ABSTRACT

Use of synthetic chemicals has caught the mind of researchers in recent years. To meet the demand of exploding population various types of synthetic chemicals are used in agricultural sector. Among these insecticides are the compounds which impart side effects on the non-target organisms. Irrespective of their mode of application, insecticides ultimately reach the soil and interfere in the soil ecosystem killing many non-target organisms. They cause many fold disturbances in natural balance and loss of agricultural production. Carbaryl, a carbamate insecticide is profusely used in more than 100 crops.

Earthworms, the non-target organisms for insecticides, constitute a major component of soil organisms and contribute significantly to soil fertility. Some insecticides like heptachlor, DDT, chlordane, carbofuran, aldicarb, anthio and benzophosphate are toxic to earthworms at agricultural dose but some others like phorate, aldrin, dioxin and oxamyl are nontoxic. The effectiveness of an insecticide depends on the climate and soil quality of the site of application. No concrete report is available on the effect of carbamates on earthworm. Therefore, in this study the effect of carbaryl is studied on the activities of earthworms and soil metabolism.

Distribution, density, population dynamics, secondary production and metabolism of earthworms have been studied in field condition with respect to carbaryl treatment. Metabolism of earthworms (sampled from experimental field) was studied taking respiration, excretion (ammonia and urea production) into consideration. In soil metabolism study activity of soil enzymes like protease, amylase, cellulase and invertase were measured from the soil.
samples of the field. Further, soil respiration was quantified in terms of carbon dioxide evolution from soil directly at the study site.

To monitor the toxicity of carbaryl at different sublethal doses to earthworms, two species i.e. *Drawida calebi* (Gates) and *Octochaetona surensis* (Michaelsen) which were found in the study site and crop fields were cultured in the laboratory and experiments were conducted in laboratory conditions. In these studies, the survival, growth and reproduction of earthworms were analysed. Activities of enzymes like acetylcholinesterase and arginase were also studied since the former is located at a key point i.e. the nerve synapse and the latter is an enzyme of the urea cycle concerned with excretion.

Different age groups of earthworms constituted juveniles (≤ 2cm in length), immatures (> 2cm and ≤ 4cm) and adults (> 4cm with clitellum). *Drawida calebi* was the dominant species and mostly found in surface soil. The average monthly biomass was 8.9 (g/m²) in control and 10.4 (g/m²) in treated plot respectively. The secondary production was 74.1g fresh weight/m² (18.5g dry weight) in control plot and 87.1g fresh weight/m² (21.7g dry weight) in treated plot. In the energetics study, assimilation was found to be 253.5 k cal/m²/year and 598.4 k cal/m²/year in control and treated plots respectively.

In the soil metabolism study, protease activity was less in the treated plot than the control. This decrease might be due to effect of carbaryl on proteolytic microorganisms. However activity of enzymes like amylase, cellulase
and invertase did not show any significant difference between control and carbaryl treated plot. There was significant seasonal variation in the enzymes activity and soil respiration in both the plots. However with respect to soil respiration no significant difference was observed between control and treated plot.

In laboratory studies, the LC$_{50}$ for juveniles, immatures and adults of $D$.calebi were found to be 15.8, 20.9 and 26.3 ppm respectively. For $O$.surensis the values were 12.6, 15.1 and 21.4ppm for juveniles, immatures and adults respectively. Mortality increased with increase in concentration of carbaryl and its toxicity also increased from adults to juveniles. Tissue growth significantly decreased in both the species with respect to carbaryl. However, both the species restored to their normal growth rate when carbaryl treatment was withdrawn. The cocoon production decreased in both the species but showed complete recovery after withdrawal of the insecticide. On continuous carbaryl application arginase activity in both the species increased under feeding and fasting conditions. In short term treatment of carbaryl (up to 3 days) arginase activity increased and later on decreased to normal showing adaptation of the worms. Arginase activity was more in fasting condition than feeding. $D$.calebi recovered earlier than $O$.surensis. Acetylcholinesterase activity in both the species was inhibited by carbaryl and inhibition increased with increase in exposure time. But they recovered to the normal state after a short term exposure (24h) to the insecticide. $D$.calebi also showed rapid recovery in AChE activity. Though in laboratory experiments the worms were affected by carbaryl they showed recovery when the treatment was withdrawn. Early recovery in $D$.calebi
is an indication of being resistant to carbaryl than *O. surensis*. Carbaryl exhibited no significant effect when applied at agricultural dose in field. In laboratory conditions though it imparted some effect, the earthworms could recover from the stress after withdrawal of the insecticide treatment.