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Residues of Certain Organophosphorus Insecticides in the Treated Bags of Wheat Flour

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Abstract. Malathion has been used for several years for the treatment of polyethylene flour bags. A new effective and safe insecticide as fenitrothion should replace malathion to overcome the possibility of insect resistance to malathion in future. The present study deals with the rate of dissipation and toxicity of malathion and fenitrothion residues on flour bags under different temperatures of storage (25° and 35°C) and at different levels of fortification (0.5, 1.0 and 2.0% a.i.). Samples of treated polyethylene bags were taken at 0-time, 0.5, 1, 2, 3, 5, 7.5 and 10 months for residue analysis and toxicity test against *Tribolium confusum* (Duv.). The results proved that the rate of dissipation was almost the same for both compounds at 25°C and the half-life value was about 7 months. On the other hand fenitrothion degraded more slowly than malathion at 35°C and the half-life values were 178 days for fenitrothion and 155 days for malathion.

Different concentrations of both insecticides provided complete protection of treated bags against infestation with *T. confusum* for at least 10 months of storage at 25° or 35°C. Therefore, the use of the lowest concentration (0.5% a.i.) would save 75% of the costs and hazards of insecticides used.

Introduction

Stored grains and their products suffer great loss in weight and quality due to insect infestation. A survey of insect pests of stored products in three main regions of Saudi Arabia was carried out during two successive years, 1978 and 1979 [1]. Thirty six species of insect pests belonging to 12 families and 4 orders in addition to 2 hymenopterous parasites were recorded.

The protective methods to safeguard stored products include the application of grain protectants and the surface treatment of flour bags with insecticides. Zewar *et*

al. [2] studied the effect of surface treatment of the cotton bags on the protection of stored flour from the flour beetle. Application of malathion at dose of 684 ppm proved to be capable of providing complete protection from the external infestation with the flour beetle within one month of storage at 27°C. Mostafa *et al.* [3] studied the comparative toxicity of four insecticides on two different fabric sacks against *Tribolium confusum* Duv. and found that the longest residual effect was obtained by using Iodofenphos followed by malathion.

Malathion is commonly used for the treatment of flour bags in Saudi Arabia, and a new effective and safe insecticides should replace malathion to overcome the possibility of insect resistance to malathion in future. Champ and Dyte [4] reported a global survey of pesticide susceptibility in stored grain pests and concluded that resistance to both malathion and lindane was widespread. Carter *et al.* [5] found that bioresmethrin plus piperonyl butoxide when applied as dust on wheat, was more active than malathion and less active than fenitrothion against *Oryaephilus surinamensis* (L) or susceptible and malathion-resistant strains of *Tribolium castaneum* (Herbst). Wallbank [6] obtained excellent control of malathion-resistant strains of *T. castaneum* and *Rhyzopertha dominica* (F.) with fenitrothion. Fenitrothion has been shown to control most malathion-resistant insects [7] and it is currently used to control malathion-resistant strains of *T. castaneum, Dermestes maculatus* De Geer and *Trogoderma granarium* Everts infesting holds of ships in Great Britain [8].

There is no available information on the dissipation of malathion and fenitrothion residues on treated bags under the prevalent conditions of storage in the silos of the Kingdom at winter (25 ± 2°C) and at summer (35 ± 2°C). Therefore the present investigation was conducted to compare the residual life of malathion and fenitrothion on treated bags under different temperatures of storage (25 ± 2°C and 35 ± 2°C). The biocfficacy of the insecticidal residues on flour bags was also studied against *T. confusum* one of the most common stored-product beetles in the silos of the Kingdom of Saudi Arabia.

Materials and Methods

Fenitrothion 50% EC and malathion 50% EC were diluted with acetone to provide 0.5, 1.0 and 2.0% active ingredient (a.e.). Small circular pieces of polyethylene bags, 9 cm diameter, were treated each with 2 ml solution of different levels of fortification (0.5, 1.0 and 2.0%) and left to dry under laboratory conditions. Each treatment was replicated 3 times. Treated pieces were placed each in a petri dish and kept in the dark at storage temperatures of 25 ± 2°C and 35± 2°C. Samples were taken at different intervals, 0–time (initial deposit), 15–days, 1, 2, 3, 5, 7.5 and 10 months.

Each piece was extracted with 10 ml acetone and the appropriate aliquot of the extract was analyzed for residues adopting the colorimetric method of Getz and Watts [9]. Persistence and degradation curves were drawn on a semi-log papers and the half-life values were established for each compound at storage temperatures of 25° and 35°C.

The bioefficacy of insecticidal residues on treated polyethylene bags was tested against adult *T. confusum* at the same intervals of chemical analysis. Thirty insects were placed on each treated piece (9 cm diam.) confined in a petri dish, using 3 replicates for each treatment. Mortality counts were recorded after 24 and 48 hr of exposure. Natural mortalities were corrected using Abott's formula [10].

Results and Discussion

Malathion 50% EC or fenitrothion 50% EC which was applied to polyethylene flour bags at concentrations of 0.5, 1.0 and 2.0% active ingredient provided the respective initial deposits of 0.164, 0.326 and 0.560 mg a.i./cm^2 for fenitrothion (Table 1). There was a gradual degradation of malathion and fenitrothion with time and the rate of dissipation was almost the same for both compounds at 25 ± 2°C. Mean percentages of initial deposits were 96.9, 94.8, 84.6, 78.5, 73.1, 44.8 and 33.4 for fenitrothion compared to 98.6, 92.2, 83.1, 74.9, 72.7, 46.5 and 34.8% for malathion after 0.5, 1, 2, 3, 5, 7.5 and 10 months of storage, respectively. The half-life value was 7 months for both compounds on polyethylene bags stored at 25± 2°C. On the other hand, fenitrothion degraded more slowly than malathion after storage of treated bags at 35 ± 2°C. Mean percentages of initial deposits were 89.1, 82.2, 73.0, 64.9, 57.5, 39.8 and 25.7 for fenitrothion compared to 85.9, 77.4, 66.4, 57.5, 50.8, 35.5 and 24.9 for malathion after 0.5, 1, 2, 3, 5, 7.5 and 10 months of storage at 35± 2°C, respectively. The corresponding half-life value were 178 days for fentitrothion and 155 days for malathion

According to the toxicity tests, both compounds provided complete protection of treated bags against infestation with *T. confusum* for at least 10 months of storage at 25 or 35°C. The results obtained suggest a single external treatment of polyethylene flour bags with malathion or fenitrothion 50% EC at rate of 0.5% a.i. instead of the higher rates of application (1% and 2% a.i.). Such treatment should give good protection for at least 10 months of storage at 23°C to 37°C. It would also save about 75% of the cost of malathion used on polyethylene bags at rate of 2% a.i., and would lead to a significant reduction in the hazards of pollution with a toxic compound. Moreover, fenitrothion is an excellent alternative contact insecticide for the control of malathion – resistant strains of stored product insects [5-8]. Dikshit [11]

Table 1. Malathion and fenitrothion residues in the treated polyethylene bags stored at two different temperatures

Time (months)	% Conc.	Malathion				Fenitrothion			
		25 ± 2°C		35 ± 2°C		25 ± 2°C		35 ± 2°C	
		mg/cm²	% of I.D.	mg/cm²	% of I.D.	mg/cm²	% of I.D.	mg/cm²	% of I.D.
0.0(I.D.)*	0.5	0.164	100.00	0.164	100.00	0.183	100.00	0.183	100.00
	1.0	0.326	100.00	0.326	100.00	0.331	100.00	0.331	100.00
	2.0	0.560	100.00	0.560	100.00	0.674	100.00	0.674	100.00
0.5	0.5	0.161	98.17	0.131	79.88	0.180	98.36	0.165	90.71
	1.0	0.320	98.16	0.300	92.02	0.314	94.86	0.300	90.63
	2.0	0.557	99.46	0.480	85.71	0.657	97.48	0.579	85.91
1.0	0.5	0.145	88.41	0.110	67.07	0.176	96.17	0.157	85.79
	1.0	0.314	96.34	0.286	87.73	0.309	93.35	0.266	80.36
	2.0	0.514	91.79	0.434	77.50	0.640	94.96	0.543	80.56
2.0	0.5	0.133	81.10	0.086	52.44	0.171	93.44	0.131	71.58
	1.0	0.274	84.05	0.244	74.85	0.266	80.36	0.227	68.58
	2.0	0.471	84.11	0.403	71.96	0.540	80.12	0.531	78.78
3.0	0.5	0.129	78.66	0.079	48.17	0.154	84.15	0.106	57.92
	1.0	0.263	80.67	0.206	63.19	0.240	72.51	0.206	62.24
	2.0	0.366	65.36	0.343	61.25	0.531	78.78	0.503	74.63
5.0	0.5	0.126	76.83	0.066	40.24	0.136	74.32	0.091	49.72
	1.0	0.249	76.38	0.203	62.27	0.234	70.69	0.200	60.42
	2.0	0.364	65.00	0.279	49.82	0.501	74.33	0.420	62.31
7.5	0.5	0.060	36.59	0.047	28.66	0.081	44.26	0.070	38.25
	1.0	0.156	47.85	0.103	31.60	0.126	38.07	0.111	33.53
	2.0	0.309	55.18	0.259	46.25	0.351	52.08	0.321	47.63
10.0	0.5	0.052	31.71	0.038	23.17	0.047	25.68	0.039	21.31
	1.0	0.118	36.20	0.079	24.23	0.120	36.25	0.084	25.38
	2.0	0.204	36.43	0.152	27.14	0.257	38.13	0.204	30.27

* (I.D.) = Initial deposit

applied fenitrothion to outside of sacks at the rate of 0.1 and 0.2 mg/cm² and it was highly effective for the protection of bagged grains stored under normal conditions against *T. castaneum* for at least 5 months. Processing treatments such as washing and baking removed much of the toxicant from the product and rendered it safe for consumption.

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متبقيات بعض المبيدات الفوسفورية العضوية في أكياس دقيق القمح المعاملة

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ملخص البحث. يستخدم مبيد المالاثيون في معاملة أكياس البولي إيثلين الخاصة بتعبئة الدقيق منذ سنوات عديدة ولابد من بديل فعال ومأمون الاستعمال مثل مبيد فنتروثيون للتغلب على احتمال ظهور سلالات حشرية مقاومة للمالاثيون مستقبلاً. يهدف البحث إلى إجراء دراسة مقارنة عن معدل تدهور وسمية متبقيات كل من مبيدي مالاثيون وفنتروثيون تحت ظروف تخزين مختلفة للأكياس المعاملة (٢٥، ٣٥°م) وبتركيزات مختلفة ٥ر٠٪، ١٪، ٢٪ مادة فعالة في الأسيتون.

أخذت عينات من أكياس البولي إيثلين المعاملة بعد المعاملة مباشرة وبعد ١٥ يومًا، ١، ٢، ٣، ٥، ٥، ٥ر٧، ١٠ شهور لتقدير متبقيات كل من المبيدين واختبار السمية ضد خنفساء الدقيق المتشابهة. أظهرت نتائج التحليل الكيميائي تماثل معدل تدهور كل من المبيدين بعد تخزين الأكياس المعاملة على درجة ٢٥°م وكانت قيمة نصف العمر لكل منهما ٧ شهور. أما في حالة التخزين على درجة ٣٥°م فقد كان الفنتروثيون أبطأ تدهورًا من المالاثيون وأصبحت قيمة نصف العمر ١٧٨ يومًا للفنتروثيون، ١٥٥ يومًا للمالاثيون. كذلك أثبتت اختبارات السمية أن التركيزات المختلفة المستخدمة في البحث قد كفلت حماية كاملة للأكياس المعاملة من الإصابة بخنفساء الدقيق المتشابهة طيلة فترة التجربة. ت لذلك فإن استخدام التركيز الأدنى (٥ر٠٪ مادة فعالة من المبيد) يوفر ٧٥٪ من قيمة المبيدات المستخدمة ويقلل من أخطار التلوث بها.