and it was comparatively higher in acid soil. The higher doses of pesticides inhibited higher level of enzyme activities and urea N-mineralization were observed at longer days of incubation. Thus, to avoid the inhibition of biochemical processes in soil it is advisable to apply the pesticides at least after one month of fertilizer application.

Key words : Soils, Pesticides, Enzymatic activities, Nitrogen mineralization.

INTRODUCTION

Soil is a living system where all biochemical activities proceed through enzymatic processes. It is well known that all biochemical reactions in soils are catalysed by soil enzymes. The physiochemical state of enzymes and their influence on biochemical reactions are markedly dependent on pH, ionic strength, temperature and presence or absence of inhibitors or activators. The use of agricultural chemicals in present agriculture is immenent, for controlling pests. Despite the beneficial impact of pesticides in improving and stabilizing agricultural productivity by the control of obnoxious weeds, fungi and insects, these organic chemical may be one of the inhibitors or activators of soil enzymes (Bollag and Stotzky, 1993). Living organisms in soils are generally produced these enzymes. It seems obvious therefore that any compound which alters the number or activity of micro-organisms could therefore affect directly the activities of soil enzymes *viz.* urease, phosphatase, dehydrogenase etc. and indirectly the soil biochemical processes and ultimately influence the soil fertility and plant growth. Keeping this in mind, a concerted effort has been made to study the effect of three popular pesticides *viz.* carbonfuran, captafol and butachlor on activities of soil enzymes, specifically urease, acid phosphatase and dehydrogenase and urea nitrogen mineralization in three different soils of Uttar Pradesh. Moreover, the influence of soil characteristics on enzyme activities and N-mineralization have also been considered. Thus, the objectives of the present study are:

- Investigation of the effect of pesticides on the activities of soil enzymes,
- Effect of pesticides on nitrogen mineralization in soils and
- Evaluation of the effect of soil properties on enzyme activity and N-mineralization in soils.

Experimental plan

The diversified properties of soils were collected from different geographical location of Uttar Pradesh *viz.* acidic soil (Dehradun, formerly U.P.) normal or neutral soil (M. Nagar) and salt affected soil (Baghpat). The physical and chemical properties were analysed by standard methods (Black, 1965 & Page, 1982). The pesticides used in these experiments were of analytical grade (*i.e.* carbofuran, 98.9% pure, captafol95.5% and butachlor 95% pure).

In these laboratory incubation study the activities of urease, acid phosphatase and dehydrogenase were assayed in both pesticide treated and untreated soils at different days intervals using spectrophotometric methods and estimating by the un-hydrolysed urea (Douglas and Bremner, 1971), p-nitrophenol (Evazi andTabatabai, 1977) and 2,3,5- triphenylformazan (TPF) (Casida and Jr. Klein, 1964), respectively in soil with the addition of respective substrates. Impart of pesticides on enzymatic activities were measured by estimating the activities in both, pesticide treated and untreated soils, incubated at 37^0C.

In another laboratory incubation study the effect of pesticide on the mineralization of urea-N was estimated. After application of 100 mg/kg of NH_2N in soils, the NH_4^+-N, NO_3^-N and NO_2^- were estimated (Dorich and Nelson, 1983; Nelson, Kurtza and Bray, 1954) at different days intervals by spectrophotometric methods in both pesticide treated and untreated soils. Impact of pesticide application on N-mineralization was calculated. After evaluating the effect of pesticides on the activities of soil enzymes and urea- N mineralization impact of soil activities of soil enzymes activities and N-mineralization were separately evaluated.

RESULTS AND DISCUSSION

The effect of carbofuran (insecticide, nematicide and ascaricide), captafol (fungicide) and butachlor (herbicide) on the activities of urease, acid phosphatase, and dehydrogenase were determined at recommended doses (2.0 kg, 2.5 kg and 1.5 kg a. i./ha, respectively) and 10 times of recommended dose of pesticide in soil and considering also the activities in oils without the pesticides. Urease activity continuously decreased with the period of incubation in both pesticide treated and untreated soils. In presence of carbofuran, captafol and butachlor, urease activity was inhibited in all the three studied soils in both recommended dose and higher the recommended dose and 10 fold doses of pesticide showed higher inhibition of urease in all the soils. In general, inhibition of activity by pesticides followed the order as: butachlor> captafol> carbofuran. In general, it was found that urease activity in presence of carbofuran, catafol and butachlor were inhibited in the three studied soils; the inhibition followed the salt-affected >acidic>neutral soil. Higher activity in neutral soil can be attributed to active urease in the absorbed form on clay and humus and also due to presence of urolytic organisms (Kiss and Dragan Bularde and Rudulagen, 1975). Soil salinity was the additional factor for the urease activity inhibition in the soil. The acid phosphatase activity increased upto second weeks and thereafter decreased in both pesticide treated and untreated soils and the activity decreased with the application of pesticides. At 10-fold of recommended dose of pesticides, the phosphatase activity was recorded lower than recommended dose, but the inhibition was not 10 times. In general the order of inhibition of acid phosphatase by pesticides was as follows: captafol> butachlor> carbofuran. The varied levels of phosphatase inhibition by these pesticides were apparently due to the adsorption/ desorption phenomenon as affected by soil texture, organic matter and also due to effect of chemicals/ or their metabolites formed during incubation in soils (Tu, 1981). In both the pesticide treated and untreated soils, dehydrogenase activity decreased upto third weeks and then started to rejuvenate the original activity after fourth weeks of incubation and in this stage inhibition by the pesticides followed the order as: captafol> butachlor> carbofuran in both recommended dose and higher dose. The acid phosphatase activity in soils was followed the same order as urease i.e. normal>acid>salt affected soil. The activity of dehydrogenase was minimum in the salt affected soil, thus order of activity was as follows: normal>acidic>salt affected soil.

The effect of carbofuran, captafol and butachlor on urea-N mineralization i.e. ammonification and nitrification processes were analysed at recommended and 10 times of recommended dose of pesticides in soils and also in pesticide untreated soils. In general, it was observed that the rate of ammonification and nitrification in presence of carbofuran, captafol and butachlor in both recommended dose and higher the recommended dose were inhibited in three studied soils. In an average both ammonification and nitrification were adversely affected by pesticides and the order of reduction of these two processes in different intervals was as follows:

captafol>carbofuran>butachlor. The maximum percent of nitrification inhibition by crabofuran was 21.08%, 24.53% by captafol and 12.36% by butachlor respectively at recommended dose and percent of inhibition were comparatively higher after 14 days of incubation and prevailed upto 28 days of incubation in all the three pesticides irrespective of doses. The higher percent of inhibition in urea-N mineralization was found to occur at higher doses of three pesticides. Sensitivity of ammonifiers and nitrifiers towards captafol (fungicide) may be a cause for maximum inhibition. Irrespective of chemical class, purpose of use (insecticide/ fungicide/herbicide) and doses of treatment of pesticides, the rate of inhibition was in the order: acidic>normal>salt affected soil.

The correlation coefficient(r) was calculated to evaluate the soil properties with enzyme activities and N-mineralization in soil. A positive correlation were found between urease, acid phosphatase and dehydrogenase activities with clay, organic carbon, available nitrogen and phosphorus and negative correlation were observed with soil pH, EC and carbon exchange capacity.

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