Pirimiphos-Methyl and Chlorpyrifos-Methyl as Controls of Indigenous Insect Infestations in Farmers' Stock Peanuts[1,2]

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ABSTRACT

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When emulsion sprays of pirimiphos-methyl or chlorpyrifos methyl were evaluated in laboratory and small bin lot studies in applications of 10, 15, and 20 ppm and compared with malathion at 50 ppm for control of indigenous populations of insects infesting Spanish-type farmers stock peanuts, they were found more efficacious than malathion.

In 3 separate warehouses in Oklahoma, bagged lots of farmers' stock Spanish-type peanuts that had been in storage for 8 mo were found to be infested by red flour beetles, *Tribolium castaneum* (Herbst), *Oryzaephilus* spp., almond moths, *Ephestia cautella* (Walker), *Cryptolestes* spp., Indianmeal moths, *Plodia interpunctella* (Hübner), confused flour beetles, *T. confusum* Jacquelin duVal, foreign grain beetles, *Ahasverus advena* (Waltl), corn sap beetles, *Carpophilus dimidiatus* (F.), and black larder beetles, *Dermestes ater* De Geer (in descending order of abundance.) Prior to storage, no thorough cleanups and residual insecticidal applications had been made in the warehouses, and during storage, no insecticidal controls had been applied.

Studies were undertaken to evaluate methods of controlling such an indigenous infestation, which appeared to be severely damaging the peanuts, and to evaluate these methods as protective treatments.

Materials and Methods

Laboratory Studies

Three bagged lots of Spanish-type farmers' stock peanuts, one from each warehouse, were used in the laboratory tests. First, 1000-g samples from each of the 3 lots were examined and found to contain similar infestations and insect damage. The detailed examinations were made to determine the amount of FM (foreign material), the numbers of LSK's (loose shelled kernels), the percent of pods that were damaged (cracked) so that insects had access to the kernels, and the extent of damage to the kernels (meats). Also established was the density of populations of the different species. At that time, avg moisture content of the kernels was 6.9%. The hulls were dry and absorbent and were easily broken when shelled. Then, the 3 lots were composited into one lot.

Malathion was used as the standard treatment for comparison; it was applied as a water emulsion spray prepared from premium grade 57% malathion EC, 0.6 kg AI/liter at a rate of 50 ppm AI. Pirimiphos-methyl EC, 0.6 kg AI/liter or chlorphyrifos-methyl EC 0.24 kg AI/liter, were applied as water emulsions at rates of 10, 15, and 20 ppm. Each rate of application was replicated 5 times with sufficient farmers' stock being treated for a complete evaluation of all doses. All sprays were applied to 4000-g lots of uncleaned farmers' stock in 19-liter wide-mouth glass jars as the jars rolled on an inclined plane at 32 rpm for a 15-min mixing period. Sprays were applied at the rate of 2.0 liters/metric ton with a ULV atomizing spray assembly (LaHue 1969) modified for micro-applications so it would deliver a short-distanced (38 cm) solid cone mist (fog) spray. Immediately after treatment, 1000-g lots were placed in 3.8-liter wide mouth glass jars fitted with rings and 40-mesh screen lids. Treated peanuts were stored in a small, open, frame building at Manhattan, KA, under ambient (spring and summer) temperature and humidity conditions for the 6-mo storage period after treatment. After one mo, the screened jar lids were removed, and jars were covered with a 4×4 mesh hardware cloth to prevent rodent and bird damage and to allow insects to migrate and enter the different jars of peanuts.

Four lots of 200 g were examined at 3 and 6 mo from each replication for insects and damage. A full complement of check (untreated) lots was maintained for comparison with the different treatments.

Small-Lot Bin Studies

Immediately following completion of the 3-mo laboratory test readings, additional tests were initiated with uninfested farmers' stock, simulating the conditions and duplicating the treatments in the laboratory tests to determine the protection afforded uninfested peanuts. The source farmers' stock used in the bin studies were frozen at −16°C for 10 days to eliminate any existing infestation. The peanuts had been cleaned to remove FM and LSK's. Foreign material and undamaged LSK's were added to simulate the physical conditions of the farmers' stock used in the laboratory studies.

The emulsion treatments, as used in the laboratory tests, were applied to 14.6 kg of farmers' stock in 208-liter steel mixing barrels fitted with diagonal mixing bars. The barrels rotated at 16 rpm for 10 min on an electric barrel roller during the spraying of the emulsions through an aperture in the lid. After treatment, the peanuts were placed in uncovered 85-liter cylindrical upright drums. The filled drums were stored in a small, open, frame building at Manhattan, KA, under ambient (summer and fall) temperature and humidity conditions for 5 mo. All treatments and the untreated checks were replicated 3 times.

Insect releases consisting of ca. 5000 red flour beetles, sawtoothed grain beetles, *O. surinamensis* (L.), and confused flour beetles, and ca. 1000 foreign grain

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[2] This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.

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beetles were made at monthly intervals for 3 mo in the storage area. Cultures of Indianmeal moths, almond moths, flat grain beetles, *C. pusillus* (Schönherr), corn sap beetles, and black larder beetles were maintained in the storage area for 4 mo.

Samples consisting of over 1000 g were taken from each bin with a vacuum probe 10 wk after treatment and at the end of the storage period. The samples were sifted on a rotary shaker to separate the free-moving insects from the farmers' stock. LSK's were hand picked from each sample, and pods were separated into lots with solid hulls and broken or cracked hulls.

Results

Laboratory Studies

Studies of the composited source peanuts used in the 1st phase of the studies showed that 200-g samples had averages of 16.8 LSK's (range 13–21) and 241 pods (range 236–246) that contained 432 kernels (range 428–440). It also was determined that 17.1% (range 15–21) pods were damaged or cracked so insects had access to the kernels. The pods averaged ca. 0.83 g in weight and the kernels ca. 0.35 g. The 1.8% by weight of FM consisted mainly of pedicels, root crowns, and other plant parts.

In evaluating the effects of the laboratory treatments, all kernels showing insect feeding were classified as damaged regardless of the amount of injury. Table 1 gives avg percentage increases in insect damage to LSK's after treatment of the insect-infested farmers' stock.

Insect damage to LSK's before treatment averaged 19.4% (range 16.7–22.3%). There was an increase in damage to the LSK's in all treatments; however, all treatments greatly reduced the amount of the increase compared to the damage done to the untreated check lots. Most of the damage to the LSK's was inflicted by late stage moth larvae, especially 4th and 5th instars of *Plodia* and *Ephestia* which were tolerant of the insecticides. These older larvae sometimes died after feeding on the LKS's but only after they had damaged the kernels. For example, the 20-ppm dose of pirimiphos-methyl was effective against moth larvae in respect to the degree of mortality, but some increase in damage to the kernels did occur. In contrast, chlorpyrifos-methyl also was effective against the feeding of these late-instars on the LSK's, but a few survived. Malathion residue was not effective against the late-instar moth larvae. The avg percentages of insect-damaged kernels found in the pods before treatment ranged from 4.4 to 5.1 and averaged 4.8. The damaged kernels after treatment are in Table 1. Only kernels in pods that were damaged or broken were attacked. An avg of 132.9 kernels (range 128–137) was found in the farmers' stock with damaged hulls (pods) per 100 pods examined. Damage to such kernels in peanuts treated with malathion was mainly done by moth larvae. The 20-ppm dose of pirimiphos-methyl prevented further damage to the kernels in broken pods, and dead small moth larvae and adult coleopterans were found inside the hulls of the broken pods treated with this dose. Damage to the kernels from the pods with broken hulls treated with chlorpyrifos-methyl also was inflicted by late-stage moth larvae. No live *Cryptolestes* spp., *Oryzaephilus* spp., foreign grain beetles, or corn sap beetles were found in any of the samples from the treated peanuts. No *Tribolium* larvae were found, although a few live adults were in some of the treated samples. Increases in damage occurred usually to kernels in broken pods that had been infested before treatment and now had both kernels damaged instead of only one.

Before the treatments were applied, averages of 21.7 live and 2.1 dead insects were found in the 200-g samples. Table 1 gives avg numbers of all live and dead insects found in 200-g samples. Peanuts treated with chlorpyrifos-methyl or pirimiphos-methyl had ca. the same number of insects. Relatively large numbers of live moth larvae and *Tribolium* adults were recovered from malathion-treated peanuts. In fact, moth larvae spun webs on the inside of all jars containing malathion-treated peanuts and a few jars of the untreated check lots. Untreated checks, after 6-mo storage, contained all of the species originally found in the source lots.

Table 1 reports the number of live insects found in 200-g samples at 3 and 6 mo after treatment. The 15- and 20-ppm treatments of pirimiphos-methyl controlled practically all insects, although a few live black larder beetle larvae were found at 3 mo. Comparable doses of

Table 1.—Number of living and dead insects; the percent of insect damage in pods; and the percent increase in damage to LSK's at intervals after treatment.

	No. of live insects		% insect damage		% increase in damage to LSK's	
(ppm)	3 mo	6 mo	3 mo	6 mo	3 mo	6 mo
Pirimiphos-methyl						
10	30.8	42.9	6.1	7.8	1.8	4.1
15	31.4	42.8	5.6	6.6	1.6	2.7
20	27.9	39.6	5.0	4.9	0.1	0.5
Chlorpyrifos-methyl						
10	39.6	48.3	6.6	10.1	4.5	9.4
15	30.4	41.7	6.1	7.2	2.8	4.5
20	26.2	40.5	5.6	6.0	0.9	1.4
Malathion 50	46.8	71.4	7.9	11.7	5.5	12.1
Untreated Check	69.3	91.3	10.1	26.1	10.1	38.0

chlorpyrifos-methyl also gave good control, but moth larvae appeared to be slightly more tolerant to this material than to pirimiphos-methyl. However, the Indianmeal moth larvae were more tolerant to chlorpyrifos-methyl than the almond moth larvae. Some parasitization of the moth larvae occurred in jars containing farmers' stock that was untreated.

Pirimiphos-methyl and chlorpyrifos-methyl were effective in controlling indigenous populations of mixed species of insects infesting the Spanish-type farmers' stock peanuts used in the 1st phase of this study.

Small-Lot Bin Studies

Eight random samples that were examined immediately before the treatments were applied disclosed, on an average, 86.2 LSK's (range 80–91) and 1196.2 pods (range 1182–1215) containing 2098 kernels (range 2081–2120) per 1000 g. It was also determined that 18.1% (range 15–21) of the pods were damaged or cracked so that insects had access to the kernels. The samples contained ca. 1.95% FM by weight.

In evaluating the protection given by the different treatments, the number of LSK's and kernels in pods exposed to insects showing insect feeding was considered as damaged, regardless of the amount of feeding. Table 2 gives percent of LSK's showing insect feeding after treatment. All treatments greatly reduced the amount of damage to the LSK's when compared to damage to LSK's in untreated lots. Most of the damage to LSK's was inflicted by late-stage moth larvae. Greater numbers of the moth larvae were observed feeding on LSK's in samples from bins with the malathion-treated peanuts than from the other treatments. The 20-ppm doses of pirimiphos-methyl or chlorpyrifos-methyl were very effective against moth larvae but some survival and later, emergence of adult Indianmeal and almond moths occurred from samples treated with 10 and 15 ppm.

Table 3 shows avg percentage of insect-damaged kernels in the farmers stock pods and the avg number of live insects/1000 g samples. Practically all damage to kernels in the farmers stock treated with malathion was inflicted by moth larvae. Live moth larvae, adult red and confused flour beetles, and *Tribolium* larvae were recovered from the malathion-treated peanuts. The un-

Table 2.—Percentage of insect damaged kernels, the number of live insects, and percent LKS's in 1000-g samples from small bins.[a]

Insecticide and dose (ppm)	Posttreatment periods						
	% damaged kernels			No. of live insects		% LKS's	
	Before treatment	2.5 mo	5 mo	2.5 mo	5 mo	2.5 mo	5 mo
Pirimiphos-methyl							
10	4.3	5.1	6.2	7.3	11.6	1.1	3.0
15	4.5	4.9	5.5	3.0	7.0	0.3	1.2
20	4.4	4.3	4.4	0	0	0	0
Chlorpyrifos-methyl							
10	4.2	5.6	6.5	8.2	12.1	1.9	4.1
15	4.4	5.1	5.6	3.1	6.7	0.5	1.6
20	4.3	4.2	4.3	0	0	0.3	0.7
Malathion 50	4.4	8.1	13.6	23.9	44.7	4.0	11.2
Untreated Check	4.3	11.6	27.5	42.1	126.4	9.8	33.2

[a] Avg of 3 replications.

Table 3.—Percentage of insect damaged kernels and the number of live insects in 1000-g samples from small bins.[a]

Insecticide and dose (ppm)	Posttreatment periods				
	% damaged kernels			No. of live insects	
	Before treatment	2.5 mo	5 mo	2.5 mo	5 mo
Pirimiphos-methyl					
10	4.3	5.1	6.2	7.3	11.6
15	4.5	4.9	5.5	3.0	7.0
20	4.4	4.3	4.4	0	0
Chlorpyrifos-methyl					
10	4.2	5.6	6.5	8.2	12.1
15	4.4	5.1	5.6	3.1	6.7
20	4.3	4.2	4.3	0	0
Malathion 50	4.4	8.1	13.6	23.9	44.7
Untreated Check	4.3	11.6	27.5	42.1	126.4

[a] Avg of 3 replications.

treated checks contained cosmopolitan populations of the species released in the storage area. The 20-ppm doses of pirimiphos-methyl or chlorpyrifos-methyl prevented additional damage to the kernels in peanuts with damaged hulls. No live adult red flour beetles, *Cryptolestes* spp., *Oryzaephilus* spp., foreign grain beetles, or corn sap beetles were found in any of the samples from the pirimiphos-methyl or chlorpyrifos-methyl treated peanuts; however, a few adult confused flour beetles were found in pods with broken hulls from the 10- and 15-ppm treatments of both insecticides.

Pirimiphos-methyl and chlorpyrifos-methyl applied as emulsion sprays show considerable promise as controls for indigenous infestations of mixed populations of stored-product insects in farmers stock peanuts, and as protectants applied to newly harvested uninfested farmers stock being placed in storage.

REFERENCE CITED

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