Effects of dimethomorph on some enzymatic activities in soil

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Abstract—In this study, soil samples (0–20 cm depth) were taken from the same test fields of Henan Institute of Science and Technology in order to determine the effects of dimethomorph on enzymes activities of soils. Basal soil catalase activity (CA) and urease (UA) enzyme activities, the results showed that high dose of dimethomorph introduced into soil had an significant effect on soil enzymatic activities, the degree of inhibition or promotion of enzymatic activities was not only related to the concentration of dimethomorph, but also to the remain time. Compared with the control, dimethomorph stimulated soil catalase and the action increased with the increasement of treatment concentration; the activity of urease treated by dimethomorph dropped down at first and then rose slowly.

Keywords—dimethomorph; catalase; urease

I. INTRODUCTION

Dimethomorph is a systemic fungicide which protects plants from molds, as well as killing molds on plants and preventing their spread. It is a cinnamic acid derivative and a member of the morpholine chemical family. Dimethomorph is a systemic morpholine fungicide for use on potatoes. Its mode of action is the inhibition of sterol (ergosterol) synthesis. Morpholines are all systemic with curative and preventative qualities. Dimethomorph was developed for downy mildews, late blights, crown and root rots for grapes, potatoes, tomatoes, and other vegetables. Dimethomorph is used as a wood preservative to control downy mildew on vines, and to control late blight on tomatoes and potatoes.

Based upon a battery of acute toxicity studies, dimethomorph technical is relatively non-toxic when administered acutely to laboratory animals and is classified as Toxicity Category III. EPA has classified dimethomorph as "not likely to be a human carcinogen" based on no increased incidence of neoplasms in the rat chronic or carcinogenicity studies or in the mouse carcinogenicity study. As dimethomorph degraded, most of the radioactivity was not extracted from the soil. Although it appears that dimethomorph will degrade in anaerobic aquatic and terrestrial systems, additional data are required to confirm the rates because the submitted studies had additional carbon sources which may have significantly accelerated the degradation rates. So it is necessary to assess the effect of dimethomorph on agroecosystem risks.

Biological and biochemical properties of the soil, including soil respiration, microbial biomass, nitrogen mineralization capacity and the activities of soil enzymes, have been proposed as indicators of soil quality and health[1-4], while soil enzyme activities are especially significant because they are intimately involved in catalyzing reactions necessary for organic matter decomposition, nutrient cycling, energy transfer, environmental quality and crop productivity[5]. The objective of the present study was to evaluate the effect of dimethomorph on the soil enzymatic activity of soil.

II. MATERIALS AND METHODS

A. Soil

A yellow loamy soil collected from 0–20 cm layer from the experimental field (Henan Institute of Science and Technology, Xinxiang, China) was used in this test. Soil samples were air-dried at room temperature; sieved with 40 mesh screen. The soil samples contained 1.68% total organic C content, and 33.9 mg*kg$^{-1}$ available N, 25.4 mg*kg$^{-1}$ available P, 164.4 mg*kg$^{-1}$ available K and had a pH of 8.03.

B. Pesticides

The dimethomorph was produced by Shandong Cynda Chemical (Group) Co., Ltd., China. This pesticide (96% TC) was used as technical and added to soil. The control rate of dimethomorph was 0 mg*kg$^{-1}$ dry soil (treatment 1), and the treatment 2–4 were added in practice at 10, 40, 100 mg*kg$^{-1}$ dry soil respectively.

C. Soil treatment with pesticides

Soil was placed in conical flasks with stopper, 1 kg in each. Pesticides were diluted with acetone and distilled water and applied to the soil as a part of the moisture required to adjust the soil to 60% of its water holding capacity (w.h.c.). These were added at rates corresponding to the treatment 1–4. Four treatments were set up in duplicates and soil was incubated at 25°C for 4 weeks. After 1st, 4th, 7th, 10th, 13th 16th, 19th, 22nd, 25th and 28th day of incubation time following pesticide application soil sub-samples were taken for assaying catalase, urease activities.

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D. Assaying of soil enzymes activity

Catalase activity was measured using the titration method. Fresh soil (2 g) was added 40 ml distilled water and 5 ml 0.3% H₂O₂, the samples were placed at 0-4 °C for 20 min again, before terminating the reaction with the addition of 5 ml 3 M H₂SO₄. After filtration, 0.1 M KMnO₄ was added to 25 ml filtrate, to measure the KMnO₄ consumption [5,6].

Urease activity (UA) was measured as follows: 1 ml toluene, 20 ml citrate buffer (pH 6.7) and 10 ml of 10% urea substrate solution were added to the 10 g sample and the samples were incubated for 24 h at 37 °C. The formation of ammonium was determined at 578 nm and results were expressed as NH₃-N mg·g⁻¹ dry soil sample [7].

E. Data analysis

Each treatment was performed in duplicate, the measurements of enzyme activities were evaluated by analysis of variance.

III. RESULTS AND DISCUSSION

A. The effect of dimethomorph on catalase

The effect of dimethomorph on catalase was showed as Fig.1: the catalase activity of all treatment fluctuated during the whole experiment, the fluctuation extent of 4 treatments were different but had the same current. After 1st day treatment, the activity of catalase began to change, the activities of 2,3,4 treatments (the concentrations of dimethomorph were 10,40,100 mg·kg⁻¹ dry soil) were significant higher than that of the control during 1-13th day treatment. After 10th day later, the activities of 2,3 treatments (the concentrations of dimethomorph were 10,40 mg·kg⁻¹ dry soil) were close to that of the control, but treat 4 (the concentrations of dimethomorph was 100 mg·kg⁻¹ dry soil) was higher than that of the control. The results showed that dimethomorph stimulated soil catalase and the action increased with the increasement of treatment concentration.

B. The effect of dimethomorph on urease

The effect of dimethomorph on urease was showed as Fig.2: the activity of urease treated by dimethomorph dropped down at first and then rose slowly. After 7th day later, the inhibition of treatment 2 (the concentrations of dimethomorph was 10 mg·kg⁻¹ dry soil) was disappeared, but that of treatments 3,4 (the concentrations of dimethomorph were 10,40 mg·kg⁻¹ dry soil) was still existing. Following the extend of treatment time, the soil urease was stimulated and the activities of urease in other treatments 2,3,4 (the concentrations of dimethomorph were 10,40,100 mg·kg⁻¹ dry soil) were higher than the control’s after 10th day treatment.

Soil enzymes could behave differently when exposure to one kind of pollutant [8]. Pesticides are used for increasing crop production, but increased usage caused hazardous effects to the environment and human health [9]. As other reports [10-13], the phenomenon of soil enzymes stimulated or inhibited was coexistent, the fluctuation extent was also different among different enzyme sorts. Soil catalase can decompose hydrogen peroxide induced by organic biological breathing processes and chemical oxidation reactions, and to remove the toxic effect on soil. The effect of dimethomorph on the activity of soil enzyme is in accordance with validamycin [6]. Dimethomorph may be toxic to some microorganism species, so the activity of urease in earlier time was inhibited, but the high activities of catalase and urease showed that it was far more likely that dimethomorph (or its degraded product) was acting as a kind of organic carbon source (to some microorganism species) which increased microbial biomass and in turn increased the activities of catalase and urease, when this kind of carbon resource exhausted, soil microorganism would resume to normal level.

As already stated in our previous letter, indicators of soil quality and health including soil respiration, microbial biomass, nitrogen mineralization capacity and the activities of soil enzymes. In this paper, we only studied the effect of dimethomorph on the activity of soil enzyme. So we must use the soil respiration, microbial biomass to analysis the effect of dimethomorph on the soil in order to evaluate the environmental satety in later study.
IV. CONCLUSION

Our results indicate that dimethomorph significantly affect enzymatic activities in soil in short time, which could be stimulated or inhibited. The results showed that high dose of dimethomorph introduced into soil had a significant effect on soil enzymatic activities, the degree of inhibition or promotion of enzymatic activities was not only related to the concentration of dimethomorph, but also to the remain time. Compared with the control, dimethomorph stimulated soil catalase and the action increased with the increasement of treatment concentration; the activity of urease treated by dimethomorph dropped down at first and then rose slowly. The present findings mean that the dimethomorph is only relative safe pesticides which could also cause environmental risk and the field to evaluate the environmental safety of other pesticides with low toxicity should be attracted attention.

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REFERENCES