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Imidacloprid application changes microbial dynamics and enzymes in rice soil

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ABSTRACT

Extensive use of imidacloprid in rice ecosystem may alter dynamics of microorganisms and can change soil biochemical properties. The objective of this study was to assess the effect of imidacloprid on growth and activities of microbes in tropical rice soil ecosystem. Four treatments, namely, recommended dose (at 25 g a.i. ha^{-1}, RD), double the recommended dose (at 50 g a.i. ha^{-1}, 2RD), five times the recommended dose (at 125 g a.i. ha^{-1}, 5RD) & ten times the recommended dose (at 250 g a.i. ha^{-1}, 10RD) along with control were imposed under controlled condition. Dissipation half lives of imidacloprid in soil were 19.25, 20.38, 21.65 and 33.00 days for RD, 2RD, 5RD and 10RD, respectively. In general bacteria, actinomycetes, fungi and phosphate solubilising bacteria population were disturbed due to imidacloprid application. Changes in diversity indices within bacterial community confirmed that imidacloprid application significantly affected distribution of bacteria. Total soil microbial biomass carbon content was reduced on imidacloprid application. Except dehydrogenase and alkaline phosphatase activities, all other soil enzymes namely, β-glycosidase, fluorescien diacetate hydrolase, acid phosphatase and urease responded negatively to imidacloprid application. The extent of negative effect of imidacloprid depends on dose and exposure time. This study concludes imidacloprid application had transient negative effects on soil microbes.

1. Introduction

Many biotic and abiotic constraints limit the rice productivity in India (Behura et al., 2011). The estimated average yield losses in rice vary between 21 and 51 per cent and seven out of 20 major challenges in rice production are insect pest and diseases (Herdt, 1991). Insect pests cause about 10–15% yield loss among the biotic stresses. Brown plant hopper, *Nilaparvata lugens* (Stal.) is one of the most important sucking pests of rice, causing huge crop losses (Srivastava et al., 2009). In recent years, outbreaks of this hopper are regularly reported from different parts of India. Besides the number of organophosphate insecticides recommended to manage these pests, imidacloprid formulations namely 17.8 SL @100–125 mL/ha, 70 WG @30–35 g/ha and 30.5 SC @ 60–75 mL/ha are recommended for efficient control of brown plant hopper, white backed plant hopper and green leaf hopper in India. Moreover, imidacloprid 0.3 G @ 15 kg/ha is also recommended against stem borer, which is again a major pest of rice in tropical India.

Imidacloprid (1-(6 chloro-3-pyridinyl methyl)-N- nitro imidazolidin-2- ylideneamine) is a systemic insecticide possessing potential activity for controlling sucking pests like aphids, white flies, thrips, scales, plant bugs, flies, *etc*. with novel mode of action (Adak et al., 2012; Kagabu et al., 1992). It causes similar action both on target and beneficial insects (Fossen, 2006). Earlier it has been found extremely toxic even at low concentrations to beneficial organisms (Cresswell, 2011). In addition to this, volatilization loss of imidacloprid is unlikely to happen due to its low vapour pressure coupled with low Henry's law constant (Fossen, 2006). Upon application, imidacloprid can be degraded in soil by different environmental components. Soil type, pH, use of organic fertilizers, manures and presence or absence of ground cover determines the persistence of imidacloprid (Flores-Céspedes et al., 2002; Wu et al., 2012). When sprayed, only a part of the active substance is translocated into the plant and metabolized and rest

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