International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(5): 2841-2845

Received: 17-07-2018
Accepted: 18-08-2018

C Bharathi
Assistant Professor (SS&AC) and Professor (Agronomy)
Department of Agronomy
Tamil Nadu Agricultural University, Coimbatore,
Tamil Nadu, India

C Chinnusamy
Assistant Professor (SS&AC) and Professor (Agronomy)
Department of Agronomy
Tamil Nadu Agricultural University, Coimbatore,
Tamil Nadu, India

Correspondence
C Bharathi
Assistant Professor (SS&AC) and Professor (Agronomy)
Department of Agronomy
Tamil Nadu Agricultural University, Coimbatore,
Tamil Nadu, India

An assessment of mitigation measures for atrazine in calcareous sandy loam soil with maize

C Bharathi and C Chinnusamy

Abstract
A pot culture experiment was conducted to assess the effect of organics and microbes in mitigating atrazine in soil. The experiment was carried out during 2017-18 at Tamil Nadu Agricultural University, Coimbatore with the test crop of maize. Soil samples were collected from the field which did not receive the atrazine previously and used for conducting the pot study. About 10 kg soil was filled up in each pot. The soil used for the study is calcareous sandy clay loam in texture having pH 8.28,EC 1.2 dS/m, OC 0.46%, available N,P,K of 145.6, 17.8 and 621 kg/ha. The treatments constituted application of FYM, green manure, crop residues, biochar, urea and microbes *Viz*., Tricoderma, Pseudomonas, phosphorbacteria and VAM along with control. The treatments were imposed 3 days before sowing of maize. Atrazine was applied to each pot equivalent to 0.5 kg/ha on 3rd day after sowing maize. Soil samples were collected from a depth of 0-15 cm on 0, 1, 3, 5, 10, 15, 30 and 45 DAA and analysed for atrazine residues. A valid homogenized representative soil sample from each replication of each treatment was taken and the atrazine was extracted using solvent mixture consisting methanol: water (7:3). The soil-suspension was centrifuged and the supernatant was filtered. The above step was repeated two times and the supernatant phase was combined and concentrated to dryness. The residues of atrazine were dissolved in HPLC grade acetonitrile and determined by HPLC equipped with Photo Diode Array Detector at a wave length of 221 nm. The initial deposition on day 0 (After 1hour) ranged from to 0.423 - 0.721 mg / kg across different treatments sources consisting of cultural and microbes application to enhance the degradation of atrazine from the soil. The degradation equation, correlation coefficient and half lives were worked out. The results revealed that the dissipation was faster under FYM, vermicompost and biochar applied treatments and the slowest degradation was noticed in control. The lowest half life of 8.8 days was observed in FYM treatment. The dissipation of atrazine in soil followed first order reaction kinetics irrespective of sources of mitigation measures and about 80 percent of the initial atrazine deposition degraded from the soil on 45th day after its application. Based on the present results it was found that the FYM @ 10 t /ha or vermicompost @ 5/ha or biochar @ 5 t/ha is efficient in reducing the residual concentration of atrazine in maize grown soil. This could be due to the enhanced adsorption of the compounds by these sources. The application of FYM degraded the atrazine very fast with the half live 8.8 days and slow degradation by microbes could be ascribed to the low quantity of application when compared to FYM.

Keywords: Atrazine, mitigation, FYM- Vermicompost, half life, HPLC- PDA

Introduction
An ideal soil applied herbicide should persist long enough to give an acceptable period of weed control but not so long that soil residues after crop harvest limit the nature of subsequent crops which can be grown (Jayakumar and Jagannathan, 2003). According to WHO 'any substance or mixture of substances in food for man or animals resulting from the use of a herbicide and includes any specified derivatives, such as degradation and conversion products, metabolites, reaction products, and impurities that are considered to be of toxicological significance' is defined as herbicide residue. Residues remaining on or in a crop commodity from a given method, timing and rate of herbicide application may vary with trial site and climate, and the limits of such variation are important to the establishment of maximum residue limits (MRLs). The enormous benefits and widespread application of herbicides has undoubtedly increased crop production but has also resulted in unintentional exposure to the ecosystem. As herbicides are chemical in nature and judicious use of herbicide provide selective and economical weed control but excessive, repeated and indiscriminate use may results in residues, phytotoxicity and adverse effects on succeeding crops, non-targets organisms, environment and ultimately hazard to human. Mitigation strategies of herbicide residue hazard need to be developed to lessen their effect on environment by reducing adverse

impacts to less than significant levels Sondhia (2014) [8]. Atrazine is a widely used herbicide because it is highly effective, inexpensive and has a flexible use pattern. Atrazine is a highly persistent herbicide (40-90 days at normal doses) and its potential to migrate to ground and surface water is substantial. Various management techniques viz., application of organics, micro organisms have been developed which can help to minimise the residue hazards in soil. Microbial degradation also plays an important role in the persistence of these herbicides in the soil due to the fact that they are used as a source of energy and of nitrogen, decreasing in this way their availability in the soil solution (Bollag and Liu, 1990). The present study envisages the use of organics and microbes in mitigating atrazine in soil.

Materials and methods

Soil samples were collected from the field which didn't receive the atrazine previously and used for conducting the pot study. The treatments constituted application of FYM, Vermicompost, Crop residue, Biochar, Urea and microbes viz., Phosphobacteria, VAM, *Pseudomonas* and *Tricoderma* together with a control. Treatments were imposed 3 days before sowing of maize. On 3rd day after maize sowing, the atrazine was applied to each pot equivalent to 0.5 kg/ha. Soil samples were collected from a depth of 0-15 cm on 0, 1, 3, 5, 10, 15, 30 and 45 DAHA and analysed for atrazine residues. Residue of atrazine was extracted using acetonitrile and determined by HPLC as detailed below.

A valid homogenized representative soil sample from each replication of each treatment was taken in 500 ml conical flask and the atrazine was extracted using 20 ml solvent mixture consisting methanol: water (7:3) after shaking in orbital shaker for 8 hrs. The soil-suspension was centrifuged at 2500 rpm for 10 mins and the supernatant was filtered. The above step was repeated two times and the supernatant phase was combined. Filtered samples were concentrated to dryness using water bath. The residues of atrazine compounds were dissolved in 2 ml acetonitrile HPLC grade solvent for HPLC determination.

	HPLC Parameters for Atrazine		
i)	Column	:	Agilent Eclipse C18, 4.6 x 150 mm, 5 µm
ii)	Mobile phase	:	Acetonitrile: MilliQ-Water (70:30% v/v)
iii)	Flow rate	:	0.5 mL min^{-1}
iv)	Detector	:	Photo Diode Array Detector
v)	Wavelength (λ_{max})	:	221 nm
vii)	Injection volume	:	10 µl
viii)	Retention time	:	4.20 ± 0.2 min
ix)	LOD	:	0.01 mg /kg
x)	LOQ	:	0.05 mg/kg

Result and Discussion

The experimental soil is a calcareous sandy clay loam having pH 8.35, EC 01.1dS/m, OC 0.46%, available N,P,K of 260, 19.8 and 593 kg/ha. Atrazine residue was analysed from soil samples collected from the pot grown with maize as test crop at periodic intervals and found that the initial deposition on day 0 ranged from to 0.423 - 0.721 mg / kg (Table 1) across different treatments sources consisting of organics and microbes application to enhance the degradation of atrazine from the soil.

Table 1: Persistence of atrazine in soil as influenced by the organic sources and microbial application under pot study

Treatments		Atrazine residues (mg/kg) in soil							
		0 day	1 day	3 day	5day	10 day	15 day	30 day	45 day
T_1	FYM @ 10 t/ha	0.494	0.301	0.278	0.204	0.126	0.072	0.039	0.010
T_2	Vermicompost @ 5 t/ha	0.564	0.418	0.317	0.314	0.145	0.078	0.043	0.024
T_9	Crop residue (maize straw) incorporation @ 5 t/ha	0.535	0.354	0.311	0.270	0.201	0.109	0.064	0.030
T_3	Biochar @ 5 t /ha	0.423	0.402	0.325	0.246	0.139	0.076	0.031	0.011
T_8	Urea @ 100 kg/ha	0.677	0.560	0.398	0.272	0.176	0.098	0.053	0.033
T_4	Phosphobacteria @ 10 kg/ha	0.576	0.453	0.356	0.208	0.200	0.092	0.035	0.020
T_6	VAM @ 10 kg /ha	0.508	0.321	0.294	0.198	0.127	0.088	0.043	0.018
T_7	Pseudomonas @ 10 kg/ha	0.551	0.492	0.353	0.268	0.169	0.082	0.050	0.021
T_5	Trichoderma @ 10 kg /ha	0.522	0.448	0.362	0.302	0.216	0.102	0.058	0.031
T_{10}	Control (no manure/bioagents)	0.721	0.566	0.428	0.318	0.234	0.112	0.060	0.037

The dissipation of atrazine in soil followed first order reaction kinetics irrespective of sources of mitigation measures. Irrespective of mitigation measures followed, about 80 percent of the initial atrazine deposition degraded from the soil on 45th day after its application (Fig.1) and the chromatograms are given in Fig. 2. It was found that the dissipation was faster under FYM, vermicompost and biochar applied treatments with the half lives of 8.8, 8.95 and 9.37 days, respectively when comparing the microbe's application and crop residues. The degradation equation, correlation coefficient and half lives are given in Table 2. Similarly the simazine persisted in laterite soils up to 60 and 80 days when it was applied at 0.25 and 0.50 kg/ha (AICRP-WC Annual report, 2002) [1].

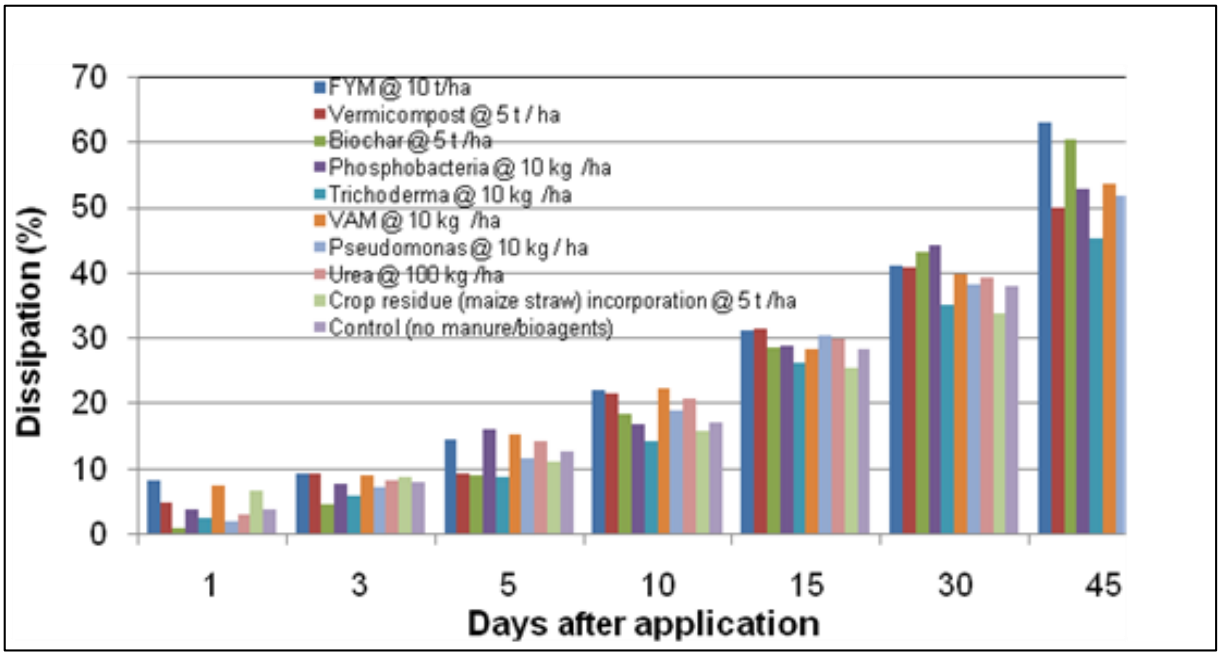
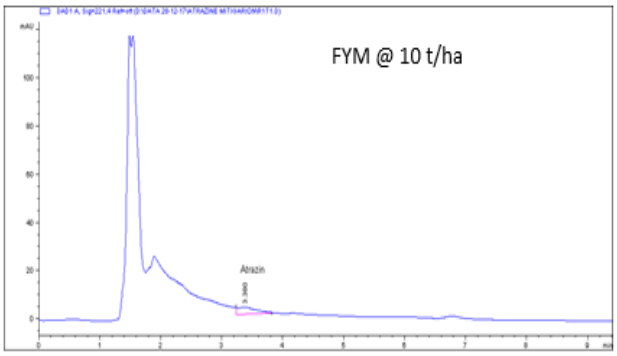
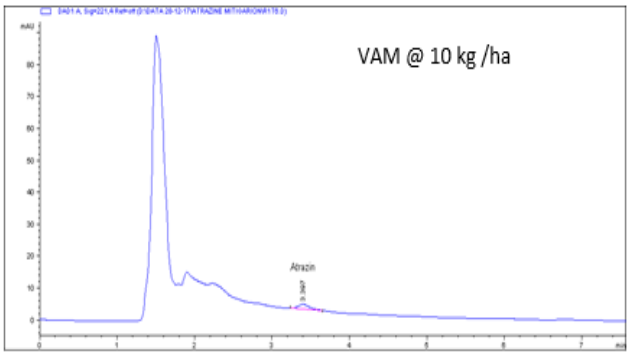


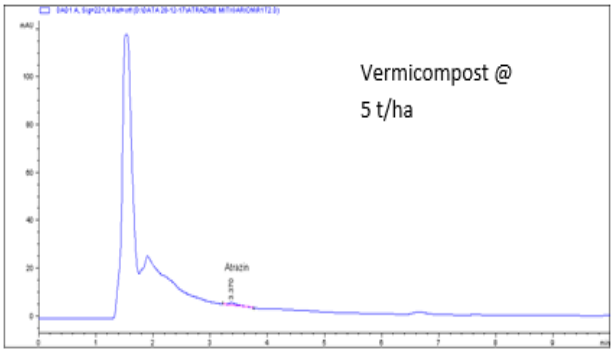
Fig 1: Dissipation of atrazine in soil under pot study

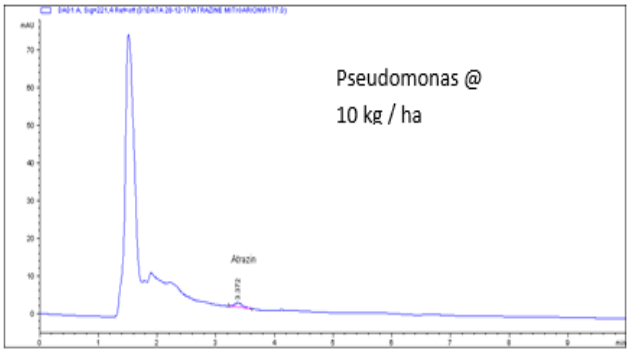
Table 2: Atrazine dissipation equation, correlation coefficient and half lives in soil

Treatments		Regression equation	R^2	Half-life (days)
T_1	FYM @ 10 t/ha	y = -0.050x + 2.600	0.964	8.80
T_2	Vermicompost @ 5 t/ha	y = -0.054x + 2.983	0.983	8.95
T_9	Crop residue (maize straw) incorporation @ 5 t/ha	y = -0.039x + 2.648	0.947	9.76
T_3	Biochar @ 5 t /ha	y = -0.050x + 2.647	0.993	9.37
T_8	Urea @ 100 kg/ha	y = -0.054x + 2.783	0.981	10.06
T_4	Phosphobacteria @ 10 kg/ha	y = -0.048x + 2.699	0.927	10.92
T_6	VAM @ 10 kg /ha	y = -0.047x + 2.604	0.946	10.53
T_7	Pseudomonas @ 10 kg/ha	y = -0.053x + 2.729	0.993	10.15
T_5	Trichoderma @ 10 kg /ha	y = -0.044x + 2.708	0.980	10.68
T_{10}	Control (no manure/bioagents)	y = -0.049x + 2.809	0.976	11.60









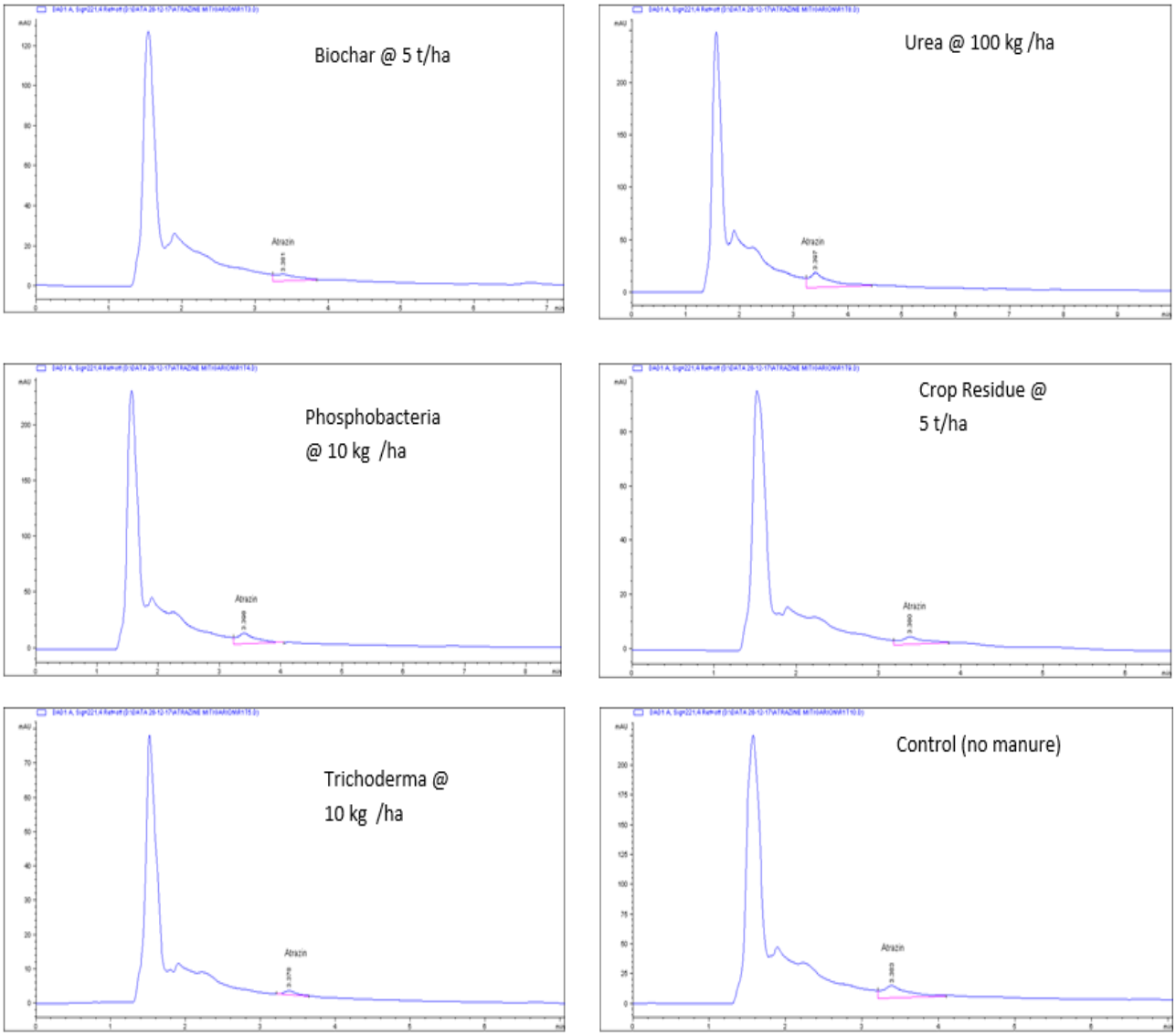


Fig 2: Chromatograms of atrazine in soil on 45th day under mitigation study

Based on the present results it was found that the FYM @ 10 t /ha or vermicompost @ 5/ha or biochar @ 5 t/ha is efficient in reducing the residual concentration of atrazine in maize grown soil. This could be due to the enhanced adsorption of the compounds by these sources. The application of FYM adsorbs the herbicide molecules in their colloidal fraction and makes them unavailable for crops and weeds after a lag phase microbial population thriving on organic matter starts decomposing the herbicide residues at a faster rate due to moisture holding capacity of high organic matter soils. Mukherjee (2009) [6] in his studies revealed that FYM was found to be most effective in soil and enhances the degradation as compared to the other amendments which is in accordance with the present findings and give a new dimension of it's utilization for removal of persistent pesticides. Meena *et al.,* (2007) [5] reported that the FYM application at 12.5 t/ha reduced the atrazine content significantly followed by compost (12.5 t/ha). Selvaraj (I985) [7], revealed that the residues of atrazine (0.5 kg/ha) applied to pearl millet crop affected the subsequent green gram and cowpea. However, the FYM application at 12.5 t/ha to pearl millet found to mitigate the residual toxicity of atrazine in soybean crop. Jayakumar *et aI*. (1990) [4] also found that application of charcoal at 5.0 kg/ha along the seed line reduced the residual toxicity of atrazine in soybean crop. The application of different microbes degraded the atrazine with the half lives ranged from 10.15 to 10.92 days and slow degradation by microbes could be ascribed to the low quantity of application when comparing the organic sources like FYM, Vermicompost, biochar etc. Chinnusamy *et al.* (2008) [3] reported that the atrazine applied at recommended level (2.0 kg/ha) left no residue in the post-harvest soils whereas, atrazine sprayed at 3.0 kg/ha left residue above maximum residue limit in two out of three years study.

Conclusion

Application of FYM @ 10 t /ha or vermicompost @ 5/ha or biochar @ 5 t/ha is efficient in reducing the residual concentration of atrazine in maize grown soil. This could be due to the enhanced adsorption of the compounds by these sources. The application of FYM degraded the atrazine very fast with the half live 8.8 days and slow degradation by microbes could be ascribed to the low quantity of application when compared to FYM.

References

1. AICRP-WC Annual report. All India co-ordinated research programme on weed control. In: Annual report. DWSRC, Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, 2002.

2. Bollag JM, Liu SY. Biological transformation processes of pesticides. In: Cheng. H.H. (Ed.). Pesticide in the soil environment**:** processes, impacts, and modeling. Madison: Soil Science Society of America. 1990, 169-211.
3. Chinnusamy C, Prabhakaran NK, Janaki P, Govindarajan K. Compendium on Weed Science Research in Tami Nadu (25 years). Dept. of Agronomy, TNAU, Coimbatore. 2008, 220.
4. Jayakumar R, Kempuchetty N, Sankaran S. Management of atrazine residue using certain amendents in soybean. In: Abst. of Papers, Biennial conference ISWS. Jabalpur, 1990.
5. Meena S, Chinnusamy C, Varsney JC. Status report on herbicide residue. Dept. of Agronomy, TNAU, Coimbatore. 2007, 1-30.
6. Mukherjee I. Effect of organic amendments on degradation of atrazine. Bulletin Environmental Contamination of Toxicology. 2009; 83(6):832-5.
7. Selvaraj T. Residual effect of herbicides in millet pulse rotation in relation to carbofuran and farm yard manure. M.Sc. (Ag) Thesis, TNAU. Coimbatore. 1985.
8. Sondhia S. Herbicides residues in soil, water, plants and nontargeted organisms and human health implications: an Indian perspective. Indian Journal of Weed Science. 2014; 46(1):66-85.