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EFFECT OF SELECTED INSECTICIDES ON SOIL ENZYME ACTIVITY

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ABSTRACT : Soil enzymes are indicators of microbial activities in soil and are often considered as an index of soil health and fertility. Insecticides being toxic in nature may affect soil microbes and in turn their activity. A field experiment was conducted at Main Agricultural Research Station, Dharwad, to study the effect of selected insecticides on soil enzyme activity during *rabi* 2015. The experiment comprised of fourteen treatments with three replications. Results revealed that, in all the treatments the activity of dehydrogenase, phosphatase and urease enzymes was lower where insecticide was used at higher concentration compared to untreated control and normal dose of insecticide. Highest soil dehydrogenase (68.59 µg TPF g^{-1} soil day^{-1}), phosphatase (36.83 µg of P-NPg^{-1} soil hr^{-1}) and urease (2.58 µg of NH_4-N g^{-1} soil day^{-1}) activity was observed in the control plot where only water spray was taken. The lowest soil dehydrogenase (45.80 µg TPF g^{-1} soil day^{-1}), phosphatase (15.7 µg of P-NP formed g^{-1} soil hr^{-1}) and urease (1.00 µg of NH_4-N g^{-1} soil day^{-1}) activity was observed in treatment where spinosad 45 SC was applied at double the normal dosage (@ 0.50 ml L^{-1}) insecticide tested did not affect the soil enzymes activity.

Key words : Dehydrogenase, insecticides, phosphatase, urease, soil.

INTRODUCTION

The use of agricultural chemicals has become an imminent necessity in the present-day agriculture. Long-term and intensive use of pesticides may contaminate agricultural land and adversely affect non-target organisms. All over the world most of the pesticides are organic or inorganic in nature, which may have prolonged persistence in the environment. Despite the beneficial impacts of the pesticides in improving and stabilizing the agricultural productivity through the control of obnoxious weeds, fungi, and insects, these allochthonous synthetic chemicals are known to contaminate the soil ecosystem. Hence, these contaminants pose a great threat to the different microbial processes, such as ammonification, nitrification, and phosphorus mineralization, which play an important role in recycling of the plant nutrients dependent on the balanced equilibrium existing among the various groups of microorganisms in the soil.

Being toxic in nature, the pesticides and their metabolites may affect the soil enzyme activities, indirectly by affecting the microbial populations in the soil. Soil enzymes are therefore, useful in describing and understanding the ecosystem quality and the interactions among the subsystem and to assess the effect of various inputs on the soil health.

MATERIALS AND METHODS

A field experiment was conducted during *rabi,* 2015-16 at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad to study the persistence of four most commonly used insecticides *viz.,* chlorantraniliprole 18.5 SC, flubendiamide 480 SC, emamectin benzoate 5 SG and spinosad 45 SC at their normal and double the normal dose in cabbage (*Brassica oleracea* L.). The experiment consisted of fourteen treatments (Table 1) and three replications and was laid out in randomized complete block design. For treatments T_1 to T_{10}, four sprays were taken up at an interval of 15 days starting from 3rd week after transplanting (WAT). In treatments T_{11} and T_{12}, two sprays were taken up at 6th and 8th WAT (as recommended in the Package of Practices of University of Horticultural Sciences, Bagalkot, Karnataka). In treatments T_{13}, two sprays were taken up at 8th and 10th WAT and the trap crop mustard was grown along the border. Other recommended package of practices were common to all the treatments. The soil of the experimental site was with clay texture, with organic carbon content of 5.3 g kg^{-1}. Soil samples were collected from top 0-15 cm layer from each treatment at harvest and used for analysis of activity of dehydrogenase, phosphatase and urease enzymes by following the procedure as described by Casida *et al* (1964), Evazi and Tabatabai (1979) and Tabatabai and Bremner (1972), respectively.

RESULTS AND DISCUSSION

Dehydrogenase activity

Soil dehydrogenase activity is an indicator of total microbial activity in soil. Dehydrogenase activity in the insecticide treated soils ranged from 59.60 to 64.69µg TPF g^{-1} soil day^{-1}at single dose of chemicals and 45.80 to 57.41 µg TPF g^{-1} soil day^{-1}at double dosage of the chemicals. Highest soil dehydrogenase activity (68.59 µg TPF g^{-1} soil day^{-1}) was observed in the control plot where only water spray was taken. The lowest soil dehydrogenase activity, which decreased about 50 per cent (Fig. 1) was observed in T_8 treatment (45.80 µg TPF g^{-1} soil day^{-1}), where spinosad was applied at double dose (Table 1), compared to the control plot. Whereas, only 15 per cent decrease in dehydrogenase activity was observed in T_7 treatment (59.60 µg TPF g^{-1} soil day^{-1}), where spinosad was applied at single dose compared to control.

Soil dehydrogenase activity in the treatments T_{13} (IPM), T_{11} (Malathion 50 EC @ 2 ml L^{-1}) and T_5 (Emamectin benzoate 5 SG @ 0.25 g L^{-1}) was on par with control. The dehydrogenase activity at higher concentration of insecticides was significantly lower than their corresponding activity in control. The reduction in dehydrogenase activity could be due to reduction in the microbial population at higher concentration of insecticides. Reduction in soil enzyme activity at higher concentrations of teflubezuron and chlorpyriphos was reported by Jastrzenska (2011), deltamethrin and profenophos by Nare *et al* (2014) and thiamethoxam by Joyt *et al* (2015). Whereas, Gundi *et al* (2005) reported enhanced soil dehydrogenase activity at the higher level of 25 µg g^{-1} concentrations of monocrotophos, quinalphos and cypermethrin.

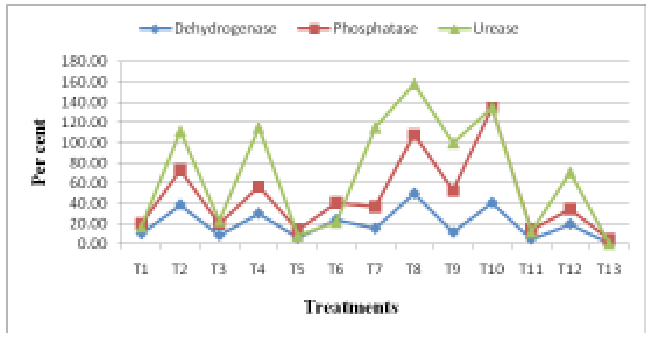

Fig. 1 : Per cent decrease in enzyme activity in soil over control.

Phosphatase activity

Phosphatase activity in the insecticide treated soils ranged from 32.30 to 24.10 µg of P-NP g^{-1} soil hr^{-1} in case of single dose of chemicals and 15.70 to 27.33 P-NP g^{-1} soil hr^{-1} at double dose the chemicals (Table 1). In most of the treatments, significant inhibition of phosphatase activity was recorded compared to the control. Highest soil phosphatase activity (36.83 µg of P-NPg^{-1} soil hr^{-1}) was recorded in control plot where only water spray was taken and followed by T_{13} (35.18 µg of P-NP g^{-1} soil hr^{-1}) where, NSKE (5%) spray was taken at 8^{th} and 10^{th} WAT.

Table 1 : Effect of insecticides on soil enzyme activity.

Treatments	Dehydrogenase activity (mg TPFg^{-1} soil day^{-1})	Phosphatase activity (mg of P-NP g^{-1}soil hr^{-1})	Urease activity (mg NH_4-N g^{-1}soil day^{-1})
T_1 : Chlorantranilipole 18.5 SC @ 0.20 ml L^{-1}	62.46	30.60	2.20
T_2 : Chlorantranilipole 18.5 SC @ 0.40 ml L^{-1}	49.46	21.30	1.22
T_3 : Flubendiamide 480 SC @ 0.25 ml L^{-1}	63.30	30.65	2.10
T_4 : Flubendiamide 480 SC @ 0.50 ml L^{-1}	52.70	23.50	1.20
T_5 : Emamectin benzoate 5 SG @ 0.25 g L^{-1}	64.60	32.28	2.38
T_6 : Emamectin benzoate 5 SG @ 0. 50 g L^{-1}	55.30	26.12	2.12
T_7 : Spinosad 45 SC @ 0.25 ml L^{-1}	59.60	26.90	1.20
T_8 : Spinosad 45 SC @ 0.50 ml L^{-1}	45.80	17.70	1.00
T_9 : T_1, T_3, T_5 and T_7 (In sequence)	61.60	24.10	1.29
T_{10} : T_2,T_4,T_6 and T_8 (In sequence)	48.80	15.70	1.10
T_{11}: Malathion 50 EC @ 2 ml L^{-1}	65.42	32.30	2.30
T_{12}: Malathion 50 EC @ 4 ml L^{-1}	57.41	27.33	1.51
T_{13}: 5 % NSKE to cabbage at 8^{th} and 10^{th} WAT	67.93	35.18	2.56
T_{14} : Control (water spray)	68.59	36.83	2.58
S.Em. ±	1.72	0.83	0.11
C.D. @ 5%	5.01	2.40	0.33
C.V. (5%)	5.08	5.21	11.31

Note: T_1 to T_{10} - Four sprays; T_{11} and T_{12} - Two sprays; T_{13}- Two sprays; WAT-Week after transplanting.

Lowest soil phosphatase activity, which was about 134 per cent less than control was observed in T_{10} treatment (15.7 µg of P-NP formed g^{-1} soil hr^{-1}) where, chlorantranilipole, flubendiamide, emamectin benzoate and spinosad applied at double dose in sequence, followed by T_8 treatment (108% decrease), where spinosad was applied at double dose. However, 50 per cent decrease in soil phosphatase activity was observed T_9 treatment which received chlorantranilipole, flubendiamide, emamectin benzoate and spinosad at single dose in sequence compared to control.

At normal rate of application, all the insecticides studied did not affect the phosphatase activity, but higher concentration reduction in the enzyme activity was observed which could be due to toxicity of insecticide to soil microbes. Reduction in phosphatase activity by application at higher concentration (10 kg ha^{-1}) of novaluron was reported by Meghana and Rangaswamy (2013). Similar results were reported for thiamethoxam by Jyot *et al* (2015).

Urease activity

Urease activity in the insecticide treated soils ranged from 2.30 to 1.20 µg of NH_4-N g^{-1} soil day^{-1} at single dose of chemicals and 2.12 to 1.00 µg of NH_4-N g^{-1} soil day^{-1} at double dose of the chemicals. Highest urease activity (2.58 µg of NH_4-N g^{-1} soil day^{-1}) was recorded in control plot where only water spray was taken. The lowest soil urease activity (1.00 µg of NH_4-N g^{-1} soil day^{-1}) was observed in T_8 treatment (158 % decrease), where spinosad was applied at double dose compared to control. Soil urease activity in the treatments T_{13} (IPM), T_{11} (Malathion 50 EC @ 2 ml L^{-1}) and T_5 (Emamectin benzoate 5 SG @ 0.25 g L^{-1}) was on par with control (Table 1).

The urease activity was significantly reduced in soil by the insecticide when applied at double dose, 2.20 to 1.22 µg of NH_4-N g^{-1} soil day^{-1} in case of chlorantraniliprole, 2.10 to 1.20 µg of NH_4-N g^{-1} soil day^{-1} in case of flubendiamide, 2.38 to 2.12 µg of NH_4-N g^{-1} soil day^{-1} in case of emamectin benzoate and 1.20 to 1.00 µg of NH_4-N g^{-1} soil day^{-1}in case of spinosad. Filimon *et al* (2015) also observed inhibitory effect of cypermethrin and thiamethoxam on urease activity compared to the untreated sample.

CONCLUSION

The activity of dehydrogenase, phosphatase and urease enzymes was lower in the insecticide treatments when used at higher concentration compared to untreated control and normal dose of insecticide. Hence at normal rate of application, all the insecticides did not affect the soil enzyme activities.

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