J. Pest Control & Environ. Sci. Vol 2 pp 117-26, 1990
Symposium of IPM & E.P. Nov.7-8, 1990 Alex. Egypt.

The Effect of Moisture Content on The Fate of Diflubenzuron in Stored Wheat and Sandy Loam Soil.

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ABSTRACT

The fate of diflubenzuron [1-(4-chlorophenyl) -3- (2.6 -diflurobenzoyl) urea] applied on wheat as a grain protectant and on sandy loam soil was investigated. The influence of different levels of moisture content on diflubenzuron fate was ascertained. Diflubenzuron degraded slowly on wheat. The half life values of diflubenzuron at moisture content of 10% and 15% were 24.3 and 17.7 weeks respectively. In soil the half life values of diflubenzuron were 13.5 and 11 days for sandy loam soil adjusted at 10% and 30% moisture content respectively.

1. INTRODUCTION

In recent years, the insect growth regulator diflubenzuron [1-(4-chlorophenyl)-3-(2,6-diflurobenzoyl) urea] has been used extensively to combat the major cotton insect pests in Egypt. The proven insecticidal efficacy of diflubenzuron, and its favourable toxicology suggest a considerable potential for extending its use to other crops, especially vegetables and stored grain. Growing interest in the application of diflubenzuron requires regular assessment of its residues and fate in different environments. Reports about the residues of diflubenzuron as a seed protectant are rather meagre. However, various reports have centered on the residues and fate of diflubenzuron on plants [1-2] and in the environment [3-4]. Nimmo et al. [5] showed that 50% of soil applied diflubenzuron was metabolized in 2 days or less. However, Willems et al. [6] have indicated that the degradation of diflubenzuron in soil is mainly related to the particle size of the soil rather than the soil type.

The aims of the present work were to assess the fate of diflubenzuron when applied as a grain protectant and the influence of the moisture content of the seeds on the persistance of this material. The present work also extends previous research on the fate of diflubenzuron in soil, ascertaining its fate in a sandy loam and establishing the influence of soil moisture content on its persistance.

2. MATERIALS AND METHODS

2.1. Wheat treatment:

Wheat, Giza variety was exposed to warm current of air, then divided into two batches whose moisture contents were adjusted to 10% and 15% respectively (wet weight basis). Wheat was kept in the incubator at 30 °C for two weeks to equilibrate before wheat samples (50g) were placed in glass jars. A formulation of diflubenzuron Dimilin 25% wettable powder was diluted with water in such a way that by addition of diluted formulation (0.5 ml) to grain, the nominal concentration of diflubenzuron (10 mg kg) $^{-1}$ was achieved. The diluted concentration of diflubenzuron was pipetted on to the glass surface, immediately above the wheat. Jars were sealed, rolled over and shaken vigorously to ensure even distribution of diflubenzuron. Jars were kept in the incubator in the dark at 30 °C. Three samples were taken for analysis for diflubenzuron immediately after insecticide application and at 5, 10, 20 and 40 weeks.

2-2 Soil treatment:

A diluted formulation of diflubenzuron (0.5 ml. 1000 mg litre) $^{-1}$ was added to (10 g) of air dried soil in a glass jar. Treated soil was diluted with untreated (40 g) soil (dry weight) and shaken for 15 minutes. The final concentration of diflubenzuron was 10mg kg $^{-1}$ based on dry weight. Distilled water was added dropwise to obtain moisture levels of 10% and 30% of the maximum moisture capacity (30% w/w). Jars were sealed and kept in the incubator in the dark at 30 ^{o}C. Distilled water was added when necessary during incubation to compensate for water loss. Three samples were taken for analysis for diflubenzuron immediately after application of diflubenzuron and after 1,3,5,10,20,40 and 80 days.

2.3. Diflubenzuron extraction:

Wheat and soil samples were vigorously shaken for 45 min. with acetonitrile (3 x 75 ml). The mixture was filtered and acetonitrile fractions were combined and evaporated to dryness on a rotary evaporator. Wheat samples were cleaned further using alumina column (Adwic, Egypt). While soil samples needed no further clean up. Diflubenzuron residues were transferred quantitatively in (1ml) methyl alcohol into small vials.

2.4. High performance liquid chromatography (h.p.l.c.):

A Beckman model 432 high performance liquid chromatograph equipped with two model 112 pumps, model 340 solvent programmer, model 210 injector and model 160 fixed wave length ultraviolet detector was used in this study. A stainless steel precolumn (4.5 cm x 4.6 m.m. i.d.) followed by an ultrasphere C-18 (ODS) analytical column (25 cm x 4.6 m.m. i.d.) was used for reversed phase chromatography. A Spectra Physics (SP 4100) computing integrator was used to measure peak areas. Operational conditions, diflubenzuron detection and quantitation were based on the method of Ahmed and Eid[7].

2.5. Recovery test:

Recovery experiments were conducted by adding known amounts of diflubenzuron to wheat and soil just before extraction. Extraction efficiencies, based on three replicates were 95% ± 3 and 92% ± 5 (mean $\pm$ S.E.) for wheat and soil respectively. No correction was applied to the results in this respect.

3. RESULTS AND DISCUSSION

3.1. The degradation of diflubenzuron on stored wheat:

Fungal contamination was evident in some samples of the wheat from the 15% moisture content treatment. These samples were not analysed. The remaining concentrations of diflubenzuron from storage periods up to 40 weeks are shown in Figure 1. The loss of diflubenzuron followed a first order rate kinetics. Rate constant (K) and half life values (T1/2) are presented in Table 1. Results indicated that diflubenzuron degraded rather slowly on wheat. The half life value of diflubenzuron at moisture content of 10% and 15% were 24.3 and 17.7 weeks respectively. Degradation was faster at higher moisture content. This result is expected since the metabolic activity of stored grain is usually enhanced once the moisture content increases. Noble et al. [8] indicated that the bulk of insecticide remains on the outside, or at least within the outer bran layer of the grain. This suggests that the bulk of degradation is non-enzymatic. Moreover, with the low vapour pressure of diflubenzuron (volatility, 4% after 48 hours), loss by volatilization would have made little contribution to the loss process which is assumed to be hydrolytic. Desmarchelier and Bengston [9] reported that the half life values for most currently used grain protectants were 12,14 and 70 weeks for malathion, fenitrothion and primiphos methyl respectively. Therefore, it can be seen that diflubenzuron would persist on stored wheat under normal conditions for well in excess of 20 weeks. Hence, a single application can be expected to protect the grain for a long period.

3.2. The degradation of diflubenzuron in soil:

Results presented in Figure 2 indicated that diflubenzuron concentration decreased at similar rates for the two levels of moisture content. Diflubenzuron could not be detected 80 days after application. Table 2 shows that the half life values of diflubenzuron at 10% and 30% moisture content levels were 8.2 5 and 6.39 days respectively. The breakdown of diflubenzuron followed a first order reaction. Degradation was rapid in the first five days of the experiment, but slowed thereafter. Hamaker and Goring [10] have explained such behaviour in terms of a two compartment model in which the pesticide is divided between available and unavailable material subject to degradation. Nimmo et al.[5] have shown that soil bound dilfubenzuron gradually increased with time and could attain values of over 50% in experiments with agricultural soil. Binding of diflubenzuron to flooded, hydro-sand clay was considerably less than this, suggesting that the abundance of water in soil reduces its adsorption capacity. In contrast, the present work has shown that diflubenzuron concentrations decreased at similar rates in sandy loam of 10% and 30% moisture content, suggesting that diflubenzuron degradation is independent of soil moisture content in the range of 10 - 30%. Negre et al. [11] in a study of the herbicide fluazifop butyl degradation in soil have indicated that under a range of 20% - 50% of maximum moisture content, no quantitative changes in the soil microbial population has occurred.

The present work is suggesting the view that diflubenzuron degradation in soil is related to microbiol activity.

Acknowledgement

The author is grateful to Dr. M. G. Ford of Portsmouth Polytechnic, England for his criticism and advice.

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TABLE 1:
Rate constant (K) and half life (t 1/2) values of diflubenzuron applied as wheat protectant.

Moisture Content (%)	Rate Constant $K(Week)^{-1}$	Standard error (±)	Half Life (t 1/2) Week
10	0.0285	0.0014	24.3
15	0.0391	0.0011	17.7

TABLE 2:
Rate constant (K) and half life (t 1/2) values of diflubenzuron applied in Sandy Loam Soil.

Moisture Content (%)	Rate Constant $K(Week)^{-1}$	Standard error (±)	Half Life (t 1/2) Day
10	0.084	0.0034	8.25
30	0.109	0.0008	6.39

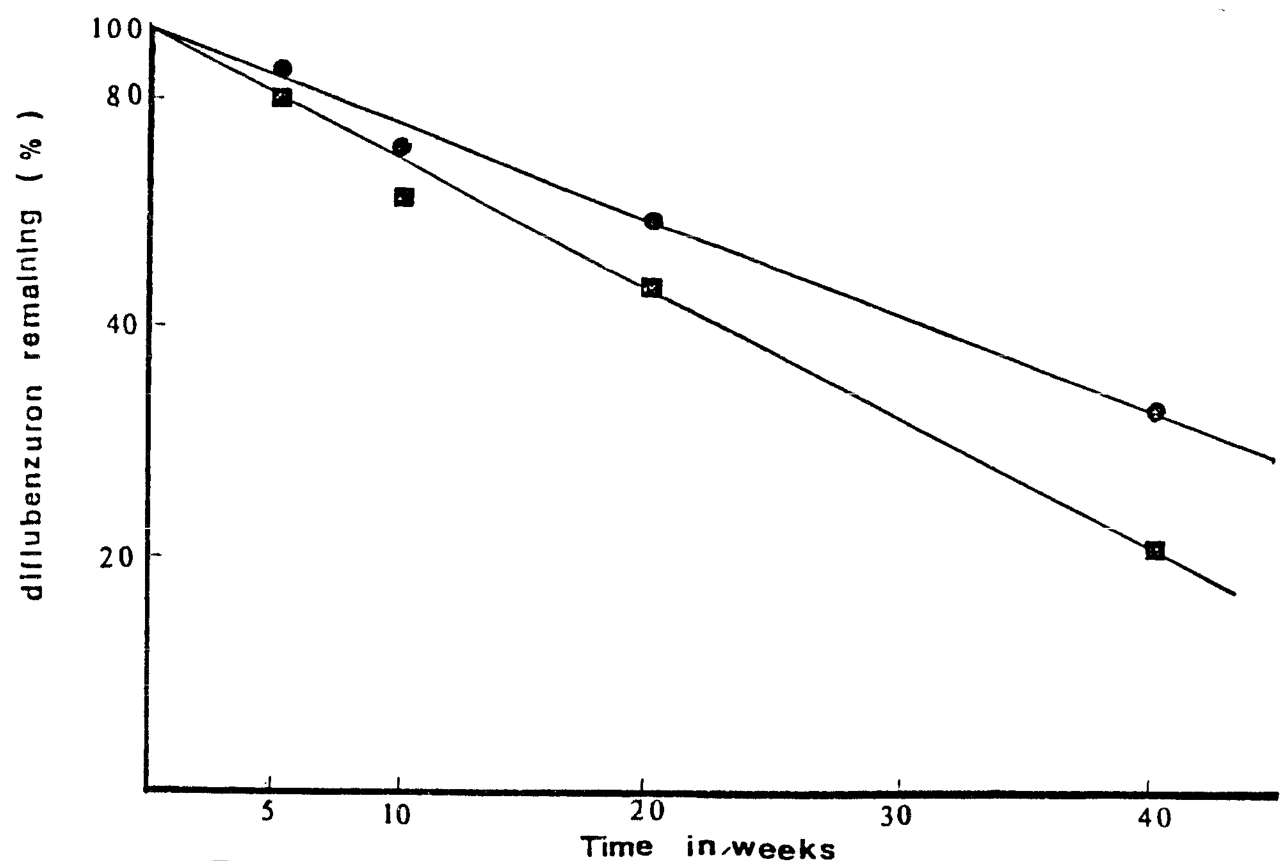

Figure 1. Diflubenzuron remaining on wheat stored for 40weeks at 10 % ● and 15% ■ moisture content

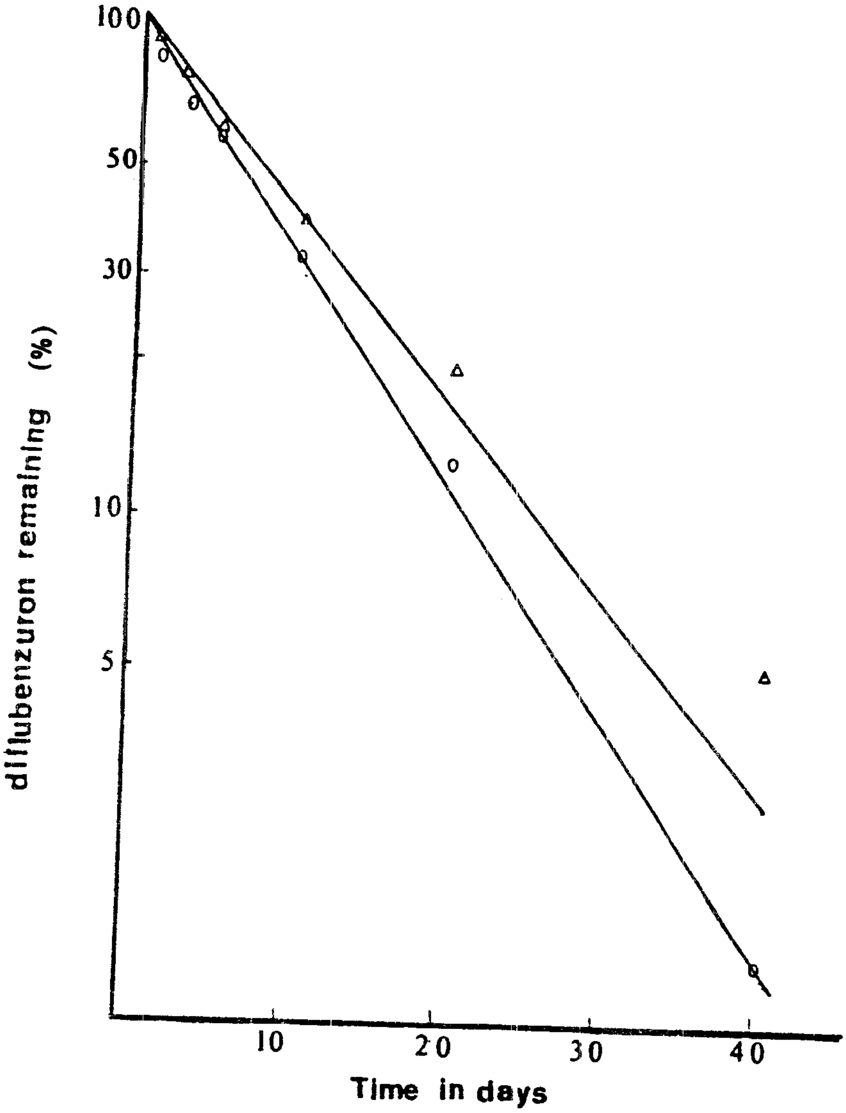

Figure 2. Diflubenzuron remaining on sandy loam soil at 10% Δ and 30 % O moisture content