The Control of External Parasites of Chickens in New York State

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THE most widely used controls for chicken lice and mites were developed more than two decades ago (Bishopp and Wagner, 1931; Cleveland, 1923; Cutright, 1929). These control measures are in part fairly effective but they are by no means completely satisfactory. Experimental data on the effectiveness of certain of these conventional methods is lacking. Likewise, little is known of the efficiency of the new organic insecticides under field conditions. Nearly all the important papers deal with tests conducted in the laboratory.

This study was conducted for the purpose of determining the effectiveness of certain of the more promising synthetic organic insecticides when applied by a convenient method against natural infestations of the economically important species of chicken lice and mites. Certain of the insecticides showing promise against lice and certain of those showing promise against mites were combined in an effort to find an all-purpose material.

MATERIALS AND METHODS

Three species of lice, the shaft louse, *Menopon gallinae* (L.); the chicken body louse, *Eomenacanthus stramineus* (Nitz.); and the less important fluff louse, *Goniocotes hologaster* (Nitz.) were included in these tests. Only flocks infested with all three species were utilized for control studies, therefore it was possible to observe variations in susceptibility among the different species of lice. Two species of mites, the northern fowl mite, *Fonsecaeonyssus sylviarum* (C. & F.) and the chicken red mite, *Dermanyssus gallinae* (Deg.) were also involved. The latter parasite was the most prevalent and caused the greatest amount of damage in New York. The northern fowl mite was the least common parasite but when present it produced the most severe injury to the chickens.

The tests were conducted over a three-year period (1951–1953) in 208 poultry houses containing more than 59,000 chickens. The following insecticides were evaluated:

1. Aramite (Butylphenoxyisopropyl chloroethyl sulphite)—Emulsion[1]
2. Benzene Hexachloride—Emulsion[2]
3. Carbolineum (anthracene oil)—Fractionated Oil[3]
4. Chlordane—Emulsion[4]
5. DDT—Emulsion[2]
6. DDT—Lindane Mixtures[2,5]
7. Dimite (Di-(p-chlorophenyl)methyl carbinol)—Emulsion[6]

[1] The United States Rubber Co.
[2] Geigy Company Inc.
[3] Carbolineum Wood Preserving Co.
[4] Velsicol Corporation.
[5] California Spray-Chemical Co.
[6] The Sherwin-Williams Co.

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8. Ground Limestone (calcium carbonate)—Dust[7]
9. Lindane—Emulsion[5]
10. Malathion (Bis(ethoxycarbonyl)ethyl dimethyl thiophosphate)—Emulsion[8]
11. Methoxychlor—Emulsion[2]
12. Neotran (Bis-(p-chlorophenoxy)-methane)—Wettable Powder[9]
13. Nicotine Sulfate—Solution.[10]
14. Nicotine Sulfate—Lindane Mixtures[5,10]
15. Ovotran (P-chlorophenyl-p-chlorobenzenesulfonate)—Wettable Powder[9]
16. Sulphenone (Parachlorophenyl phenyl sulfone)—Wettable Powder[11]
17. Toxaphene—Emulsion[12]

The insecticides were applied principally as sprays to selected surfaces of the chicken house. Dilutions were made with water on a weight basis. In the smaller establishments a standard five gallon tank capacity knapsack sprayer[13] fitted with a cone delivery nozzle was employed. In the larger houses a 15 gallon tank capacity gasoline powered portable sprayer[14] operating at 200 to 300 pounds pressure per square inch was used. This sprayer was equipped with 100 feet of high pressure hose to which a pistol grip cut-off and five foot spray rod with a cone delivery nozzle set at a 45 degree angle were attached.

Certain dust treatments with ground limestone and neotran which appeared warranted against mites were included. The ground limestone was broadcast about the entire pen. Neotran dust was applied to the birds as well as to the litter. A small shaker duster was used to treat the birds while the litter applications were made with a rotary type hand duster.[15] Individual treatment of birds was avoided whenever possible since such a method is costly and impractical in commercial establishments.

The comparative effectiveness of a new method of application, *i.e.*, continuous vaporization of insecticides from thermostatically controlled electrical heating devices,[16] was also tested. Previous work revealed that the vaporization method using lindane was effective against chicken lice (Moore, 1952).

Conventional materials, *i.e.*, nicotine sulfate for lice and the northern fowl mite, and carbolineum for the chicken red mite were included for comparative purposes. Each concentration of each of the 17 materials used was tested on at least two different flocks of chickens.

The roosts and adjacent walls, dropping boards, feed roosts, outside surfaces of nests and other likely harborages were sprayed to run-off in tests against the fowl mite and the red mite. For lice control, only the roosting areas were treated. Approximately 74 percent more spray material was required to treat a chicken pen for mites than for lice. All birds were made to roost on treated areas in control tests with lice and fowl mites. The air ventilation was held at normal conditions during the tests. The chickens were allowed to remain in the house during treatment. No pre-treatment cleaning of the house was undertaken.

Parasite populations were measured before and after treatment. The number of each species of lice observed along the sides of the body and within a two inch radius of the vent was estimated. The total

[7] Allied Chemical and Dye Corp.
[8] American Cyanamid Co.
[9] Dow Chemical Co.
[10] Tobacco By-Products and Chemical Corp.
[11] Stauffer Chemical Co.
[12] Niagara Chemical Div., Food Mach. and Chem. Corp.
[13] D. B. Smith & Co., Inc.
[14] John Bean Mfg. Co.
[15] Niagara Chemical Div., Food Mach. and Chem. Corp.
[16] American Aerovap Inc.

was then taken and the average number of lice (all species) per chicken was calculated. Approximately ten percent of the flock was examined at each observation.

Fowl mite populations were determined by estimating the number present about the vent, neck and along the sides of the body. A check was made on ten percent of the flock to obtain the average number of mites per chicken expected in the entire flock. In addition several house areas were examined for the presence of fowl mites.

Population estimates of red mites were based on an examination of several selected house areas. The areas included cracks and crevices in roosts, walls, dropping boards, feed hoppers and nests. The under surfaces of dried manure found adhering to these structures were examined also. If no mites were detected in these areas, an examination of the litter and nesting material was made. In all instances the places selected were those which showed the greatest evidence of mite activity. Approximately 10 two-square-inch areas were checked in houses of 100 square feet or less. Two more examination places were added for every additional 100 square feet of house space. Hence, 20 examination points were observed in a house of 600 square feet. The average number of mites per area examined was then calculated.

The intensity of the louse, fowl mite and red mite infestations were rated by means of the following scale:

Average number of parasites per chicken or house area	*Intensity of the infestation*
0	none
1–10	slight
10–25	light
25–50	medium
50–100	abundant
over 100	heavy

"Excellent," "satisfactory" and "unsatisfactory" were used to designate the comparative effectiveness of the various insecticides. "Excellent" control indicated that no lice or mites were found for eight weeks following treatment. "Satisfactory" control specified that the mite population was reduced to less than one to ten mites per area or bird examined for twelve weeks. "Unsatisfactory" control was assigned to those insecticides which failed to eliminate lice or reduce the mite population to less than one to ten mites per bird or house area within four weeks. Observations were made at least once each week.

RESULTS

Chicken Lice.—Of the materials tested, lindane, benzene hexachloride, chlordane, DDT-lindane, nicotine sulfate-lindane and malathion applied as single spray treatments to roosting areas gave the most effective control of chicken lice (Table 1). The lice were killed principally by vaporization of the insecticides. The active stages of all three species of lice

TABLE 1.—*Summary of the comparative effectiveness of the various insecticides used as single roost spray treatments against natural infestations of chicken lice*

Tompkins County, New York, 1951, 1952, and 1953

Insecticide and concentration	Mean av. no. of lice per bird in two or more flocks before treatment	Av. maximum percent reduction of lice	Control rating
Lindane—0.25%	70	100	Excel.[1]
Benzene Hexachloride 0.25% (gamma)	87	100	Excel.
Chlordane—0.50%	65	100	Excel.
DDT—4.00%+Lindane—0.25%	87	100	Excel.
Nicotine Sulfate—4.00% +Lindane—0.25%	100	100	Excel.
Malathion—3.00%	75	100	Excel.
Toxaphene—5.00%	75	66	Unsat.
DDT—5.00%	37	66	Unsat.
Methoxychlor—5.00%	37	33	Unsat.
Aramite—4.50%	56	0	Unsat.
DDT—5.60 gms./20,000 cu. ft./day[2]	75	0	Unsat.
Nicotine Sulfate—4.00%[3]	79	78	Unsat.[4]

[1] The lowest effective dosages of the insecticides producing excellent control are listed.
[2] Applied continuously as an aerosol from electrical vaporizer for 28 days.
[3] Two applications gave excellent control.
[4] The highest dosages tested are listed for those insecticides giving unsatisfactory control.

were eliminated within 48 hours after treatment and no live lice were found during or at the end of the eight week observational period. This evidence suggests strongly that the lice were eradicated. There were no noticeable differences in the effectiveness of morning and afternoon treatments with these toxicants. Apparently the insecticides possessed sufficient residual properties to insure kill of all of the lice nymphs hatching during the 10 to 14 day incubation period.

Single spray treatments with nicotine sulfate, toxaphene, DDT and methoxychlor produced only a temporary reduction of the louse populations (Table 1). Toxaphene, DDT and methoxychlor have low vapor pressures in comparison to lindane, benzene hexachloride and chlordane. Aramite sprays and high dosages of DDT applied from electrical vaporizers as an aerosol produced no noticeable effect on the lice populations. Two applications of nicotine sulfate were required to achieve excellent control. It was necessary to apply the solution in late afternoon to insure effective results due to its high volatility. Nicotine sulfate at the 4 percent level applied at the rate of one quart to every 30 feet of roost is about equivalent to the standard recommendation of 1 to 1½ ounces of 40 percent to every 30 feet of roost.

TABLE 2.—*The comparative susceptibility of natural infestations of the chicken body louse, the shaft louse, and the fluff louse to single roost spray treatments with various insecticides*

Tompkins County, New York, 1951, 1952, and 1953

Insecticide and concentration	Av. maximum percent reduction of lice in two flocks of chickens		
	Body louse	Shaft louse	Fluff louse
Benzene Hexachloride—0.125% (gamma)	97	72	79
Chlordane—0.25%	75	87	30
DDT—1.00%	100	100	25
DDT—2.00%	100	60	50
DDT—3.00%	85	100	73
DDT—5.00%	88	75	45
Lindane—0.031%	92	70	36
Lindane—0.062%	100	76	33
Lindane—0.125%	100	75	50
Methoxychlor—3.00%	78	81	39
Methoxychlor—5.00%	43	21	25
Nicotine Sulfate—2.00%[1]	66	66	0
Nicotine Sulfate—4.00%	100	35	50
Toxaphene—4.00%	66	75	55
Toxaphene—5.00%	66	66	66
Total Percent Reduction	1,256	1,049	656
Average Percent Reduction	84	70	44

[1] Two applications ten days apart.

TABLE 3.—*The results of field tests with neotran dust and nicotine sulfate and nicotine sulfate-lindane house sprays against the northern fowl mite*

Otselic, N. Y. 1951 and 1952

Material and concentration	Average number of mites per bird before treatment	Maximum percent reduction of mites	Control rating
Neotran—10.00%[1]	41	100	Excel.
Neotran—10.00%[1]	75	100	Excel.
Nicotine Sulfate—4.00%	37	99	Satis.
Nicotine Sulfate—4.00%[2]	63	100	Excel.
Nicotine Sulfate—4.00% +lindane—0.25%[2]	89	100	Excel.
Nicotine Sulfate—4.00% +lindane—0.25%	77	99	Satis.

[1] Applied at the rate of 0.5 oz. per bird and 5 lbs. per 1,000 sq. ft. of house area.
[2] Two applications three days apart.

Natural infestations of the chicken body louse, the shaft louse and the fluff louse varied in their susceptibility to the insecticides (Table 2). In general, the chicken body louse was the most susceptible and the fluff louse the most resistant. The shaft louse was slightly more resistant than the chicken body louse. The degree of activity shown by these species follows a similar pattern, *i.e.*, the chicken body louse is the most active, the shaft louse slightly less active and the fluff louse rather sluggish. It is suggested that greater sorption of the toxicants occurred with the more active species. However, certain morphological or physiological variations may have been the cause of the differences in susceptibility.

Northern Fowl Mite.—Neotran dust and nicotine sulfate and nicotine sulfate-lindane house sprays were effective in controlling the northern fowl mite (Table 3). Only a single application of neotran dust was necessary to eliminate the mites. However, the inconvenience of hand treat-

TABLE 4.—*Summary of the comparative effectiveness of the various insecticides used as single house spray applications against natural infestations of the chicken red mite*

Tompkins County, N. Y. 1951, 1952, and 1953

Insecticide and concentration	Mean av. no. of mites per area examined in two or more flocks before treatment	Average maximum percent reduction of mites	Control rating
DDT—4.00%	65	100	Excel.[1]
DDT—4.00%+lindane—0.25%	55	100	Excel.
Nicotine Sulfate—4.00%	56	100	Excel.
Nicotine Sulfate—4.00% +lindane—0.25%	87	100	Excel.
Malathion—1.00%	62	100	Excel.
Methoxychlor—10.00%	37	99	Satis.[2]
Lindane—1.00%	60	88	Unsat.[2]
Benzene Hexachloride—1.00% (gamma)	62	72	Unsat.
Toxaphene—5.00%	56	10	Unsat.
Chlordane—2.00%	56	29	Unsat.
Ground Limestone—10#/100 sq. ft.[3]	37	33	Unsat.
Carbolineum—97.00%	53	99	Satis.[4]
Neotran—5.00%	37	16	Unsat.
Ovotran—5.00%	27	41	Unsat.
Dimite—1.24%	56	29	Unsat.
Sulphenone—5.00%	56	99	Satis.[4]
DDT—10.14 gms./20,000 cu. ft./day[5]	37	0	Unsat.
Lindane—2.51 gms./20,000 cu. ft./day[6]	37	0	Unsat.

[1] The lowest effective dosages of the insecticides producing excellent control are listed.
[2] The highest dosages tested are listed for those insecticides giving satisfactory and unsatisfactory control.
[3] Five applications at weekly intervals.
[4] Two applications gave excellent control.
[5] Applied continuously as an aerosol from electrical vaporizers for 28 days.
[6] Applied continuously as a vapor from electrical vaporizers for 28 days.

ment makes dusting with neotran less promising from a practical view. The time required for two men to treat 250 birds by this procedure was three hours. The same house was treated by one man eight months later with a spray application in 15 minutes time.

Double house spray treatments of nicotine sulfate and nicotine sulfate-lindane applied three days apart gave excellent control of the fowl mite (Table 3). Previously it was necessary to use three applications of nicotine sulfate (40%) roost paint to obtain comparable results. The mites located in the cracks and crevices about the house were more readily eliminated with the house spray method. The actual amount of nicotine sulfate utilized by both methods is approximately the same.

Single house spray treatments with nicotine sulfate and nicotine sulfate-lindane reduced the mite population to a very low level (Table 3). In fact, the level of control achieved appeared adequate for use under commercial conditions. Due to their high volatility the toxicants should be applied in late afternoon for optimum results, and the chickens should be made to roost on the treated areas for the following three or four nights under normal ventilating conditions.

Chicken Red Mite.—DDT, DDT-lindane, nicotine sulfate, nicotine sulfate-lindane and malathion gave the most effective control of the materials tested (Table 4). A single spray application eliminated the mites which were killed primarily by the contact action of the toxicants. DDT acted rather slowly, usually requiring from five to seven days and sometimes longer to eliminate the mites. DDT-lindane, nicotine sulfate, nicotine sulfate-lindane and malathion reduced the red mite population to a very low level in three days or less. A thick crust of manure on roosting areas was found to reduce the effectiveness of the insecticides somewhat. This was probably due to excessive sorption of the toxicants by the manure leaving an insufficiently toxic residue.

Satisfactory control resulted when the concentration of methoxychlor was increased to 10 percent (Table 4). However, five of the six flocks treated with methoxychlor were only moderately infested with red mites. Lindane and benzene hexachloride spray treatments produced erratic control, although infestations were usually markedly diminished. A decided lessening of effectiveness was evident with these materials in the more severely

infested houses. The rapid loss of residual deposits was probably responsible for the results obtained. Relatively high concentrations of toxaphene and chlordane failed to decrease the red mite population significantly.

Repeated dust applications of ground limestone were ineffective in controlling red mites (Table 4). The investigation seemed warranted since many poultrymen were of the opinion that such a procedure would eliminate the mites. The lime dust caused a slight reduction in the number of mites, probably by its abrasive and desiccating action.

Carbolineum sprays applied at full strength produced only satisfactory results (Table 4). Within a week's time considerable drying occurred and the mites appeared unharmed by the remaining residue. The feathers of the chickens were severely stained in the pens treated with carbolineum.

Three plant miticides, neotran, ovotran and dimite showed little promise against the chicken red mite as single spray treatments (Table 4). Sulphenone, another plant miticide, was found to be effective. This material required from four to six days to exert its full effects. Dosages of sulphenone ranging from 2.5 to 5 percent held the mite population at a very low level for more than twelve weeks which was considered satisfactory control. Contradictory data were obtained with aramite so that further investigation is required before any conclusions can be reached.

DDT and lindane applied from electrical vaporizers at concentrations in excess of those recommended commercially gave no noticeable reduction of mites (Table 4).

TABLE 5.—*Summary table of insecticides showing promise as single house spray treatments in controlling natural infestations of chicken ectoparasites*

Materials and concentrations	Control Rating			Rating as all purpose insecticide
	Lice	Fowl Mite	Red Mite	
Lindane	Excel.	—	Unsatis.	Poor
Benzene Hexachloride	Excel.	—	Unsatis.	Poor
Chlordane	Excel.	—	Unsatis.	Poor
Neotran[1]	—	Excel.	Unsatis.	Poor
Carbolineum	—	—	Satis.[2]	Poor
Sulphenone	—	—	Satis.[2]	Poor
Methoxychlor	Unsatis.	—	Satis.	Poor
DDT	Unsatis.	—	Excel.	Poor
Nicotine Sulfate	Unsatis.[2]	Satis.	Excel.	Fair
Malathion	Excel.	—	Excel.	Good
DDT+lindane	Excel.	—	Excel.	Good
Nicotine Sulfate +lindane	Excel.	Satis.	Excel.	Excel.

[1] Applied as 10.00% dust on birds for fowl mites and as a 5.00% house spray for red mites.
[2] Two applications gave excellent control.

DISCUSSION

The chicken external parasites of major economic importance in New York, *i.e.*, chicken lice, the northern fowl mite and the chicken red mite were effectively controlled with several common organic insecticides (Table 5). The house spray method of application proved to be very convenient and practical for use under commercial conditions. Likewise the cost of these insecticides compared favorably with the conventional materials.

Certain of the materials, malathion, DDT-lindane and nicotine sulfate-lindane gave effective control of both lice and mites (Table 5). This feature should be very desirable since flocks were frequently found infested with chicken lice and the chicken red mite simultaneously. A single house spray treatment applied as for mites eliminated both lice and red mites.

Malathion and the DDT-lindane mixture appeared more desirable for lice and red mite control than the nicotine sulfate-lindane combination due to its lower cost. However, the nicotine sulfate-lindane combination was more versatile since it was acceptable for use against the northern fowl mite as well. If it was desired, either compound of the mixtures could be used separately against the parasite for which it is intended. Further in-

vestigation of this objective (all purpose material) with newly developed insecticides and certain other promising materials in combinations seems warranted.

No unusual reaction or apparent harm was detected among the chickens from any of the insecticides tested. Numerous poultrymen were of the opinion that effective control increased egg production, improved the general health of the flocks and decreased death losses although experimental proof was lacking. The house spray method of application appeared to be a relatively safe technique from the standpoint of toxic residues in poultry products since little, if any, consumption of the insecticides by the chickens occurred. The possible hazards to the operator from these toxicants seem slight when normal precautions are observed.

SUMMARY

Natural infestations of five species of chicken ectoparasites, the shaft louse, *M. gallinae* (L.); the chicken body louse, *E. stramineus* (Nitz.); the fluff louse, *G. hologaster* (Nitz.); the northern fowl mite, *F. sylviarum* (C. & F.); and the chicken red mite, *D. gallinae* (Deg.), were treated with several relatively new insecticides. Conventional materials were included for comparison. The insecticides were applied principally as single spray treatments to selected house surfaces.

Excellent control of the three species of chicken lice was obtained with single roost spray treatments of chlordane, lindane, benzene hexachloride, DDT-lindane, nicotine sulfate-lindane, and malathion. The conventional nicotine sulfate, toxaphene, methoxychlor, DDT, and aramite gave unsatisfactory control of lice as single roost spray treatments. Likewise DDT applied from electrical vaporizers failed to control chicken lice. Varying gradations of susceptibility to the insecticides occurred among the different species of lice. In order of increasing resistance they were placed as follows: the chicken body louse, the shaft louse and the fluff louse.

Excellent control of the northern fowl mite resulted from single dust treatments (birds and litter) of neotran and double house spray treatments of nicotine sulfate and nicotine sulfate-lindane. The two latter materials applied as single house spray treatments gave satisfactory control. The nicotine sulfate spray method was preferred over the less costly neotran dust method because of the convenience of application.

DDT, DDT-lindane, nicotine sulfate, nicotine sulfate-lindane and malathion produced excellent control of the chicken red mite. Sulphenone, methoxychlor and the standard carbolineum exhibited only satisfactory control while lindane, benzene hexachloride, toxaphene, chlordane, neotran, ovotran and dimite gave unsatisfactory control. Repeated applications of ground limestone dust and high dosages of vaporized DDT and lindane had little effect on populations of red mites.

Malathion and the mixtures of DDT-lindane and nicotine sulfate-lindane approached more closely the ideal chemical control of chicken ectoparasites. Single house spray treatments with malathion or DDT-lindane gave excellent control of both lice and the red mite while a nicotine sulfate-lindane mixture gave satisfactory control of the fowl mite as well.

No apparent harmful effects from the toxicants were observed among the chickens. Feeding, mating and egg production continued normally during the tests. The problem of toxic residues in meat and eggs did not appear likely since the chickens consume little if any of the insecticide and other contact is slight with the house spray technique. Little danger is involved

from the standpoint of the operator when the insecticides are properly handled.

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Studies on Pheasant Nutrition

2. PROTEIN AND FIBER LEVELS IN DIETS FOR YOUNG PHEASANTS

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EXPERIMENTS on the nutrition of pheasant chicks presented in an earlier report (Scott and Reynolds, 1949) showed that excellent growth was obtained up to five weeks of age with diets containing 28% of protein. No effort was made in these studies to determine the age at which the protein level in the ration could be reduced. Previous studies by Callenbach and Hiller (1933), and Norris, Elmore, Ringrose and Bump (1936), indicated that the protein requirement of Ringnecked pheasants is approximately 28% for early growth, but also failed to show the age at which the protein requirement drops to a lower level.

Although most of the diets used in the earlier studies by Scott and Reynolds were high in available energy, indications were obtained that pheasant chicks may develop better on diets containing appreciable amounts of fibrous ingredients such as ground whole oats and wheat standard middlings. Diets containing the higher fiber levels tended to decrease the incidence of feather picking, but did not eliminate it when the pheasants were reared in well lighted rooms.

It is the purpose of this report to present evidence showing that the protein requirement of pheasant chicks may be reduced from 28% to 24% at 2–3 weeks of age and that growth, feathering and general body development is satisfactory or superior on rations fairly high in fiber content.

EXPERIMENTAL

All of the experiments described in this report were conducted with Ringnecked pheasant chicks from the New York State Game Farm, Ithaca, N. Y. Except where indicated otherwise, the experiments were conducted in the Nutrition Laboratories, Department of Poultry Husbandry at Cornell University, in thermostatically