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Status of some enzymatic activities in cumin field soil under the influence of propiconazole

P. N. Dubey*, S. N. Saxena and B. K. Mishra

ICAR-National Research Centre on Seed Spices, Ajmer-305206, Rajasthan

Abstract

Cumin (*Cuminum cyminum* L.) variety Gujarat Cumin-4 (GC-4) was cultivated on coarse loamy soils taxonomically classified as Typic Haplustepts in the experimental farm located at NRC on Seed Spices, Ajmer, Rajasthan. The crop was sprayed with the fungicide propiconazole at recommended rate (RR), 2-times recommended rate (2RR) and 5-times recommended rate (5RR) at 60 and 75 days after crop sowing. The effect of foliar spray of propiconazole on the soil enzymatic activities was studied. Propiconazole application at RR and 2RR resulted in a temporary and less toxic effect on soil biochemical activities but the 5RR dose had a slightly longer toxic effect. Soil urease activity indicated variability with application rate. It was least affected and regained after 15 days in RR & 2RR as compared to 5RR, better explained as the urea degrading enzyme does not have any role in degradation pathway of fungicides and therefore least affected by fungicide application. The dehydrgenase activity (DHA) activity decreased up to 30th day at RR & 2RR but it continued to decline in 5RR till harvest. DHA in soil is an overall indicator of microbial activity being most susceptible parameter to pesticide application. From this study it could be concluded that the application of propiconazole at 5RR had adverse effect on soil biochemical activities.

Key words : Bio-chemical activity, microbial activity, propiconazole, soil enzymes, soil health.

Introduction

Cumin (*Cuminum cyminum* L.) is one of the most important cash crops grown in the arid and semi arid region of Rajasthan and Gujarat. The variety Gujarat Cumin-4 (GC-4) having partial resistant to blight is extensively cultivated in these regions. The area, production, export and export revenue respectively for cumin is 760130 ha, 485480 tonnes, 119000 tonnes and 196320 lakh Rs. (indianspices.com; Spice Board of India, 2017). The intensive cultivation and mono cropping of cumin leads to the outbreak of various pests and diseases particularly blight in cumin reducing the yield drastically and often total collapse of the crop. Propiconazole a member of triazole group is one of the most effective and efficacious fungicides against blight. The excessive use of chemicals leads to edaphological contaminations, pesticide residue load and acts on non-target microorganisms. Propiconazole 1-[[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-yl]methyl]-1,2,4-triazole is a penetrable (systemic), broad spectrum, eradicant and protectant fungicide used against fungal diseases of various crops. Through foliar spray it reaches the soil through draining and repeated application can result into its soil accumulation. Among the methods used for estimating relationships between pesticide treatment and soil microbial parameters, soil enzyme assay is used to predict biological/biochemical indicators of soil quality (Dick,1994; Amador *et al.*, 1997 and Kourtev *et al.*, 2002). It is stipulated that the above mentioned parameters may be affected by propiconazole application in cumin cultivation, hence this study was undertaken to investigate the soil microbial and biochemical indicators in the soil under study. A field study was conducted on cumin crop to study the effect of propiconazole on the biochemical scenario in Typic Haplustept soil at NRCSS farm, Ajmer during the cropping season under report.

Material and methods

A field study was conducted at NRCSS experimental farm, Ajmer during winter season of 2016-17. The area is located under arid, subtropical ecological zone. The soil is sandy loam in texture, deep and classified as Typic Haplustept. The organic carbon content ranges between 0.24- 0.31%. Randomised block design was used with three replications for each treatment with plots (4x3 m^2) separated by 0.5m distance. Cumin variety GC-4 was sown at recommended seed rate with 30 cm row-to-row spacing. Propiconazole (Tilt 25% EC) obtained from Syngenta Ltd. was applied at recommended rate (RR), 2-times recommended rate (2RR) and 5-times recommended rate (5RR) at 60 and 75 days after crop sowing (DAS) to study the side effects of

*Corresponding author email: pnd.nrcss@gmail.com

propiconazole on soil bio-chemical parameters. Untreated control plots were used for comparison of results.

Soil sampling

Five soil samples were collected from each treatment after the second spray of propiconazole (75 DAS) at 0, 1, 7, 15, 30, 45 days interval and at harvest. Samples were mixed to derive a homogeneous representative sample from each treatment and stored for further analysis at -20^{0}C.

Estimation of bio-chemical indicators

Dehydrogenase activity was estimated by monitoring the rate of triphenylformazan (TPF) formation from the substrate 2,3,4-tri-phenyl tetrazolium chloride (TTC) as per the protocol of Klein *et al.,* (1971) and Urease activity was measured following the protocol developed by Tabatabai and Bremmer (1972). Data was analysed using Microsoft Excel (Microsoft Inc.). All analysis was carried out in triplicates and results expressed as means and standard deviations. Significant differences between means were determined using analysis of variance (ANOVA).

Results and discussion

Dehydrogenase activity (DHA)

Dehydrogenase activity (DHA) in soil is an indicator of overall microbial activity. Effect of propiconazole foliar spray on decreased DHA was clearly visible in the results at RR, 2RR and 5RR doses. The DHA activity decreased up to 30th day at SD & DD but it continued to decline further in 5RR dose till harvest (Fig. 1). Literature data suggests that DHA is most susceptible parameter to pesticide application (Bacmaga *et al.,* 2014 & 2015a, b and Kucharski *et al.,* 2008). The resilience of soil DHA in soil under the influence of propiconazole (SD & DD) is moderate ie. 30 days only. Kalam and Mukherjee (2002) reported that triazoles like hexaconazole and propiconazole significantly reduce the DHA up to 21 days.

Dehydrogenase occurs in soils as an intra-cellular enzyme closely linked to microbial respiratiory processes. The dehydrogenases released from the dead cells do not accumulate in soil and undergo rapid degradation. Free enzymes normally have a short span activity which can be quickly degraded irreversely (Cycon and Pitrowska-Seget, 2015).

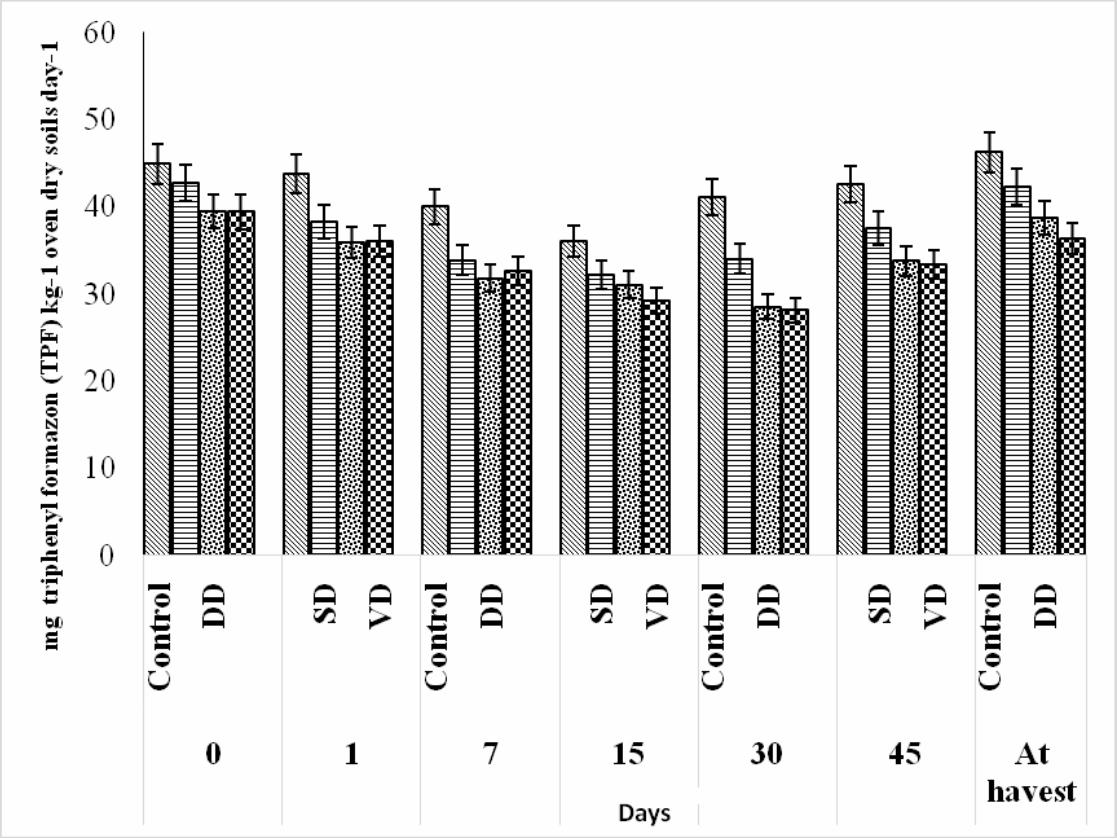

Fig 1: ***Effect of foliar application of propiconazole on soil dehydrogenase activity (DHA)***

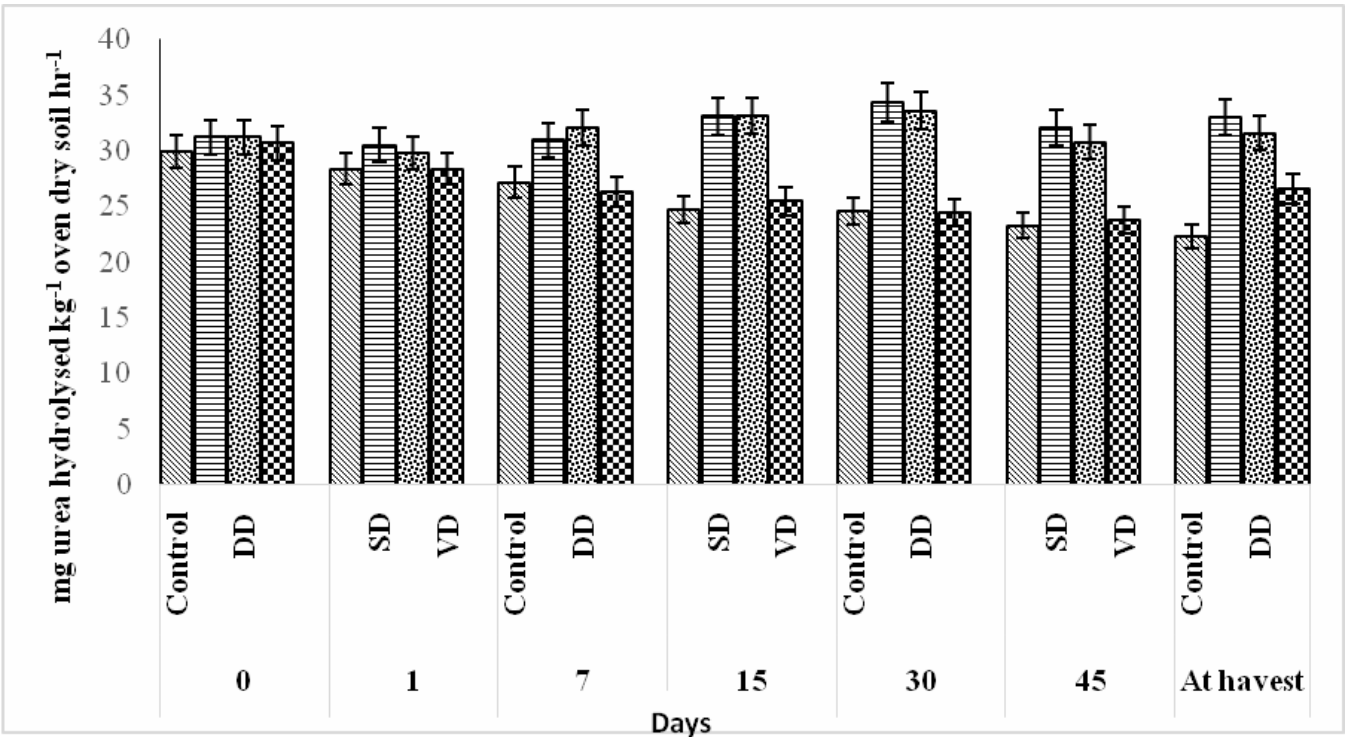

Fig 2: ***Effect of foliar application of propiconazole on soil urease activity***

Effect of foliar application of propiconazole on soil urease activity

Soil urease activity indicates variability with application rate. It regains after 15 days in SD & DD as compared to VD (Fig.2). This could be explained by the fact that the urea degrading enzyme does not have any role in degradation pathway of fungicides and therefore least affected by fungicide application (Tejada, 2011). Further the presence of optimum quantity of metabolites in soil could have supported the earlier regain of urease activity at SD & DD, as after the degradation of propiconazole, these metabolites cold have been used as substrate for urease activities (Moreno *et al.,* 2007). Urease being an extracellular enzyme is strongly bound to organic matter and chelated to mineral sites of soil thus forming a complex with the humic matter and becoming relatively stable to degradation and denaturation by fungicides (Ramudu *et al.,* 2011).

Conclusion

Propiconazole application at SD & DD had a short lived and transitory toxic effects on microbial parameters studied in the present experiment. However at higher concentrations (5RR), it decreases the soil enzyme activities. Significant decrease of dehydrogenase and urease enzymes activity and microbial activity with propiconazole at 5RR reveals that it's harmful to the soil environment, hence higher doses through repeated/ frequent application must be avoided. The evaluation of propiconazole on soil quality needs to be further evaluated.

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