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Maggie Phillips
University of Arkansas, Fayetteville

T. A. Yazwinski
University of Arkansas, Fayetteville

C. A. Tucker
University of Arkansas, Fayetteville

Jennifer Robins
University of Arkansas, Fayetteville

Jeremy Powell
University of Arkansas, Fayetteville

See next page for additional authors

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Acaricidal efficacy of various agents in the treatment of naturally occurring *Ornithonyssus sylviarum* (*Acari: Macronyssidae*) infestations of chickens

Maggie Phillips, T.A. Yazwinski*†, C.A. Tucker§, Jennifer Robins‡, Jeremy Powell§§, and Linda Stamps‡‡*

ABSTRACT

The northern fowl mite (NFM), *Ornithonyssus sylviarum*, is a commonly occurring external parasite of chickens. Primarily, caged layers have the greatest incidence of this mite, with bird unrest, unthriftiness and lowered production as some of the adverse effects of the infestation. In the current study, birds with natural NFM infestations were randomized into five treatment groups, placed in individual cages in treatment-specific batteries (all in one room), and evaluated for 28 d for infestation quantification by way of index scoring and feather digest. No treatments were 100% effective in eliminating all life stages of the mite. Tetrachlorvinphos in combination with dichlorvos (RAVAP E.C.® Boehringer Ingelheim) was the most effective with consistently negative post-treatment index scores and the greatest decrease in mite life stages (eggs, larvae, and nymphs/adults). Malathion dust (Hi-Yield® Voluntary Purchasing Groups, Inc.) and 10% garlic oil were next in level of effectiveness, with significant ($P < 0.05$) post-treatment reductions in both index scores and mite life-stage populations. Permethrin (Permectrin II® Boehringer Ingelheim) provided the least control of the infestations, with no significant reductions in index scores and only slight reduction in the abundance of life stages after treatment.

* Maggie Phillips is a senior majoring in animal science with a minor in equine science.

† T.A. Yazwinski, faculty sponsor, is a professor in the Department of Animal Science and an adjunct professor in the Department of Poultry Science.

§ C.A. Tucker is a program associate in the Department of Animal Science.

‡ Jennifer Robins is a graduate student majoring in animal science.

§§ Jeremy Powell is an assistant professor in the Deptartment of Animal Science and an extension veterinarian in the University of Arkansas Cooperative Extension Service.

‡‡ Linda Stamps is a program associate in the Department of Poultry Science.

MEET THE STUDENT-AUTHOR

Maggie Phillips

I graduated from Huntsville High School in 1999. After graduation, I attended the University of Central Arkansas for two years and studied chemistry. I transferred to the University of Arkansas in fall 2001 and am currently pursuing a B.S. degree in animal science with a minor in equine science.

Since attending the University of Arkansas, I have participated in numerous internships, mostly concentrating on equine science. After taking the course, Parasitology of Non-Herbivores, my interest was sparked in that field of study. I then conducted this special problems course under Drs. Yazwinski and Tucker on the effectiveness of different pesticides on *Ornithonyssus sylviarum* in poultry. My part in the study lasted eight weeks and taught me things I had known nothing about when it comes to scientific investigation. It improved my writing and research skills as well as skills for working in a lab in a way that only hands-on work can do. It was very beneficial to my college career and in gaining experience for future career paths.

INTRODUCTION

Commercial chickens are parasitized by a number of organisms. The incidence of the parasites, as well as their degree of impact on production, varies greatly between production types and segments. Arthropods that adversely impact poultry production can be categorized as ectoparasites (mites, lice, bedbugs, fleas, soft ticks, black flies, mosquitoes, etc.) and premise pests (darkling beetles, a variety of flies, moths, cockroaches, mud "daubers", etc.). An excellent discussion of the offending organisms that coexist with poultry (excluding internal parasites) has recently been published (Axtell, 1999) and should be reviewed for additional information. In regard to ectoparasites (order: Acarina), the Northern Fowl Mite (*Ornithonyssus sylviarum*) (Canestrini and Fanzago) has emerged as the most important "permanent" ectoparasite of poultry in the U.S.A. This status, coupled with the fact that it is an omnipresent offender at the University of Arkansas Department of Poultry Science research farm (personal communication; Nicholas Anthony), prompted the current investigation into the effectiveness of various acaricidal compounds against natural Northern Fowl Mite infestations.

MATERIALS AND METHODS

Birds

All study birds (female, white leghorn) were obtained from the University of Arkansas Department of Poultry Science research farm. At the time of acquisition, all birds were healthy, 30 weeks of age, and verified to be naturally infested with Northern Fowl Mites (NFM) by visual inspection of the vent area. Once obtained, they were immediately transported to the battery cage facility at the U of A Parasitology/Physiology Unit for acclimation.

Housing and Bird Maintenance

Birds were housed in stainless steel battery cages, one bird per cage, for both acclimation and study conduct. Each cage was 38cm wide, 50cm deep and 50.cm high. Water was provided ad libitum via an automatic-nipple watering system. Feeding was according to NRC (National Research Council) and industry standards. Dropping pans were cleaned and provided with new lining paper on a daily basis. All batteries were in one, environment-controlled room that was also cleaned on a daily basis. Batteries were 2m apart.

NFM Infestation Quantifications

Index scoring

Infestations were inspected at the vent area with 3X magnification and quantified by way of index scoring similar to a system detailed elsewhere (Williams and Berry, 1980). For the current study, index scores and estimated total bird/mite populations were 0 (no mites), 1 (1-50 mites), 2 (51-1000 mites), 3 (1001-25000 mites), 4 (25001-100,000 mites), and 5 (> 100,000 mites).

Feather digest

Feather digest for mite quantification was conducted according to a procedure by Mullens, et. al. 2000. During inspection, a representative feather was selected, extracted, and placed in a sealed container. The total contents of the container were then submersed in 10% KOH and brought to a transient boil. The resultant digest was then washed over a number 400 sieve (aperture of 40 microns) and the residue collected into 1000 ml with water. A count of the mite life stages was then made either by stereomicroscopic viewing of the entire 1000 ml, or by viewing representative aliquots until 500 specimens were counted. Photographs of characteristic specimens identified and counted in this study are in Fig. 1.

Study schedule

On the day of initial treatment (day 0, after 7 d of acclimation), the birds were index scored, ranked by the score, and evenly allocated to treatment-specific batteries, with five birds per battery. In addition, feathers were obtained for digest immediately prior to treatment. Index scores were obtained on study days 0, 7, 14, 21, and 28. Feather digests were conducted on study days 0, 14 and 28. Treatments were given on study days 0 and 14.

Treatments

The treatment groups and respective treatments were as follows:

Treatment 1 – Control, no treatments or facsimile

Treatment 2 – Permethrin (Permectrin ® Boehringer Ingelheim), given as a spray at the rate of 15 mls per bird

Treatment 3 – A preparation of tetrachlovinphos with dichlorvos (RAVAP E.C. ® Boehringer Ingelheim), given as a spray at the rate of 30 ml per bird

Treatment 4 – Garlic oil, given as a 10% solution in a spray deliver, at the rate of 22.5 ml per bird

Treatment 5 – Malathion (Hi-Yield ®), given as a 5% dust to cover thoroughly

Statistics

Index scores and digested feather, mite life-stage counts were analyzed for differences amongst days by way of analysis of variance (PROC GLM of SAS; SAS Inst. Inc., Cary, N.C.). For mite stages, data were transformed to the log 10 of (X + 1) prior to analysis. When means (within treatment, amongst days) were found to be different at a level of probability ≤ 0.10, they were separated using the PDIFF option of the LSMEANS program of PROC GLM.

RESULTS AND DISCUSSION

Data obtained in this study are presented on a treatment group-by-day of study basis for index scores, parasite eggs, parasite larvae, and parasite nymphs combined with adults in Tables 1-4, respectively. Regarding index scores, control and permectrin values did not change significantly during the study although there was reduction in the permectrin group following each treatment. Significant post-treatment reductions were seen for garlic oil, malathion, and RAVAP, with values for the latter two treatments of 0.0 (no live mites seen) at various points in time during the study.

Regarding parasite egg numbers per representative feather, control levels remained high throughout the study, but reductions were evident for each acaricidal group, albeit not statistically evident for garlic oil or permectrin (Table 2). A tendency for reduction (P< 0.10) was seen for malathion and a significant reduction (P< 0.05) was seen with RAVAP.

Northern Fowl Mite larvae counts did not vary amongst days for the control birds (Table 3). Levels of larvae were reduced for all acaricidal-treated groups post-treatment; numerically for garlic oil, at the probability level of < 0.10 for permectrin, and significantly (P< 0.05) for both malathion and RAVAP. Reductions were most pronounced for the RAVAP treatment group, in which group the only negative counts of the study were seen (day 28).

Levels of nymphs and adults combined, were very similar to those seen for larvae (Table 4). Control numbers remained high throughout, and post-treatment supressions were seen for each acaricide. Only malathion and RAVAP-treated birds experienced significantly reduced populations after treatment (P< 0.05). Garlic oil and permectrin provided some control, but only for garlic oil was the reduction somewhat statistically evident (P < 0.10).

According to the latest insecticide/acaricide recommendations for Arkansas (U. of A. Cooperative Extension Service publication MP 144), treatments that can be applied directly to caged layers include carbamates (carbaryl dust, wettable powders and emulsifiable concentrates); organic phosphates (malathion, tetrachlorvinphos and dichlorvos); and synthetic pyrethroids. At the time of this study, use of the carbamate products was being discontinued due to residue and toxicity concerns, leaving only the synthetic pyrethoids and organic phosphates as indicated treatment for NFM infestations. In addition to the above, garlic oil also was evaluated in this study due to promising results reported elsewhere (Birrenkott et al, 2000).

Therefore, of the products available for direct treatment of birds with NFM infestation, only the organic phosphate preparations of malathion dust (Hi-Yield ® Voluntary Purchasing Groups, Inc.,) and tetrarchlorvinphos in combination with dichlorvos (RAVAP E.C. ® Boehringer Ingelheim) provided excellent acaricidal activity as evidenced by low index scores and mite, life stage populations post-treatment. The synthetic pyrethroid preparation of Permectrin II (® Boehringer Ingelheim) and a 10% solution of garlic oil provided some reductions in mite populations (stages and index scores) but no reductions that could be considered truly effective or that would provide infestation control in the field.

ACKNOWLEDGMENTS

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Table 1. Mean NFM index scores for each treatment group by day of study.

	Day of study				
Treatment	0	7	14	21	28
Control	3.5	3.5	3.5	4.0	4.8
Garlic oil	3.6^{a}	1.7^{b}	1.3^{b}	1.0^{b}	1.3^{b}
Malathion dust	3.6^{a}	0.0^{c}	0.0^{c}	$0.6^{b,c}$	1.4^{b}
Permectrin II	3.4	2.0	2.8	2.0	2.4
RAVAP E.C.	3.4^{a}	0.0^{b}	0.0^{b}	0.0^{b}	0.7^{b}

^{a,b,c} Means on the same line with unlike superscripts are significantly different ($P < 0.05$).

Table 2. Geometric means for *O. sylviarum* eggs per digested/representative feather for each treatment group x study day combination.

	Study day		
Treatment	0	14	28
Control	1437	1115	1349
Garlic oil	822	208	47
Malathion dust	1205^{x}	87^{y}	112^{y}
Permectrin II	2029	492	419
RAVAP E.C.	814^{a}	53^{b}	3^{b}

^{x,y} Means on the same line with unlike superscripts are different ($P< 0.10$).

^{a,b} Means on the same line with unlike superscripts are significantly different ($P< 0.05$).

Table 3. Geometric means for *O. sylviarum* larvae per digested/representative feather for each treatment group x study day combination.

	Study day		
Treatment	0	14	28
Control	236	71	742
Garlic oil	103	7	26
Malathion dust	530^{a}	8^{b}	25^{b}
Permectrin II	590^{x}	22^{y}	89^{y}
RAVAP E.C.	187^{a}	6^{b}	0^{b}

^{x,y} Means on the same line with unlike superscripts are different ($P < 0.10$).

^{a,b} Means on the same line with unlike superscripts are significantly different ($P < 0.05$).

Table 4. Geometric means for *O. sylviarum* nymphs and adults (combined) per digested/representative feather for each treatment group x study day combination.

	Study day		
Treatment	0	14	28
Control	862	1078	4712
Garlic oil	1048^{x}	167^{y}	168^{y}
Malathion dust	1392^{a}	62^{b}	89^{b}
Permectrin II	1534	419	490
RAVAP E.C.	684^{a}	24^{b}	2^{z}

^{x,y,z} Means on the same line with unlike superscripts are different ($P < 0.10$).

^{a,b} Means on the same line with unlike superscripts are significantly different ($P < 0.05$).

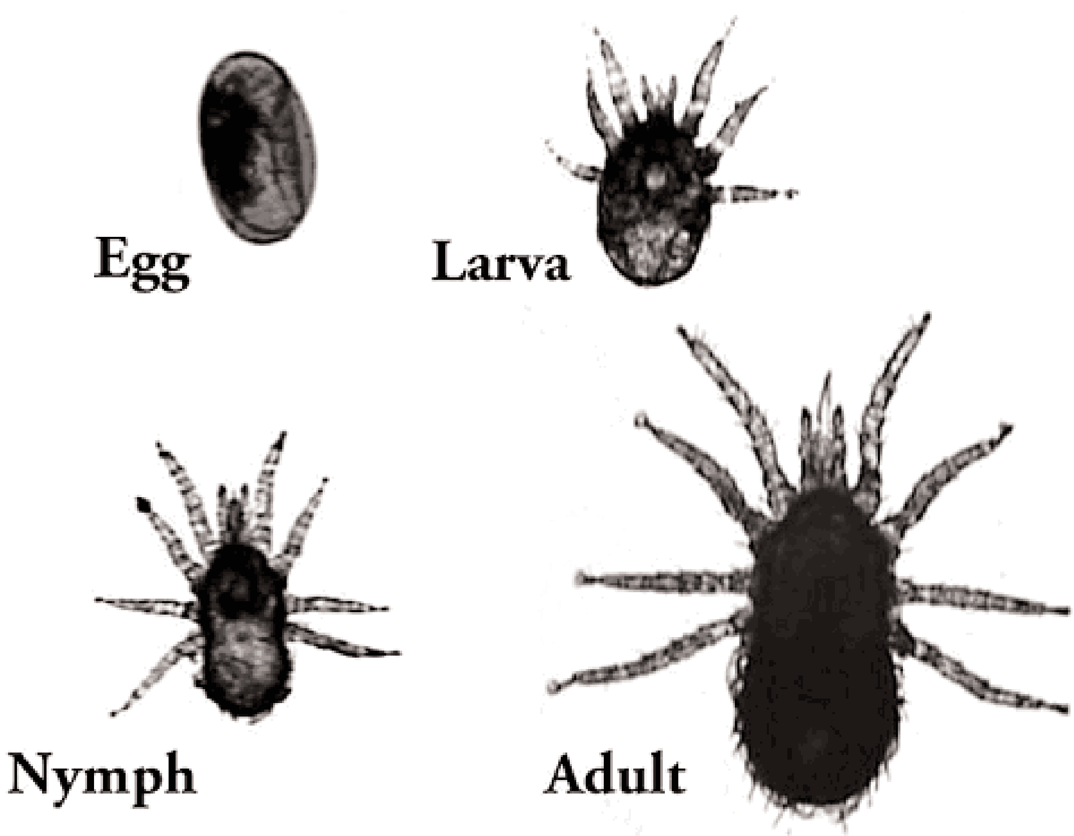

Fig. 1. Lifestages of the Northern Fowl Mite, *Ornithonyssus sylviarum* (40x)