The Effect of Loose-Shelled Kernels and Foreign Material on Pirimiphos-Methyl Residues in Stored Farmers Stock Peanuts[1]

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ABSTRACT

Farmers stock peanuts containing either 0% loose-shelled kernels (LSK) and 0% foreign material (FM), 5% LSK-10% FM, or 10% LSK-20% FM were sprayed with 20 PPM pirimiphos-methyl. Peanut samples were analyzed for insecticide residues during a 1-year storage period. Significantly lower residues were found on in-shell peanuts with 0% LSK-FM than on either of the 2 LSK-FM combinations. Insecticide residues accumulated in the FM and to a lesser extent in the LSK. Negligible residues were found on sound mature kernels from solid pods.

Key Words: Peanuts, pirimiphos-methyl, residues, foreign material, FM, loose-shelled kernels, LSK, cleaning.

Peanuts harvested in the fall and loaded into commercial storage facilities usually contain foreign material (FM) such as sticks, dirt, rocks, etc., and loose-shelled kernels (LSK). It is recommended that FM and LSK be removed from peanuts before they are stored (4), but often the peanuts are not cleaned due to cost of equipment and labor (3). Also, the large amount of peanuts that must be processed during harvest season may impose time constraints on cleaning operations (2). Peanuts that contain more than 10% FM are usually cleaned when sold to shelling plants the following spring (1).

Farmers stock peanuts should be protected from insect damage during storage. At the present time malathion, synergized pyrethrins and methoprene are the only chemicals registered and labelled for direct surface application to stored peanuts. Malathion resistance is widespread in the southeast (8) and the other 2 chemicals are more expensive than malathion. Low rates of pirimiphos-methyl, an organophosphate, have proven effective in preventing economic damage in stored peanuts in both small bin (5) and large scale storage (6) tests.

There is no published information concerning the effect of extraneous material on insecticide residue degradation in stored peanuts. The purpose of this test was to determine if the inclusion of LSK and FM would affect pirimiphos methyl degradation during a 1-year storage period.

Materials and Methods

In April 1985, Segregation I Runner variety farmers stock peanuts (1984 crop) were removed from cold storage at the USDA Stored-Product Insects Research and Development Laboratory in Savannah, Georgia. Forty-five kg of cleaned peanuts (0% LSK - 0% FM) were weighed into each of 20 paperboard containers. For peanuts put into another series of 20 containers, LSK and FM were added so that the final 45 kg would contain ca 5% (2.25 kg) LSK and 10% (4.5 kg) FM. Peanuts with 10% LSK and 20% FM were weighed into the final series of 20 containers.

Ninety kg (2 containers) was a replicate. Five 90 kg lots from each of the 3 LSK-FM combinations were treated with distilled water (125.2 mL/rep) and the remaining 5 lots were treated with pirimiphos-methyl applied to achieve a theoretical residue of 20 PPM. Peanuts were sprayed as they fell from a conveyor belt into a hopper-bottom cart. They were thoroughly mixed by transferring them 3 times from one cart to another. Each replicate was then divided into 6 cardboard boxes (ca 15 kg each) as the peanuts fell from the bottom of the cart.

Peanuts were sampled for residue analysis in the following manner. After the insecticide was applied, a peanut sample divider was used to divide the contents of one of the 6 15 kg boxes into 2 lots of 7500 g. One lot was discarded and the other was divided to obtain 2 3750 g lots. One lot was divided again to 1875 g and from this fraction a 250 g sample was collected to determine residue on the in-shell peanuts which contained LSK-FM, and enough solid pods were shelled to obtain a 250 g sample of sound mature kernels (SMK) free of LSK-FM.

The second lot of 3750 g was used only when sampling the two LSK-FM combinations. Ca 175 g of LSK and 300 g of FM were collected for residue analysis on these components. A peanut sample sizer was used to remove all LSK-FM from 250 g of inshell peanuts. All samples were then held at O C until analyzed. The remaining boxes were randomly placed in a metal warehouse and the entire sampling procedure was repeated at 2, 4, 6, 9 and 12 months. A different 15 kg box was used for each sample period. A Motomco Moisture Meter was used to determine the moisture content of the peanuts when they were sampled. Moisture content was ca 7% throughout the year for all three treatments.

The sample jars containing inshell peanuts, cleaned inshell peanuts, LSK, FM, and SMK were prepared for chromatographic analysis by grinding the contents in a Waring blender. A 40 g sample was then extracted in 120 mL of pesticide-grade acetone by shaking 3 h on a wrist-action shaker and filtering the extract. Analysis was performed on a Varian model 3700 gas chromatograph equipped with a Flame Photometric Detector (FPD). A 4µL sample was injected from each vial into a 2 m x 2 mm I.D. glass column packed with 2% HI-EFF-8AP + 8% OV-101 on 80/100 mesh Gas-Chrom-Q. The temperature of the injection port was 300 C, the detector temperature was 280 C, and the temperature of the column oven was 230 C. The flow rates were: helium, 30 mL/min, air #1, 80 mL/min, air #2, 170 mL/min, and hydrogen, 140 mL/min. Residues were quantified using a Varian CDS 111 recording integrator. Each sample was analyzed twice at 0, 6, 9 and 12 months and once at 2 and 4 months. The GLM procedure of the Statistical Analysis System (7) was used to analyze the data.

Results

Residues on in-shell peanuts containing no LSK or FM decreased from 21.4 ppm at the time of application to 6.11 ppm in just 2 months, and then gradually declined to 1 ppm by the end of the year (Table 1). In contrast, residues on in-shell peanuts from the 2 LSK-FM combinations remained at fairly high levels for the entire year. Residues on the 2 LSK-FM peanut groups were always significantly greater than the residues on the cleaned peanuts except at time of application.

Table 1. Pirimiphos-methyl residues (PPM, mean ± SE) on whole in-shell peanuts during a 1-year storage period.

Treatment	APR	JUN	AUG	OCT	JAN	APR
0% LSK - 0% FM	21.4± .67 a[1]	6.1± .28 b	3.7± .25 c	2.6± .10 b	1.7± .05 b	1.3± .05 c
5% LSK - 10% FM	25.0±2.52 a	19.7±1.54 a	13.8± .87 b	7.2± .61 a	8.4± .83 a	7.3± .68 a
10% LSK - 20% FM	21.1± .63 a	22.4± .54 a	16.6±1.27 a	8.0± .62 a	9.7± .44 a	5.7± .58 b

[1]Means within columns followed by the same letter are not significantly different (P <.05, Duncan's [1955] multiple range test).

[1]Stored-Product Insects Research and Development Laboratory, Agricultural Research Service, U. S. Department of Agriculture, Savannah, Georgia 31403.

Insecticides residues were concentrated in the FM (Table 2). Residues were greatest on FM taken from the 5% LSK - 10% FM treatment (174 ppm at the time of application as opposed to 118 ppm in the 10% LSK - 20% FM treatment). Residues on both groups gradually declined; by the end of the year the residues were 45.3 and 33.5 ppm for the 5% LSK - 10% FM and 10% LSK - 20% FM combinations, respectively.

Table 2. Pirimiphos-methyl residue (PPM, mean ± SE) on FM and LSK during 1 year of storage.

Treatment	APR	JUN	AUG	OCT	JAN	APR
			FM			
5% LSK - 10% FM	174.0±9.75 a[1]	105.9±7.72 a	88.6±5.44 a	63.7±2.25 a	50.7±1.75 a	45.3±3.49 a
10% LSK - 20% FM	118.3±3.32 b	78.8±3.25 b	71.5±4.32 b	44.9±1.15 b	42.0±1.86 b	33.5±1.66 b
			LSK			
5% LSK - 10% FM	5.9± .38 a	15.0±.62 a	24.6±1.29 a	26.6±1.32 a	21.4± .45 a	18.2± .84 a
10% LSK - 20% FM	3.8± .20 b	11.5±.26 b	15.5± .98 b	16.8± .45 b	15.6± .50 b	12.7± .73 b

[1]Means within columns followed by the same letter are not significantly different (P <.05, Duncans [1955] multiple range test).

Patterns for accumulation and degradation were different for the LSK taken from the 2 treatment combinations (Table 2). Residues for the two groups increased to a maximum of 24.6 and 15.5 ppm at 6 months and then fell to final concentrations of 18.2 and 12.7 ppm. These amounts were considerably higher than the residues at the time of application (5.9 and 3.8 ppm). Again, the residues were highest in the LSK taken from the 5% LSK - 10% FM treatment combination.

The low residues found on the cleaned in-shell peanuts (LSK and FM removed prior to analysis) from the two LSK - FM treatments reflect the fact that much of the residue is tied up by the LSK-FM and is not present on the peanut pods (Table 3). Only 4.1 and 2.8 ppm were detected at the time of application on the peanuts from these two treatments. Residues gradually declined over the year and again the highest residues were on the 5% LSK - 10% FM combination. Residues on sound mature kernels (SMK) were negligible throughout the year (Table 3), though the amount was slightly higher in the SMK taken from the 0% LSK - 0% FM treatment combination.

Table 3. Pirimiphos-methyl residues (PPM, mean ± SE) on cleaned in-shell peanuts[1] and sound mature kernels (SMK) during 1 year of storage.

Treatment	APR	JUN	AUG	OCT	JAN	APR
			Cleaned In-shell Peanuts			
5% LSK - 10% FM	4.1±.28 a[2]	2.3±.13 a	2.0±.05 a	1.6± .07 a	1.2±.03 a	0.9±.08 a
10% LSK - 20% FM	2.8±.19 b	1.6±.11 b	1.5±.07 b	1.2±1.21 b	1.0±.05 b	0.7±.01 b
			SMK			
0% LSK - 0% FM	.06±.000 a	.21±.024 a	.21±.018 a	.24±.021 a	.26±.030 a	.24±.022 a
5% LSK - 10% FM	.06±.000 a	.09±.012 a,b	.09±.000 b	.09±.005 b	.13±.013 b	.13±.007 b
10% LSK - 20% FM	.06±.000 a	.12±.046 b	.09±.011 b	.09±.009 b	.09±.005 b	.10±.011 b

[1]LSK and FM were removed prior to analysis

[2]Means within columns followed by the same letter are not significantly different (P <.05, Duncan's [1955] multiple range test).

Discussion

The results of our study show that pirimiphos-methyl residues are apparently concentrated in FM, which in our study included grass stems, twigs, rocks and soil. One explanation for the greater amount of residue detected in the 5% LSK-10% FM combination is that when FM samples from the two combinations were collected, weighed and subsequently re-weighed for chemical analysis, the soil content in the 20% FM combination was increased. Therefore FM samples from the 20% FM combination occupied a smaller volume than FM samples from the 10% FM combination, even though both samples weighed the same amount. Insecticide residues were more concentrated in the FM sample with the greatest surface area.

Pirimiphos-methyl residues were greatest on LSK and cleaned inshell peanuts from the 5% LSK-10% FM combination. The increased grass and twig content of the 20% FM treatment may have led to a corresponding increase in the amount of residue which was concentrated in FM when the insecticide was applied. Thus, less residue was depositied on LSK and inshell peanuts from the 10% LSK-20% FM combination.

The increased concentration of pirimiphos-methyl in LSK during storage may be due to migration of the insecticide from the FM. Since the LSK are particularly vulnerable to pest pressure (5,6), residue accumulation in LSK would be beneficial unless it exceeds tolerable limits. However, if the residues are being concentrated in the FM, the peanuts may not be adequately protected by the insecticide. Insect pests would probably encounter residues if they came into contact with the FM, but removing the FM before peanuts are treated and stored may increase the amount of residue on the peanut pods and reduce insect damage.

This study also shows that pirimiphos-methyl degradation in cleaned in-shell peanuts occurs fairly rapidly. Therefore increased rates of application at the time peanuts are loaded into storage and/or additional surface treatments during the storage season may be necessary. The rate of degradation was slower in the in-shell peanuts containing LSK-FM, but this was due primarly to the selective distribution of insecticide into these components.

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