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### Fate Of Pendimethalin Herbicide In Soil And Pea Plant (*Pisum Sativum* L.)



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#### ABSTRACT

The persistence and dissipation of pendimethalin herbicide at two fortification levels i.e. 1 and 2kg/ha in soil, leaves and pods of pea plant were performed. The degradation of pendimethalin in soil during 0 to 2 days was many folds higher than the later degradation which continued till 60 days for 1 kg/ha and upto 74 days for 2kg/ha. No detectable residue was found after 60 days and 74 days for both the rates of application. Dissipation followed first order kinetics which could be better accounted by a biphasic pattern. © 2006 Trade Science Inc. - INDIA

#### KEYWORDS

Dissipation;  
Persistence;  
Pendimethalin;  
First order kinetics;  
Pea plant.

#### INTRODUCTION

Pendimethalin [N-(1-ethylpropyl)-3, 4-dimethyl 2,6-dinitrobenzenamine], commercially named as Prowl or Stomp, has selective pre-emergence characteristics<sup>[1]</sup>. It is a soil applied herbicide basically used for controlling of weeds in crops such as peas, soybean and several other vegetable crops. In Europe, it has also been approved for use in winter wheat (*Triticum aestivum* L.)<sup>[2]</sup>.

Pendimethalin is a selective herbicide, principally absorbed by the roots and leaves. It acts by inhibiting cell division and cell elongation. The affected plant dies shortly after germination or following emergence.

Pesticide dissipation is its degradation or loss from different system into the environment. It depends on several factors such as temperature, moisture, soil microbes etc. Pesticides that reach the soil dissipate by various methods like co-distillation, volatilization

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and degradation to simpler compounds or may get bound to organic matter or soil<sup>[3]</sup>.

Since, pendimethalin is a soil applied herbicide and is frequently used for weed control in pea plants, the present study was conducted with the aim to study about the fate of pendimethalin in soil which is essential from the environmental soil pollution point of view as pea forms an important edible commodity of this region. The study is important from the health point of view as longer persistence of herbicide may cause its gradual leaching to underground waters which can contaminate the drinking water sources.

### MATERIALS AND METHODS

#### Chemicals

The technical grade pendimethalin (99% purity) was obtained by courtesy of American Cyanamid company, USA. The chemicals used during the course of this study were of analytical and HPLC grade, obtained from E. Merck (India) Ltd.

#### Sample collection and determination of $\lambda_{max}$

Samples of soil, leaves and pods of pea plant for the present investigation were collected from Crop Research Centre, Pantnagar. The samples were collected immediately after herbicide application and then at different time intervals up till the harvest time.

A stock solution of 100 ppm of pendimethalin was prepared to determine the  $\lambda_{max}$  of the herbi-

cide. It was found to be 239 nm.

Serial dilutions of varying concentration in a range of 5-10 ppm of pendimethalin were prepared for plotting a calibration curve. Peak area vs. different concentrations of pendimethalin was plotted and a straight line was obtained (Figure 1)

#### Extraction and clean up of soil, leaf and pod samples

Soil samples were collected at different time intervals 0 (1 hr), 1, 2, 4, 7, 14, 28, 35, 45, 60, 74, 90 days after application and finally on the harvest day (i.e. 120d after herbicide application). Leaves were collected from the day of their emergence on plants i.e. 30 days after herbicide application till harvest time. Pod samples were collected four months after herbicide application and then at harvest time.

Twenty gram soil was taken from each of the control and treated plots and was transferred to centrifuge tubes. Thirty ml of acetone-hexane mixture in a ratio of 1:4 was added to these tubes. The tubes were shaken properly and kept for centrifugation for 30 minutes. The clear supernatants were filtered through Whatman filter paper in a round bottom flask and the whole process was repeated twice. The collected supernatant was evaporated on a rotary evaporator at  $45 \pm 2^\circ\text{C}$  and the residue was dissolved in 2 ml acetonitrile, filtered through 0.45  $\mu$  Millipore filter and kept in freezer till HPLC analysis.

In case of leaves and pods, 10 g of each were weighed, and subjected to extraction process as above. The supernatants collected after centrifugation were passed through a column of charcoal, silica gel and sodium sulfate. The elutes were dried on a rotary evaporator at  $45 \pm 2^\circ\text{C}$ . The residues were dissolved in 2 ml acetonitrile (HPLC grade), and filtered through 0.45  $\mu$  before HPLC analysis.

#### Analysis of pendimethalin

Schimidzu HPLC system with varying wavelength UV detector was used for chromatographic analysis. The operating parameters were RP-18 column, mobile phase acetonitrile : water in 80 : 20 ratio in isocratic mode at a flow rate of 1 ml/ minute and UV detection at 239 nm. The retention time of pendimethalin under the above conditions was 14

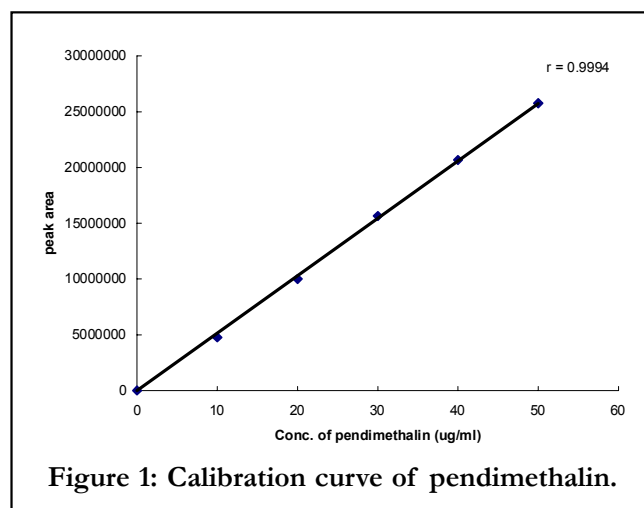


Figure 1: Calibration curve of pendimethalin.

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**TABLE 1: Amount of pendimethalin in soils applied at 1 Kg/ ha and 2 Kg/ha of herbicide**

Incubation interval	Amount of pendimethalin recovered ( $\mu\text{g/g}$ )			
	1 kg/ha		2 kg/ha	
	persistence	% dissipation	persistence	% dissipation
0 day	0.4565 (100)	0.00	0.913 (100)	00.00
1 day	0.4331 (94.88)	5.12	0.736 (80.7)	19.3
2 day	0.394 (86.52)	13.49	0.697 (76.33)	23.67
4 day	0.390 (85.52)	14.48	0.672 (73.76)	26.24
7 day	0.387 (84.94)	15.06	0.662 (72.58)	27.42
14 day	0.334 (73.20)	26.8	0.636 (69.81)	30.19
28 day	0.332 (72.78)	27.22	0.558 (61.27)	38.73
35 day	0.260 (57.07)	42.93	0.495 (54.25)	45.75
45 day	0.18 (39.4)	60.6	0.329 (36.10)	63.9
60 day	0.06 (13.14)	86.86	0.129 (14.22)	85.78
74 day	ND	ND	0.089 (9.85)	90.15
90 day	ND	ND	ND	ND
124 day	ND	ND	ND	ND

Values in parenthesis show % persistence of the herbicides. (ND < 0.01  $\mu\text{g/g}$ )

minutes.

### RESULTS AND DISCUSSION

Persistence and dissipation studies of pendimethalin in soil at two different concentrations were performed. Percent dissipation values at different time intervals were calculated considering the amount of herbicide recovered on 0<sup>th</sup> day (1 hr after application) as 100%. The values obtained for persistence as well as dissipation at 1 and 2 kg pendimethalin ha<sup>-1</sup> application rates are depicted in TABLE 1.

As evident from the table the herbicide degraded faster during first two days at both the rates of application followed by a decrease in dissipation rate and later, on an increase in dissipation pattern till 60<sup>th</sup> and 74<sup>th</sup> day of application at 1 and 2 kg ha<sup>-1</sup> application rates respectively, after which it became non detectable.

The amount of pendimethalin recovered from soil at different time intervals for both 1 and 2 kg ha<sup>-1</sup> application rates were fitted in first order kinetic equation.

$$C = C_0 e^{-\lambda t}$$

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**TABLE 2:** Computed values of degradation rate constant, half –life and coefficient of determination for pendimethalin as per biphasic first order kinetics.

Computed values	Pendimethalin Application Rate ( kg/ha)	
	1	2
Initial Phase (0 – 2 d) Degradation Rate Constant ( $\lambda$ )	0.0736	0.1350
Half – life ( $t_{1/2}$ )	9.42	5.13
Coefficient of Determination ( $R^2$ )	0.974	0.894
Later phase ( 4 d –onward) Degradation Rate Constant ( $\lambda$ )	0.0295	0.0297
Half – life ( $t_{1/2}$ )	23.50	23.34
Coefficient of Determination ( $R^2$ )	0.832**	0.905**

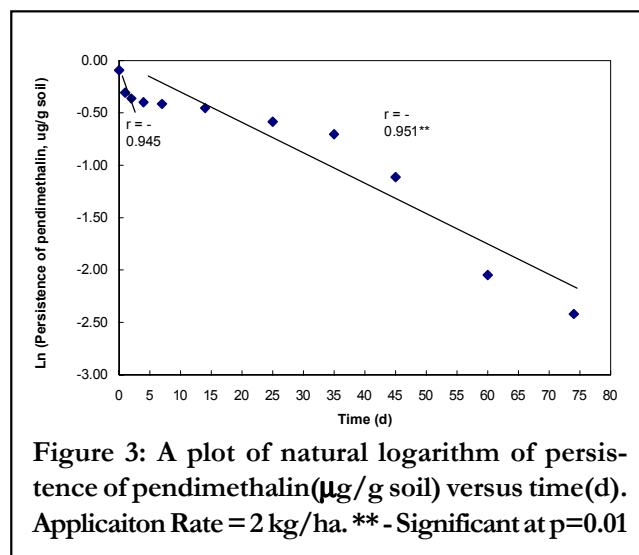
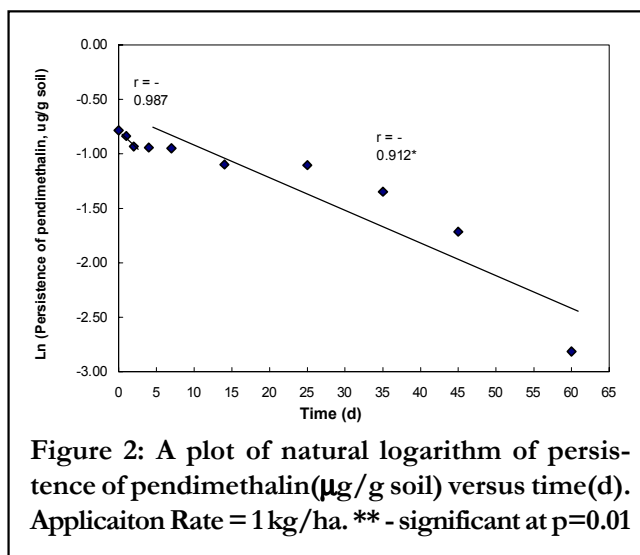
\*\* Significant at  $p = 0.01$

Where C is amount of pendimethalin recovered from soil at time t.  $C_0$  is amount of pendimethalin recovered at  $t = 0$ ,  $\lambda$  is degradation constant and t is time in days.

For both the rates of pendimethalin application (1 and 2 kg/ha) logarithm plots of pendimethalin residues versus time were plotted (Figure 2 and 3). The figures depict two distinct straight line patterns which signify that kinetics of pendimethalin degradation at both the application rates occurs in the biphasic mode and each phase could be well accounted by a first order kinetics. A similar two phase dissipation for pendimethalin has also been reported<sup>[4]</sup>. Computed values of degradation constant ( $\lambda$ ), half life ( $t_{1/2}$ ) and coefficient of determination ( $R^2$  values) are presented in TABLE 2. It is evident from the data in TABLE 2 that the degradation of pendimethalin during 0 to 2<sup>nd</sup> d was many folds

higher than the degradation afterwards. The half life ( $t_{1/2}$ ) values were 9.42 and 5.13d, for initial faster degradation at 1 and 2 kg ha<sup>-1</sup> application rate respectively. However,  $t_{1/2}$  values for the later slower degradation were 23.5 and 23.3d at 1 and 2 kg/ha rate, respectively. The coefficient of determination ( $R^2$  values) varied from 0.832 to 0.974. A 6 and 27 d time as half life period of pendimethalin during initial 2-5 d and later 12 d sampling period has also been reported<sup>[5]</sup>.

Persistence of pendimethalin was found to be only 8.51% and 14.92% of the initial concentration after one month of herbicide application at 1 and 2 kg ha<sup>-1</sup> treatment rate in leaves but became non detectable ( $<0.01 \mu\text{g/g}$ ) after 2 months in both the cases. At harvest time (i.e after 120d of herbicide application) the residues of pendimethalin were non detectable ( $<0.01 \mu\text{g g}^{-1}$ ).



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### REFERENCES

In case of pod samples also the residues of Pendimethalin at both the application rates (i.e. 1&2 kg ha<sup>-1</sup>), were non detectable after 120d or harvest time.

The persistence of pendimethalin for a long duration in soil could be attributed to the presence of high organic matter content in soils of this region which firmly adsorb the herbicide and render it unavailable to microbial degradation. Soil microorganisms also play an important role in release and dissipation of pesticide<sup>[6-8]</sup>.

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