THE CONTROL OF THE HOUSE FLY, *Musca domestica*, Linn., WITH ORGANIC PHOSPHATE BAITS

By

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PREFACE

While a member of the United States Air Force it was my privilege to be assigned to Oklahoma Agricultural and Mechanical College to work toward an advanced degree in entomology. Since problems frequently develop in controlling medically important insects, a thesis problem of this type was sought. A problem was found when Dr. D. E. Howell, Professor of Entomology and Head of the Entomology Department, Oklahoma A and M College, suggested to me during the summer of 1954, that organic phosphate baits be investigated as control measures against house flies in the college barns and in the city of Stillwater, Oklahoma. This I have endeavored to do by a series of tests to determine the attractiveness and toxicity of the baits, attractiveness of different colored sugars and the feeding habits of the flies on dry sugar baits. In college barn and city control the results obtained were based on Scudder grill and visual counts after treatments with organic phosphate sugar baits.

My sincere appreciation is expressed to Drs. D. E. Howell, my major adviser, whose kind and patient assistance and cooperation have proven an invaluable aid in helping me carry out this problem, D. E. Bryan, Assistant Professor of Entomology, F. A. Fenton, Professor of Entomology and Head Emeritus of the Entomology Department, R. R. Walton, Associate Professor of Entomology and J. R. Egerton, Assistant Professor of Zoology, for their constructive

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CHAPTER I

INTRODUCTION

The house fly, Musca domestica, Linn., due to its feeding habits, mouthparts and rapid rate of reproduction, has attained vast public health importance in the spread of such diseases as typhoid fever, cholera, dysentery, infantile diarrhea and yaws.

As early as biblical times the house fly was suspected of causing disease. This can be seen in the twenty-fourth verse, eighth chapter of Exodus which reads: "And there came a grievous swarm of flies into the house of Pharaoh, and into the servants' houses, and unto all the land of Egypt: the land was corrupted by reason of the swarm of flies."

Howard (1911) states that Sydenham, who is believed to have lived prior to 1689, said that if flies were abundant in the summer it would create an unhealthy condition in the people in the autumn.

Sanitary measures in the disposal of breeding media and preventive measures, such as screening, have been known for many years to be the best protection against the house fly (Howard, 1911). Unfortunately these precepts are not always attainable, because of carelessness or for other reasons so that chemical control added to sanitary measures remains the only possibility for adequately reducing fly populations.

Along with fly paper and other fly traps some of the first chemical controls used were poison baits. According to Weiss (1912) a bait prepared from corrosive sublimate, King's yellow and Quassia was used to control house flies in England around 1800. Smith (1911) reported that buildings were cleared of flies in 36 to 48 hours with a formalin bait mixed with water or milk. Fenton (1936) was successful in killing large numbers of flies with a formalin, milk, water and molasses bait. Various other workers report good results with formalin baits using sugar, bread or beer as attractants.

Mally (1915) found that a wet bait containing sodium arsenite, sprayed on eucalyptus branches gave good control of the house fly.

Lodge (1918) reported killing 99 percent of these pests in 21 hours with sodium iodate used as a wet bait. Marcovitch (1929) used sodium fluosilicate and water to good advantage in killing house flies in a laboratory by permitting them to drink the solution. Pearson (1933) stated that an effective wet bait can be made from trisodium arsenite and arsenic acid dissolved in cane sugar and requiring about one gram of poison to 100 cubic centimeters of solution for an adequate kill.

The earliest report of the use of a dry bait to control house flies came from Russia. Good control was obtained by dusting the walls, ceilings, doors, window frames and electric light fixtures with a mixture of 94 to 95 parts of finely powdered sugar and five to six parts of sodium arsenite, applied at the rate of 0.5 gram to ten square feet of surface area. Flies fed readily on the bait and died in two to three hours. Lower and higher concentrations of bait were tested with a decrease in effectiveness at lower concentrations and

no appreciable increase in effectiveness with higher concentrations. Aniline dye was mixed with the bait so dusted surfaces could be easily distinguished (Pivovarov, 1939).

The various baits mentioned above and space sprays were used with some success, but with the advent of DDT,[1] residual sprays took over. Lindquist (1945) reported almost complete kill overnight with DDT-kerosene treated muslin strips and DDT painted on cages. Van Leeuwen (1944), and Sweetman (1946) obtained remarkably effective control of houseflies with residual and spot treatments of DDT. West (1951) presented a good summary of the historical development of DDT and the control obtained with it when used as residual sprays, space sprays, aerosols or paints.

As early as 1947 DDT was shown by Missiroli and Sacca (1947) to be losing its effectiveness on certain strains of houseflies. Barber (1948) stated this to be true with strains of houseflies in New York. Soon King (1949) reported strains resistant to DDT from Florida and shortly afterward the same was true over much of the world. Bruce (1952) gave a review of the literature of resistance in houseflies to DDT, in which he stated that it was first shown in Italy, then California, Illinois and soon over much of the rest of the world.

Since the development of resistance to some of the residual chlorinated hydrocarbons, of which group DDT is a member, the emphasis has been on the poison baits and sprays formulated with the organic phosphates. Thompson (1953) reported good results with a wet bait

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[1] 1,1,1,-trichloro 2,2-bis (p-chlorophenyl) ethane.

composed of corn syrup, water and TEPP[1] or 99 percent lindane[2]. The lindane remained effective for 48 to 72 hours while TEPP was effective for only 12 to 24 hours.

Farrar (1953) proposed that an effective bait for use against house flies could be prepared from 1.5 to 2.5 cubic centimeters of 40 percent TEPP, four fluid ounces of molasses and one gallon of water.

Floor treatments of dairy barns with malathion[3], lindane, TEPP or Bayer 13/59[4] and wall treatments with malathion or diazinon[5] gave effective control of house flies. In milking parlors burlap bags sprinkled with malathion wet bait also gave good control (King, 1953).

Malathion used as a 25 percent wet bait combined with 2.5 percent sugar or 25 percent sugar and ten percent whey on strings suspended from ceilings gave good control of house flies for seven to eight weeks. Bayer 13/59 was not effective as a spray but was promising as a bait (Price, 1953).

Bruce (1953) found that flies could be controlled effectively with Bayer 13/59 dissolved in four ounces of water and mixed with one pint of dark corn syrup. The bait was applied to window frames, posts and other places frequented by flies. The baits hardened and remained effective (90 to 99 percent control) from 12 days to 26 weeks.

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[1] Tetraethyl pyrophosphate.

[2] 99 percent - of the gamma 1:2:3:4:5:6 hexachlorohexane.

[3] O,O-dimethyl dithiophosphate of diethyl mercaptosuccinate.

[4] O,O-dimethyl-1-hydroxy-2,2,2-trichloroethylphosphonate.

[5] O,O-diethyl-O-[2-isopropyl-4-methyl-pyrimidyl(6)] thiophosphate.

In tests with a diazinon spray good control was shown for ten weeks against non-resistant flies and four weeks against resistant flies (Hansens, 1953).

Gahan (1954) obtained good control of house flies with a bait containing 0.1 percent of diazinon, malathion or Bayer 13/59 and ten percent attractant. Diazinon and Bayer 13/59 were more toxic than malathion in aqueous solutions containing ten percent molasses. Certain concentrations of Bayer 13/59 and malathion reduced the attractiveness of baits.

Effective control of house flies was obtained with malathion wet bait when sprayed on garbage cans, lids and surrounding areas (Langford, 1954). One percent diazinon sprays were shown by Guthrie (1954) to give good control for six weeks and malathion wet baits for two weeks when used in dairy barns; however, malathion wet baits did not give effective control in barns where molasses was fed in cattle rations. Johnson (1954) reported good control of house flies with malathion, 4124[1], diazinon and chlorthion[2] used as dry baits. Malathion, diazinon, 4124 and chlorthion all gave good control when used as wet baits. Wet baits gave a quicker initial kill than dry baits. Also malathion, diazinon and 4124 gave the best results when used as wall sprays, remaining effective for two to three weeks. Hansens (1954) obtained effective control for 40 to 60 days with 4124 used as a residual spray. Chlorthion gave protection for three to five weeks; malathion was less effective. Diazinon and chlorthion

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[1] 0,0 dimethyl O-(2-chloro-4-nitro phenyl) thiophosphate.

[2] 0,0 dimethyl, 0,3, chloro-nitro phenyl thiophosphate.

gave good control when used as dry sugar baits. Sprays were considered superior to baits because they gave longer protection. Scott (1954) found little difference in control obtained with one and two percent diazinon sprays and sugar when added to wettable powder sprays did not enhance control. Keller (1954) reported that wet baits containing organic phosphates, (two of which were chlorthion and Bayer 13/59) when applied to refuse at slaughter houses, city dumps, and garbage and trash piles reduced housefly and blow fly populations from 90 to 99 percent. Baits were diluted with mixtures of molasses, malt or sugar and water. Results varied with the species of flies and where the baits were applied. Malathion gave good control against houseflies at a two percent concentration when mixed with the above attractants and applied to trash dumps.

CHAPTER II

METHODS AND MATERIALS

An attempt was made during the summer of 1954 to determine if house flies could be controlled in the Oklahoma A. & M. College barns and in the city of Stillwater, Oklahoma, with organic phosphate dry and wet sugar baits. Experiments were conducted to determine the differences in the attractiveness and effectiveness of the different organic phosphate dry sugar baits to house flies. Tests were also conducted with different colored sugars and different colored dry sugar baits to determine color preference in house flies. Feeding observations were made and the distance traveled by house flies after feeding was also studied.

Fly Counts

Both Scudder grill and visual methods of fly population estimation were used to check the effectiveness of baits. A Scudder grill is a device for estimating fly populations, constructed of wood strips 1/4 inch wide by three feet long. These strips are tacked on a Z-shaped three-piece frame 3/4 inch apart to form a one-yard square grill. The grill is placed in a highly populated area after the flies have been flushed and the number of flies landing on the grill in 30 seconds is the count (Scudder, 1947). Visual fly counts are made on the basis of the Scudder grill. When

an operator is familiar enough with the grill he estimates the number of flies landing on a square yard of surface in a given amount of time, usually 30 seconds. It has been established that visual counts are reliable to within ten percent of Scudder grill counts (Welch, 1953). In the Oklahoma A. & M. College barns at Stillwater, the counts were taken in four of the heaviest populated sections of each barn and an average was taken of the three highest to determine the count. Fly counts were taken between 1:00 p.m. and 5:00 p.m. daily during June and twice weekly or less frequently from July 1 to October 13, 1954. In downtown Stillwater fly counts were taken from garbage receptacles behind grocery stores and restaurants located on each side of Main Street. Other city counts were taken at poultry plants, creameries, a mill and a swimming pool. Fly counts were taken between 9:00 a.m. and 12:00 a.m., three times weekly from June 24 to October 13, 1954.

Description of College Barns (Figure 1)

Beef barn

The beef barn was composed of three wings, an east and west wing each running north and south and a central walkway running east and west and connecting the east and west wings (Figure 1a). Ensilage was fed in the north half of the east wing; this tended to attract more flies and made heavier fly populations in this area. Also small calves were kept here and doors were left open at the north end making access to flies much easier. The north half of the west wing was seldom used and presented no fly problem; therefore, it was not treated. The remainder of the barn housed

beef cattle. Pens were located down the sides of each wing and on each side of the central walkway. All floors were of cement construction and were swept daily when the cattle pens were cleaned. Dry sugar baits were applied to the floors of the walkways and to window ledges. This comprised about 50 percent of the floor space in the barn. A feed room was located about middle way down the central walkway on the north side. Feed was infrequently ground and the floor was seldom swept making in unnecessary for frequent reapplication. Approximately 50 percent of the floor space was treated in the feed room.

Horse barn

The horse barn was comprised of two wings, an east and west wing running north and south and a central walkway connecting the two wings (Figure 1b). Horses were housed in the west wing only when they were fed grain and the area was kept closed and dark so no fly problem developed; therefore, the area was not treated. The east wing housed swine, rabbits and sheep. The floor of the swine pens was of cement construction and was washed down daily. The floor under the rabbit pens was of wood construction and the floor of the sheep pens was made up of dirt, manure and loose litter. Approximately 50 percent of the area was treated and treatment was inside the pens in all cases.

Experimental beef barn

The experimental beef barn was composed in part of a long shed running east and west, open on the south side and closed on the north (Figure 1c). Open cattle pens ran the length of the shed adjacent to a walkway. Manure in the pens offered a constant breeding

source for flies. The floors of this barn were of brick construction but were infrequently swept resulting in dust covering the floor most of the time. Dry sugar baits were applied to the floor of the walkway and to window ledges. The walkway composed an estimated 20 percent of the floor space in the barn. A feed room was located in the north end of the barn; feed was frequently ground here and the floor was swept several times a day making reapplication necessary. One-hundred percent of the floor space in the feed room was treated.

Sheep barn

The sheep barn was arranged similar to the experimental beef barn. It consisted of a long shed running east and west connected by a central walkway (Figure 1d). Sheep were kept in pens adjacent to the walkway running the length of the shed. The pens were open on the south and closed on the north. Wet baits containing 0.016 percent Bayer[1] 13/59A were applied to the cement floor of the walkway the entire season. On one occasion Karo syrup containing Bayer 13/59A was applied to the mangers and part of the walls. An estimated 32 percent of the floor space in the barn was treated.

North swine barn

The swine pens at the north swine barn are open pens located about 50 feet north of the barn. There were 20 pens with 96 square feet of cement floor space per pen (Figure 1e). Manure was washed into a trench in front of the pens and disposed of weekly. Dry

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[1]The suffix A has been assigned to Bayer 13/59 to distinguish it from another bait, 13/59B, mentioned elsewhere. The active ingredient is the same in both baits, only the color is different.

sugar baits were applied to 100 percent of the area including tops of feeders and the trench in front of the pens. Inside the north swine barn were located the farrowing pens and the feed room (Figure 1e). There were six pens running east and west adjacent to a cement floored walkway. Dry sugar baits were applied to the floors and window ledges of the walkway and feed room. Feed was frequently ground in the feed room; consequently, the floor was swept several times a day making reapplication necessary. Approximately 87 percent of the floor space in the north swine barn and the feed room were treated.

South swine barn

The south swine barn was composed of an east and west wing running north and south and connected by a central walkway (Figure 1f). Farrowing pens were located in the east and west wings and a feed room was located in the central walkway. Sows did not farrow until late in the season so most of the fly population encountered came from manure from swine located in pens south and southeast of the south swine barn. Reapplication of dry baits was necessary in the feed room due to frequent grinding of feed, making it necessary to sweep the floor more often. Dry sugar baits were applied to the cement floors and window ledges of the walkway and feed room. An estimated 37 percent of the floor space was treated in the south swine barn. A long shed which housed swine and had been termed the east swine shed was located about 30 feet southeast of the south swine barn (Figure 1f). This shed was similar to the sheep barn in that it was enclosed on the north and open on the south. Swine pens were located adjacent to a cement walkway and ran the full length of the shed. A manure pit was located about 10 feet south of this shed

and offered an excellent breeding place for flies until it was removed about three weeks subsequent to the time treatment started. Dry sugar baits were applied to the floor of the walkway which composed about 25 percent of the floor space in the east swine shed.

Dairy barn

The dairy barn was divided principally into three wings: east, central and west (Figure 1g). Dry sugar baits were applied to the cement floors and window ledges in the barn. No baits were applied to feed in mangers because the cows were repelled by the odor of the bait; however, baits were sprinkled on sacks of feed in the feed room with no difficulty in cows eating their feed. The south half of the east wing housed small calves and the north half housed dairy cows. Due to improper cleaning of calf pens in the south half of the east wing, flies were allowed to breed in manure under straw the entire season. Approximately 33 percent of the floor space was treated in this wing. The feed room was located on the north side of the central wing and opened into the central wing. Heaviest populations were encountered in the feed room and the central wing. The major breeding area was located near the feed room and the door was kept open most of the time, permitting flies to enter. Milking was done in the central wing and molasses feeds were fed; this served as an added attractant and drew flies from the feed room. The floors in the central wing were washed down several times daily making it difficult to apply dry baits; however, most of the baits were applied in a drier area between the two rows of stanchions. Feed was ground and the floor was swept several times a day in the feed room making reapplication necessary. Approximately 77 percent of the floor

space was treated in the central wing and 100 percent was treated in the feed room. The south half of the west wing housed dairy calves and the north half housed dairy cows. An estimated 66 percent of the floor space in this wing was treated.

Organic Phosphate Baits and Their Application

The organic phosphate materials used in dry sugar baits were malathion[1], chlorthion[2], diazinon[3], and 4124[4]. Bayer 13/59B, a proprietary product, manufactured under the trade name "Dipterex" was used to some extent as a dry bait in the south swine barn. This bait contains the same active ingredient as Bayer 13/59A[5] and differs only in the respect that it has a blue-gray dye in it. In some instances another proprietary product manufactured under the name "Fly Flakes"[6] was used. This bait was made up of oyster shell coated with malathion and contained an attractant. Bayer 13/59A was used as a wet bait consisting of an aqueous solution of insecticide and granulated sugar. On one occasion Bayer 13/59A in Karo syrup was used. Dry sugar baits were applied as a one percent mixture, 1 part insecticide to 99 parts granulated sugar, at the rate of 1 ounce

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[1]Supplied by American Cyanamid Company, New York, N. Y.

[2]Supplied by Pittsburgh Coke and Chemical Co., Pittsburgh, Pa.

[3]Supplied by Geigy and Company. Bayonne, N. J.

[4]Supplied by American Cyanamid Company, New York, N. Y.

[5]Supplied by Pittsburgh Coke and Chemical Co., Pittsburgh, Pa.

[6]Supplied by Florida Agricultural Supply Co., Jacksonville, Fla.

to 500 square feet of surface area. The dry sugar applications were made with the aid of a pint or quart jar with a perforated lid. The baits were usually mixed in 25-pound lots, 24 pounds of granulated sugar to 1 pound of 25 percent wettable powder, in a 55-gallon steel drum. Commercial baits with dyes added included the previously mentioned blue-gray Bayer 13/59B, yellow malathion, brown diazinon and pink Bayer 13/59A. These were used to some extent but the author also mixed his own baits from bulk supplies of malathion, chlorthion, diazinon and 4124 to which no dyes were added. Pink Bayer 13/59A was used as a dry bait in experimental tests but not in house fly control in the college barns. Dry sugar baits used in college barns were applied to all horizontal surfaces on which house flies were known to rest, particularly the floors of barns, window ledges, the tops of feeders, feed sacks and in some instances the floors of swine pens and in mangers or feeders. The dry sugar baits malathion, chlorthion, diazinon, 4124 and Bayer 13/59B were applied in several sequences in college barns. In most cases during June the same bait was used in the same barn for the entire month. After July 1, 1954 several different baits were applied in the same barn in sequence or different baits were used simultaneously in separate wings of the same barn. The frequency of application and the percent of total floor space treated varied in each barn, so it is presented in the evaluation of the effectiveness of organic phosphate baits in college barns (Page 25) or in the description of college barns (Pages 8 to 13).

The organic phosphate dry sugar baits used in the housefly control program in the city of Stillwater were malathion and diazinon.

Applications were made with the aid of fruit jars the same as in the college barns. The principal areas treated were in and around garbage receptacles in the alleys behind grocery stores and restaurants on Main Street from Sixth Street south to Fourteenth Street (Table 8). Other areas treated were poultry plants, a mill, a swimming pool and refuse containers behind creameries. Control areas were set off in two regions; one including all establishments east of Main Street and the other including all the establishments west of Main Street. Malathion was applied on the west side of Main Street from June 24 to July 24 and on the east side from July 27 to October 13. Diazinon was applied on the east side from June 24 to July 24 and on the west side from July 27 to October 13 when work was discontinued.

In the sheep barn the wet bait was applied at a rate of 1 ounce of bait (at a 0.016 percent concentration) to 71 square feet of floor space. A three-gallon sprinkling can was used for mixing and applying the bait. The bait was mixed at a hydrant by introducing one pound of granulated sugar, 1.5 grams of 100 percent Bayer 13/59A concentrate and then running water into the sprinkling can. Application was made by rapidly moving down the walkway and permitting the wet bait to sprinkle out of the can. Another wet bait prepared by thoroughly mixing Bayer 13/59A with Karo syrup was used in the sheep barn. A single application with this material was made to the sides of feeders and portions of the walls of the barn. The frequency of application and the percent of total floor space treated is presented in the evaluation of the effectiveness of organic phosphate baits in college barns (Page25) or in the description of college barns (Pages 8 to 13).

Attractiveness and Effectiveness Tests

These tests were conducted in the east wing of the dairy barn to determine the attractiveness and effectiveness of the different organic phosphate dry sugar baits to house flies. This wing housed small dairy calves and was chosen because, at the time tests were conducted, populations were high; also there was less chance for interruption from barn personnel during the tests. The baits tested were diazinon and sugar; chlorthion and sugar; Bayer 13/59A and sugar; malathion and sugar; malathion, fish solubles and sugar and oyster shell and malathion. A check was also included in one of the tests. The baits were applied to one foot square pieces of brown paper at the equivalent of one ounce to 500 square feet of surface area. This was about 0.05 grams of bait. Oyster shell and malathion were applied at the equivalent of four ounces to 100 square feet of surface area because of the smaller surface area by weight covered by oyster shell as compared to granulated sugar. Calf pens were located along the sides of this wing with a walkway down the center. The one-foot-square pieces of paper were lined up about one foot in front of the pens for the full length of the wing. The treatment papers were spaced one foot apart and each of the six materials tested was replicated five times. The entire test was repeated the next day. Live flies observed on the insecticide treated papers were counted every 30 minutes, then the live flies were disturbed and the number of dead flies on each treated paper was recorded. Counts were made from 9:30 a.m. to 3:30 p.m.

Sugar Color Tests

The sugar color tests were carried out to determine if house flies show a preference for certain colors. The colors selected for the tests were yellow, pink, blue, white and black. The colored sugar, with the exception of black, was prepared by mixing finely ground chalk with the granulated sugar at the rate of five parts sugar to 1 part chalk. The black sugar was prepared by adding lamp-black to the sugar at the same rate as for the ground chalk. A control check was also included in the test. The procedure for the sugar color test was exactly the same as for the attractiveness and effectiveness tests (Page 16), with the exception that colored sugars were used as treatments rather than poison baits and the tests, composed of five replicates, were repeated three times.

Organic Phosphate Dry Sugar Bait Color Test

This test was set up after the sugar color test had been completed to determine if house flies show a preference for different colored dry sugar bait mixtures and the effectiveness of the different baits. The colored baits used were yellow malathion and sugar, white Bayer 13/59A and sugar, brown diazinon and sugar, tan malathion and sugar, pink Bayer 13/59A and sugar and tan diazinon and sugar. The procedure for the organic phosphate dry sugar color test was exactly the same as for the attractiveness and effectiveness tests (Page 16) with the exception that the test, composed of five replicates was not repeated and only the first five counts were used since the flies consumed all the bait on the more attractive treatments after two and one-half hours and then moved to the less attractive treatments.

The Distance Traveled by House Flies After Feeding on Organic Phosphate Dry Sugar Baits

In order to show how far flies move after they receive a toxic dose of dry sugar bait and before they die an experiment was set up in the east shed of the south swine barn. This shed was selected for the experiment because it offered a high population with which to work. The shed was 120 feet long with a door separating it in the middle into two 60 feet sections. The walkway next to the pens where the experiment was run was four feet wide. A one foot square piece of brown paper was placed half way down the length of the 60-foot sections and the distance was measured off each way into two-foot intervals for 30 feet. The paper was treated with one gram of dry sugar bait at 8:30 a.m. and the dead flies were counted at the different stations at 12:30 p.m. The first count was made one foot from the center of the paper. The dry baits tested were Bayer 13/59B and sugar, chlorthion and sugar, diazinon and sugar, 4124 and sugar and Bayer 13/59A and sugar. One poison was placed in each section of the shed on a different day. Due to a population drop later in this shed, malathion and sugar was tested in the east wing of the dairy barn; the same procedure was used with the exception that the wing was 42 feet long and six feet wide.

Feeding Observations

Feeding studies were made of house flies feeding on malathion and sugar, Bayer 13/59B and sugar, diazinon and sugar and chlorthion and sugar. A few granules of sugar were placed on a table and when a fly began to feed it was caged in an open-bottomed cage and observations were made. Fifteen flies were observed with Bayer 13/59B

and sugar and ten were observed with the remaining baits to determine the number of granules necessary to cause toxic symptoms, the number of additional granules picked up and dropped with the labellum and the amount of time for symptoms to appear. Some of the symptoms of poisoning were also observed.

CHAPTER III

RESULTS

Attractiveness and Effectiveness Tests

In these tests the number of live flies feeding on the bait and the number of dead flies were recorded every 30 minutes (Page 16). Since all organic phosphate baits are toxic to house flies it may be assumed that all flies that fed and were feeding on dry baits died shortly thereafter. This being the case all the live and dead flies were lumped together (Table 1) under flies present. It can be seen from the distance traveled test (Table 6) that an average of 86 percent of the dead flies are found within ten feet of the feeding point. Since the papers on which the bait was placed were only one foot apart this would tend to cause considerable overlap in that dead flies from one treatment may be found near another treatment and counted for that treatment; however, the same population would be present in each replicate so the overlap should be constant among all treatments. In comparing the replicate totals (Table 1) it can be seen that Bayer 13/59A and sugar was slightly more attractive and effective than malathion and sugar and both were much more attractive and effective than chlorthion, sugar and fish solubles; chlorthion and sugar; diazinon and sugar, and malathion, sugar and oyster shell. Chlorthion, sugar, and fish solubles were less effective than the remaining five treatments. The treatments in order of

decreasing effectiveness were: Bayer 13/59A and sugar; malathion and sugar; malathion, sugar and oyster shell; chlorthion and sugar; diazinon and sugar, and chlorthion, sugar and fish solubles.

Sugar Color Tests

In comparing the replicate totals in the sugar color tests we find that more flies were attracted to yellow and less to black than were attracted to white, red or blue. By replicate totals more flies were attracted to yellow in tests number one and three than were attracted to other colors. Although black attracted less flies in the totals of all tests, it attracted more flies in test number two than other colors (Table 2). The colors in order of decreasing attractiveness were: Yellow, white, blue, red and black; however, statistical analyses of the three sugar color tests showed that there was no significant difference at the one percent level in the attractiveness of different colored sugar to house flies.

Organic Phosphate Dry Sugar Bait Color Test

This test was run, after the sugar color test had been completed, to determine if certain colored organic phosphate dry sugar baits were more attractive to house flies than other colored baits. Commercial mixtures of pink Bayer 13/59A, yellow malathion and brown diazinon bait were used. The same insecticides were mixed by the author in their natural color and used as checks against the commercial colored baits above; diazinon and malathion were tan in color and Bayer 13/59A was white. The live and dead flies were counted and recorded every 30 minutes. The numbers of live and dead flies were added together as in the attractiveness and effectiveness tests

(Pages 20 and 21) and shown as flies present (Table 3). Only the results of the first five counts (Page 17) were tabulated. The colored baits in order of decreasing attractiveness were: White malathion, white Bayer 13/59A, brown diazinon, pink Bayer 13/59A and white diazinon. Since white baits ranked first, third and last and malathion bait ranked first and second it would appear that flies showed a preference for the bait rather than the color. The results closely parallel those of the attractiveness and effectiveness tests (Table 1) where malathion and Bayer 13/59A were superior to diazinon with the exception that malathion was much more effective than Bayer 13/59A in this test.

The Distance Traveled by House Flies After Feeding on Organic Phosphate Dry Sugar Baits

Of the six baits tested; 4124, Bayer 13/59A, Bayer 13/59B chlorthion, malathion and diazinon, figures show that the number of dead flies (Tables 4 and 5) counted at one foot from the feeding point ranged from 23 percent with diazinon to 64 percent with Bayer 13/59A. The percentage of dead flies counted within one foot of the feeding point for other baits were 30 percent for malathion, 34 percent for Bayer 13/59B, 37 percent for 4124 and 39 percent for chlorthion. Within five feet of the feeding point the percentage of dead flies counted ranged from 54 percent with malathion to 90 percent with Bayer 13/59A. Other baits showed the percentage of flies taken at five feet from the feeding point to be 66 percent for Bayer 13/59B, 72 percent for diazinon, 73 percent for chlorthion and 75 percent for 4124. Within ten feet of the feeding point the percentage of dead flies taken ranged from 73 percent with malathion to 98 percent

with Bayer 13/59A. Other baits showed Bayer 13/59B with 84 percent, diazinon with 89 percent, 4124 with 90 percent and chlorthion with 91 percent. Within 15 feet of the feeding point the percentage of dead flies taken ranged from 89 percent with malathion to 99 percent with Bayer 13/59A. Other baits showed 93 percent for Bayer 13/59B and diazinon, 94 percent for 4124 and 95 percent for chlorthion. When an average of the percentage of dead flies counted at different intervals with all the baits combined (Table 6), it was shown that only four percent of the total population were found between 20 and 30 feet from the feeding point.

With an average of the total figures of all the baits tested (Table 6), results showed that 38 percent of the dead flies were taken within one foot of the feeding point, 34 percent between two and five feet, 14 percent between six and ten feet, ten percent between 11 and 15 feet and 4 percent beyond 15 feet. Accumulative averages showed that 38 percent of dead flies were found within one foot of the feeding point, 72 percent within five feet of the feeding point, 86 percent within ten feet, 96 percent within 15 feet and 100 percent within 30 feet.

It would appear from the data that Bayer 13/59A was more toxic to house flies than other baits since it killed a greater number in the one foot area; diazinon would appear to be considerably less toxic. This is the reverse of what was found in the feeding tests. White diazinon was the material that was used in the test; it is possible that this material could have lost some of its toxicity because this was later found to be true in barn treatment. All baits tested appeared to be quite toxic to house flies since very few seemed to

get beyond 15 feet of the feeding point. Results shown here may not be conclusive since this test was not replicated.

Feeding Observations

Observations of the feeding habits of house flies on organic phosphate dry sugar baits (Page 18) showed that with Bayer 13/59B the average number of sugar granules consumed before toxic symptoms appeared was 6.2, the average number of granules picked up with the labellum and dropped after toxic symptoms appeared but before death was 6.4 and the time which elapsed between feeding and the first appearance of toxic symptoms was 8.8 minutes (Table 7). With chlorthion the average number of sugar granules consumed was 3.7, the average number picked up and dropped was 1.3 and the elapsed time before toxic symptoms appeared was 5.5 minutes. With diazinon the average number of sugar granules consumed was 2.5, the average number picked up and dropped was 1.8 and the elapsed time before toxic symptoms appeared was 2.3 minutes. With malathion the average number of sugar granules consumed was 5.4, the average number picked up and dropped was 3.3 and the elapsed time before toxic symptoms appeared was 6.3 minutes.

A general state of restlessness was characteristic of the symptoms preceding death. During this period the symptomatic fly successively picked up and dropped one or more granules with the labellum while moving about erratically. Finally, the fly became airborne or turned over on its back with wings in motion and spun in a circle on a horizontal surface for several minutes prior to immobilization.

The Evaluation of the Effectiveness of Organic Phosphate Baits in College Barns

Since all the organic phosphate baits tested were effective against house flies, with few exceptions, it is not the purpose of the author to show the differences in the control obtained with the various baits in college barns. Rather he proposes to show the differences in control received under high and low population pressures, in placement of baits, and when insecticides were dispersed in different types of media. Also the author attempts to show the difference in control obtained in feed rooms where feed is often ground making frequent sweeping of the floor and reapplication of bait necessary, when treatment is inside and outside of swine pens and the control received under varying weather conditions. In order to accomplish this, graphs (Figures 2 to 7) are presented, plotting grid counts on a three-point running curve. The barns and some of the areas in the barns have been grouped in units for comparison of the above differences.

Experimental Beef Barn, Horse Barn (Sheep Pens), Horse Barn (Rabbit Pens) and Beef Barn

The population pressure was much higher in the experimental beef barn than in the remaining barns in this group. The sheep pens and rabbit pens in the horse barn had dirt floors, the experimental beef barn had a dust covered brick floor and the beef barn had a cement floor (Pages 8 to 10). The data on grid counts shows the difference in the control obtained under the above factors. In comparing the control obtained, as indicated by the grid counts for the four barns (Figure 2), counts in the rabbit pens rose no higher than 11 for the entire season from June 9 to October 13 when this study was discontinued.

Applications of dry sugar baits (Page 13) were made every one to three days during June and every five to seven days during the rest of the season. Only a few sheep were kept in pens from June 9 to July 26 and good control was obtained with dry sugar bait. On July 29 additional sheep were added to the pens and an experiment was begun using molasses in experimental rations for the sheep; the molasses attractant tended to increase fly populations. It was soon evident that dry sugar bait was not controlling flies under this heavier population pressure. On August 10 oyster shell coated with malathion was applied and counts decreased. Treatment was repeated with oyster shell and malathion on August 16 and 18. On August 27 counts started to increase again so malathion and sugar was tested again. There was no appreciable decrease in numbers of flies so oyster shell and malathion was again applied on September 9 and 10 and on October 12. Good control was then obtained for the rest of the season. Applications were made every one to three days during June and every five to seven days the rest of the season. When dry baits were used in the beef barn, the fly population decreased fron an original count of 33 to 3. Good control was obtained from June 8 when work started, until September 8 when the counts rose to 27. This rise was a result of insufficient bait having been applied in one wing of the barn. After this situation was corrected counts decreased to five by the end of the season. Applications were made every one to two days during June, every two to five days during July, August and October and every 10 to 13 days during September. In the experimental beef barn dry sugar baits gave good control from June 9 until a rain occurred (Figure 2 and Table 9) on June 15. New flies

emerged and the count increased. This was probably due to the rain. Applications of dry sugar bait every one to two days brought the count down to ten within a week and counts remained low until mid-September when diazinon seemed to lose some of its effectiveness. This loss of effectiveness was later borne out in treatments at the south swine barn. On October 1 chlorthion was applied but a decrease was not noted at this time due to a drop in temperature and the flies did not come down to the floor to feed; however, when the weather warmed up on October 12, the population decreased again and good control was obtained the rest of the season. Applications were made every two to five days during July, August and October and every two to ten days during September.

Feed Rooms: Experimental Beef Barn, Beef Barn, Dairy Barn

The difference is shown here in control received under high and low population pressures and in feed rooms (Pages 8, 9, 10, 12 and 13) where feed was frequently ground, the floor was frequently swept and reapplication made. Sometimes operators were too busy or too lax and did not re-treat with bait after the floor was swept. Population pressure was much greater in the dairy barn feed room than in the feed rooms of the other two barns. Feed was seldom ground in the feed rooms of the other two barns. A comparison of grid counts in the feed rooms (Figure 3) showed that there was an increase in population the first week after treatment started but by the middle of June counts started decreasing in the experimental beef barn feed room and the beef barn feed room and remained low for the remainder of the season. Therefore, good control was obtained with dry sugar baits in these two barns. The dairy barn feed room showed a sharp

rise in population after the rain on June 15, but it started decreasing on June 22, and remained low the rest of the season. Dry sugar baits were used here, also. Applications were made with the same frequency as in the experimental beef barn and the beef barn (Pages 27 and 28).

Swine Pens: North Swine Barn, South Swine Barn (East Shed), Horse Barn

The difference is shown here in control obtained when dry sugar bait was applied both inside and outside of pens (North Swine Barn and Horse Barn), where it was applied only on the outside of pens (South Swine Barn) and where there was a difference in population pressure. Treatment in the walkway outside the swine pens at the east shed of the south swine barn started on June 8. At first, counts continued to rise but by June 11 they began to decrease (Figure 4). On June 15, it rained and emerging flies caused a population increase. On June 24, the manure pit was cleaned and manure was regularly disposed of thereafter and counts remained low until mid-September when it was discovered that white diazinon had lost some of its effectiveness as was also evidenced in the experimental beef barn. Chlorthion was applied on October 12, and flies were reduced to a negligible number by the next day when work was discontinued for the season. Treatments at the north swine barn pens were inside the pens, on top of feeders and outside the pens along the manure trench. Counts in the pens at the north swine barn started decreasing on June 7 when work began but started increasing on June 11. It rained on June 15 and counts decreased, probably because the pens were open at the north swine barn and flies went inside the barn to shelter and the counts were taken outside, in the pens. It should be noted that at the south swine barn pens counts went up after the rain, undoubtedly because

flies never left their shelter inside where the pens were located and where the counts were taken. After June 15 counts decreased in the swine pens at the north swine barn and rose to 18 on only one occasion in late September. Applications of bait were made every one to two days at the swine pens of the north and south swine barns during June. At the north swine barn pens, applications were made on alternate days during July, August and September and every one to two weeks in October. At the south swine barn pens, applications were made on alternate days during July, then no applications were made from July 16 to August 16 to allow the fly population to increase sufficiently so that additional tests could be conducted. Applications were then made every two to five days for the remainder of August, September and October. Dry organic phosphate sugar baits were effective when used in the swine pens at the horse barn. Counts decreased from 44 on June 9 to one on July 20 when the swine were removed from the barn and counts were discontinued. Pens were hosed down daily. Treatments were made every one to two days during June and every two to five days during July.

Sheep Barn And South Swine Barn (East Shed)

A comparison was made between control obtained with wet baits and that obtained with dry baits (Pages 10 and 11). Wet baits were used the entire season in the sheep barn and dry baits were used the entire season in the south swine pens of the east shed of the south swine barn. Applications were made to the floors of walkways in both barns. Treatments were made every day in the sheep barn during June and on alternate days from July 1 to October 13 when work was discontinued. Population pressure was much greater at the south swine

barn than at the sheep barn. Good control was obtained (Figure 5) at the sheep barn from June 8 until it rained on June 15. After that date populations tended to increase due to emerging flies, therefore, Karo syrup containing one percent Bayer 13/59A was applied to mangers and part of the walls where flies were resting. This bait was applied on June 21 and the population was reduced by approximately 60 percent. This single application and the subsequent use of Bayer 13/59A, sugar and water bait, reduced the population to a negligible number for the rest of the season. The results obtained from the south swine barn pens have been presented elsewhere (Pages 28 and 29) in the report.

Dairy Barn; East Wing, Central Wing and West Wing

A comparison of the three wings of the dairy barn (Pages 12 and 13) showed the differences in control obtained between the central wing and the other two wings (Figure 6). The central wing opened into the feed room and was more accessible to flies from the feed room than were the east and west wings. In the west wing treatment was made every one to two days during June and every two to three days during July, August, September and October. The east wing was treated every one to two days from the start of the season on June 9 to July 12. There was no treatment from July 14 to August 31 because an experiment was being conducted and live flies were needed. Treatments were made every three to ten days from August 20 to October 13. In the central wing treatments were made every one to two days from June 9 to July 19 and every two to four days for the remainder of the season. In the central wing, counts (Figure 6) started decreasing after treatment began on

June 9. From June 19 to 23 the fly counts increased from 8 to 21. This was due to the attractiveness to flies in the adjacent feed room of molasses that was being fed to cows in the central wing of the dairy barn. Counts exceeded 12 on only two occasions when they rose to 16 and 22. In the east and west wing, dry sugar baits gave very effective control. Counts rose above 12 on only one occasion in the east wing where experimental work was being conducted and treatment was not made. This was during the period August 17 to 31 when the count reached 34. Application of baits after the experiment was concluded caused a decrease in the counts.

Farrowing Barns: South Swine Barn, North Swine Barn

The south swine barn was located north and northeast of the swine pens where breeding was quite heavy (Page 11) and the north swine barn was located south of swine pens where breeding was not as heavy (Pages 10 and 11). The wind was predominantly from the south during the summer, which probably accounted for the high population of flies in the south swine barn during the month of June, therefore, the differences in control obtained with the use of dry sugar baits in both barns early in the season are presented (Figure 7). At the south swine barn, counts tended to increase during the early part of June due to the heavy population and the south wind, while at the north swine barn counts did not rise as high and flies were not as difficult to control. Also treatments were made inside the pens at the north swine barn and outside the pens at the south swine barns (Pages 28 and 29). This materially affected the number of flies entering the farrowing barns. After the rain of June 15th, counts increased at both the south and north swine barn because

flies sought shelter in the barns where the counts were being made. Dry sugar baits gave good control at the south swine barn, after manure was disposed of in late June. Manure was regularly disposed of thereafter and breeding potential was lowered; all dry sugar baits gave effective control at both barns for the rest of the season.

House Fly Control With Dry Sugar Baits in The City of Stillwater, Oklahoma

Good control was obtained in Stillwater, Oklahoma during the summer of 1954 with the use of malathion and diazinon dry sugar baits; however, hot dry weather and the regular disposal of garbage were important factors in control. Most of the fly breeding areas were sprayed with chlordane in early June but by June 24 when this work started, counts ranging from 3 to 99 could be found (Table 8). Treatments and visual counts were made daily to twice weekly (Page 8) from June 24 to October 13. At the start of the season diazinon was used east of Main Street (Pages 14 and 15) and (Table 8) and malathion west of Main Street. Both baits decreased fly populations considerably; daizinon gave the better control although populations were not as high on the east side at that time. The baits were switched to opposite sides of the street in the middle of the season and equally good control was obtained with both baits.

CHAPTER IV

DISCUSSION

One of the heaviest house fly populations in years was seen around Oklahoma A. and M. College barns during the summer of 1954. This was possibly due to continuous breeding throughout the previous exceptionally mild winter. Obviously, any chemical control against house flies would be more effective where breeding potential is kept low. In most instances populations were high at the college barns when dry sugar baits were first applied and for a few days visual counts indicated no decrease in population, but after thousands of flies had succumbed to poison baits and after manure had been removed the population tended to decrease. Of all the dry baits tested malathion and sugar and Bayer 13/59 and sugar appeared to be the most attractive and effective. Diazinon and sugar and chlorthion and sugar gave a quicker kill than malathion and sugar and Bayer 13/59 and sugar but did not seem to have the attractiveness. White diazinon evidently had a short shelf life because it was shown to lose some of its effectiveness after about six weeks. This was noticed when it was used at the south swine barn and the experimental beef barn. Also, loss of effectiveness may be true with 4124 because control was poor late in the season when it was used at the south swine barn. Dry sugar baits were more effective when there was less competition from other strong attractants. This was evident

in the central wing of the dairy barn where molasses was being fed to stock. By treating the adjoining feed room where populations were greatest most of the flies were killed, but with a strong attractant in the central wing some flies were drawn through, since the doors were left open most of the time. When dry baits could not be applied in the mangers but were applied outside to floors some of the flies would not leave the molasses feed. Control with dry baits was much more effective when they were placed wherever flies congregated. This was shown to be true in the swine pens at the north swine barn. Flies sought moisture in dry weather and usually congregated around the swine where sprinklers were usually running. At the north swine barn control was more effective than at the south swine barn. Dry baits at the north swine barn were placed in the pens, on feeders and outside of the pens along the drain while at the south swine barn they were placed on the floor of the walkway running past the pens. Flies could be observed swarming around swine at the south swine barn when poison baits were on the floor; however, this was not true later on when breeding potential was lower. After the initial population decreased at the north swine barn no flies whatsoever were observed for several days during the summer.

Dry baits and wet baits both appeared to be more attractive and effective during hot, dry weather. Flies seeking moisture in dry weather fed more readily on wet than on dry baits. At temperatures of 50 to 60 degrees F., flies sought shelter on walls or ceilings and would not come to the floor to feed on dry baits nor would they feed on wet baits when no moisture was sought. Dry sugar baits were easily blown around when there was much wind and could not be used on

cement floors where there was a draft. It is also assumed that one would have difficulty in using dry sugar baits in an area of high humidity because the sugar would absorb water and become caked. This was particularly true of Bayer 13/59 because it was quite soluble in water. On the other hand treatment with dry baits was inexpensive compared to sprays. It was easy to apply, took little time to apply and required no expensive equipment. Wet baits had these advantages also but stained the floor and when used in the form of syrup were very messy to apply.

Oyster shell and malathion gave much better control than dry sugar when used on dirt floors; sugar granules became lost in the dirt while oyster shell stayed on top. It is also believed that oyster shell and malathion would be much more effective in garbage containers because it would not be lost in the dirt and garbage in the bottom of garbage receptacles.

It is difficult to compare the effectiveness of the organic phosphate baits used in the city control program because of low populations and weather conditions. Hot, dry weather began prior to July 1 and lasted through September (Table 9). For 50 days during July and August maximum temperatures were 100° F. or above, on one day in July the temperature reached 113° F. Temperature records for June show a peak of 100° F. on only one day while those for September show nine days of 100° F. or higher. The rainfall was considerably below average for the summer with 2.49 inches reported for June compared to a normal of 4.09 inches, 0.03 inch reported for July compared to a normal of 2.65 inches, 1.93 inches for August compared to a normal of 3.23 inches, 0.96 inch for September compared to a

normal of 3.52 inches and 1.53 inches for October compared to a normal of 2.50 inches. Total rainfall reported for the five month period was 6.94 inches compared to a normal of 15.99 inches.

CHAPTER V

SUMMARY AND CONCLUSIONS

An attempt was made to determine if Musca domestica, Linn., the house fly, could be controlled in the Oklahoma A. and M. College barns and in the city of Stillwater, Oklahoma, by the use of organic phosphate baits. To determine this, the barns were treated with several kinds of organic phosphate baits from June 7 to October 13, 1954. The dry baits consisted of a one percent concentration of insecticide mixed with granulated sugar. They were used in all the barns except the sheep barn where a 0.016 percent concentration of Bayer 13/59A was used as a wet bait. Also, a single application of one percent Bayer 13/59A in Karo syrup was made in this barn. Dry baits were applied to floors, window ledges, tops of feeders and other areas where flies frequent. The wet bait consisted of a mixture of Bayer 13/59A and granulated sugar in an aqueous solution. It was applied to the floors of the barn and in the case of the Karo mixture to mangers and parts of the walls. Frequency of application of both kinds of organic phosphate baits in barns varied from every day to every two weeks. The amount of total floor space treated in each barn varied from 20 to 100 percent.

In Stillwater, counts and treatments with malathion and diazinon dry sugar baits were made three times weekly from June 24 to October 13, 1954. Urban areas checked included garbage receptacles

behind food handling establishments on Main Street, from Sixth Street south to Fourteenth Street, refuse containers behind creameries, poultry plants, a mill and a swimming pool.

The effectiveness of baits was measured by the Scudder grill and visual fly counts in the college barns and in the urban areas.

The attractiveness and effectiveness of the dry sugar baits containing diazinon, chlorthion, Bayer 13/59A, malathion, fish solubles and malathion, and oyster shell and malathion, were tested in an experiment set up in the east wing of the dairy barn. The results showed Bayer 13/59A and sugar and malathion and sugar to be more attractive and effective than the remaining baits tested.

A test was conducted in the east shed of the south swine barn to determine whether certain colors were more attractive to house flies than others. Granulated sugars mixed with white, red, yellow and blue ground chalk were used as treatments. Black was also tested using lampblack as the coloring agent. Statistical analyses showed that there was no significant difference at the one percent level in attractiveness of different colored sugar to house flies. Following this test, a test was run in the east wing of the dairy barn with different colored dry baits to determine if house flies were attracted to certain colored baits more than to others. The baits used were yellow malathion and sugar, white Bayer 13/59A and sugar, brown diazinon and sugar, tan malathion and sugar, pink Bayer 13/59A and sugar and tan diazinon and sugar. Results showed that attractiveness was due to factors other than color since more flies were attracted to malathion of tan and yellow color than were attracted to other baits. Tan baits ranked both first and last indicating that color was not an attracting factor.

Another test was carried out in the east shed of the south swine barn to determine how far flies traveled after receiving a toxic dose of dry sugar bait. The walkway of the shed was marked off in two foot intervals from a point where the bait was placed. The bait was applied at 8:30 a.m. and the dead flies were counted at the different stations at 12:30 p.m. Tests with chlorthion, diazinon, Bayer 13/59A and B and 4124 indicated that an average of 72 percent of the dead flies were taken within five feet of the feeding point, 86 percent within ten feet and 96 percent within 15 feet of the feeding point.

Feeding observations were made of house flies feeding on malathion, Bayer 13/59B, diazinon and chlorthion baits to determine how many sugar granules were consumed before toxic symptoms appeared, how many additional granules were picked up and dropped by the labellum after toxic symptoms appeared and the amount of time that elapsed before toxic symptoms appeared. Diazinon appeared to give a quicker kill and Bayer 13/59B a slower kill than others. An average of 2.5 granules was required and 2.3 minutes elapsed before toxic symptoms appeared with diazinon as compared to 3.7 granules for chlorthion and a lapse of 5.5 minutes, 5.4 granules for malathion and a lapse of 6.3 minutes and 6.4 granules for Bayer 13/59B with a time lapse of 8.3 minutes. The possible insecticidal effects from picking up additional sugar granules were less for chlorthion (1.3 granules) and diazinon (1.8 granules) than with malathion (3.3 granules) and Bayer 13/59B (6.4 granules).

Good control was obtained in the college barns with either dry or wet sugar baits but was influenced by hot dry weather with below normal rainfall. Flies did not feed on baits as readily in cool wet

weather due to temperature and moisture factors. Dry sugar baits used in barns were malathion, white and brown diazinon, chlorthion, Bayer 13/59B and 4124. All of these baits gave effective control with the exception of white diaznon and 4124 late in the season. It would appear that white diazinon and possibly 4124 have a short shelf life since diazinon and 4124 had only been used about six weeks when their effectiveness decreased. Dry baits were applied in several different sequences in different barns during the season.

Wet baits gave good control in the sheep barn the entire season but population pressure was not so great as in some of the other barns and the wet bait was supplemented on one occasion with a Karo syrup and Bayer 13/59A treatment.

Better control was obtained when dry baits were placed in swine pens where flies congregated than when placed in walkways outside the pens. It was not possible to apply baits in cattle feeders because the odor of the organic phosphate material repelled the cattle from their feed; however, it had no effect on swine. Also, better control was obtained in feed rooms where the floors were not swept as often as in others and frequent reapplication was not necessary.

Trouble was encountered at one barn where a dry bait containing a dye had been applied to window ledges. Rain leaked in and the dye ran down the wall making an unsightly appearance. Also, in some of the barns treated dry baits tended to blow off the floor when there was a draft. Rainfall was considerably below average for the summer and only one rain, on June 15 seemed to affect population counts. This was probably because late spring temperatures were not high and flies sought buildings for shelter, where the fly counts were taken

in most cases. Oyster shell and malathion bait was more effective than were dry sugar baits on dirt covered floors because sugar baits often were lost in the litter while oyster shell stayed on top.

Good control was obtained in the city of Stillwater with malathion and diazinon dry sugar baits; however, population pressure was not high during the summer. Good control was also influenced considerably by the hot dry weather, below normal rainfall and the regular disposal of garbage. The oyster shell and malathion bait was not tested in the urban area but it is believed that it would be more effective than dry sugar bait in that it would stay on top of debris accumulated at the bottom of receptacles, whereas granulated sugar would tend to get lost in the debris.

It is the author's belief that organic phosphate baits could be used to control house flies effectively during the entire fly season if supplemented with sprays early and late in the season, or they could also be used effectively as supplements to a spray control program for house flies.

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A P P E N D I C E S

Table 1. Comparison, by Replicate Totals, of the Attractiveness and Effectiveness of Some of the Organic Phosphate Dry Sugar Baits Against the House Fly.

	T^1	T^2	T^3	T^4	T^5	T^6	Check
Test No. 1							
Replicate No.	Flies Present						
1	43	57	65	77	30	58	-
2	51	42	57	53	38	53	-
3	42	51	103	132	49	67	-
4	31	26	19	46	23	38	-
5	24	41	54	73	26	17	-
Total Test No. 1	191	217	298	381	166	233	-
Test No. 2							
1	24	19	59	39	21	57	13
2	36	50	158	132	33	52	7
3	47	22	150	76	15	16	4
4	7	8	10	22	6	9	1
5	13	17	74	21	8	5	8
Total Test No. 2	127	116	451	290	83	139	33
Total Test No. 1 and 2	318	333	749	671	249	372	33

T^1 = Treatment with diazinon and sugar
T^2 = Treatment with chlorthion and sugar
T^3 = Treatment with Bayer 13/59A and sugar
T^4 = Treatment with malathion and sugar
T^5 = Treatment with fish solubles, chlorthion and sugar
T^6 = Treatment with oyster shell, malathion and attractant

Table 2. Comparison, by Replicate Totals, of the Attractiveness of House Flies to Different Colored Granulated Sugars.

		Flies Present					
	Replicate	Black	White	Red	Yellow	Blue	Check
Test No. 1	1	275	498	496	535	467	8
	2	487	435	495	510	504	14
	3	672	834	724	763	556	14
	4	319	224	297	293	404	5
	5	276	309	324	352	282	5
Total		2029	2300	2336	2453	2213	46
Test No. 2	1	100	94	130	225	150	17
	2	227	171	108	92	181	17
	3	323	184	172	297	330	13
	4	140	78	40	110	118	14
	5	67	205	81	66	73	10
Total		857	732	531	790	852	71
Test No. 3	1	14	39	32	97	35	7
	2	78	69	56	48	43	4
	3	50	34	42	78	61	10
	4	11	10	11	6	9	3
	5	67	133	156	71	47	2
Total		220	285	297	300	195	26
Total Tests 1, 2 and 3		3106	3317	3164	3543	3260	143

Table 3. Comparison of Some of the Organic Phosphate Dry Sugar Baits of Different Colors for Attractiveness and Effectiveness to the House Fly.

	T^1	T^2	T^3	T^4	T^5	T^6
Replicate No.	Flies Present					
1	103	33	90	157	60	97
2	136	79	109	146	127	100
3	55	23	56	132	156	103
4	24	53	74	125	10	23
5	32	13	23	26	41	41
Total Flies	350	201	352	586	394	364

T^1 = Treatment with brown diazinon and sugar
T^2 = Treatment with tan colored diazinon and sugar
T^3 = Treatment with pink Bayer 13/59A and sugar
T^4 = Treatment with tan colored malathion and sugar
T^5 = Treatment with yellow malathion and sugar
T^6 = Treatment with white Bayer 13/59A and sugar

Table 4. Comparison of the Distance Traveled by House Flies After Feeding on 4124, Bayer 13/59A and Bayer 13/59B Dry Sugar Baits.

	No. of Dead Flies			Accumulative Percent of Total Population		
Feet Traveled	T^1	T^2	T^3	T^1	T^2	T^3
1	657	1256	854	37.050	64.082	34.957
5	670	506	779	74.895	89.898	66.844
10	260	151	426	89.560	97.601	84.282
15	74	22	208	93.733	98.723	92.797
20	80	19	127	98.245	99.692	97.996
25	24	4	49	99.598	99.896	100.002
30	8	2	0	100.048	99.998	100.002
Total	1773	1960	2443	100.048	99.998	100.002

T^1 = Treatment with 4124 and sugar
T^2 = Treatment with Bayer 13/59A and sugar
T^3 = Treatment with Bayer 13/59B

Table 5. Comparison of the Distance Traveled by House Flies After Feeding on Chlorthion, Malathion and Diazinon Dry Sugar Baits.

	No. of Dead Flies			Accumulative Percent of Total Population		
Feet Traveled	T^4	T^5	T^6	T^4	T^5	T^6
1	433	206	117	39.009	30.117	23.400
5	380	167	245	73.244	54.535	72.400
10	195	124	83	90.813	72.663	89.000
15	48	111	18	95.138	88.890	92.600
20	47	71	12	99.372	99.272	95.000
25	7	5*	13	100.002	100.003	97.600
30	0	-	12	100.002	100.003	100.000
Total	1110	684	500	100.002	100.003	100.000

*The last fly was taken 21 feet from the feeding point.
T^4 = Treatment with chlorthion and sugar
T^5 = Treatment with malathion and sugar
T^6 = Treatment with diazinon and sugar

Table 6. Comparison of the Average Percentage of Dead Flies Counted at Different Intervals with All Dry Sugar Baits Combined.

Feet Traveled	Average Percent of Dead Flies Counted	Average Accumulative Percent of Dead Flies Counted
1	38	38
5	34	72
10	14	86
15	10	96
20 to 30	4	100
Total	100	100

Table 7. Comparison of Some of the Organic Phosphate Dry Sugar Baits in Feeding Tests with the House Fly.

	Granules Consumed*				Additional Granules Consumed**				Time Elapsed***			
Flies Observed	T^1	T^2	T^3	T^4	T^1	T^2	T^3	T^4	T^1	T^2	T^3	T^4
1	3	6	3	7	1	4	4	2	2	5	3	6
2	5	4	10	6	0	6	12	5	4	6	15	8
3	3	3	4	4	3	2	7	5	2	10	8	10
4	1	4	6	8	2	0	9	1	2	4	8	6
5	4	3	3	7	1	0	6	4	2	4	5	4
6	1	4	5	4	4	0	4	5	1	4	6	8
7	2	4	13	5	1	0	7	7	3	4	13	7
8	1	2	10	3	0	0	3	3	2	7	9	3
9	3	4	6	3	5	1	10	0	2	6	4	7
10	2	3	7	7	1	0	5	1	3	5	14	4
11#	-	-	2	-	-	-	7	-	-	-	6	-
12	-	-	7	-	-	-	9	-	-	-	8	-
13	-	-	4	-	-	-	4	-	-	-	10	-
14	-	-	6	-	-	-	6	-	-	-	13	-
15	-	-	7	-	-	-	3	-	-	-	10	-
Average	2.5	3.7	6.2	5.4	1.8	1.3	6.4	3.3	2.3	5.5	8.8	6.3

#Flies 11 to 15 observed only with Bayer 13/59B and sugar
*Number of granules of sugar consumed before the appearance of toxic symptoms.
**Additional granules of sugar bait consumed after the appearance of toxic symptoms and before death.
***Time in minutes that elapsed before toxic symptoms appeared.
T^1 = Treatment with diazinon and sugar
T^2 = Treatment with chlorthion and sugar
T^3 = Treatment with Bayer 13/59B and sugar
T^4 = Treatment with malathion and sugar

Table 8. Visual Fly Counts Taken from June 24 to October 13, 1954 in Stillwater, Oklahoma after Treatment with Dry Sugar Baits.

CITY GRILL FLY COUNTS

Date of Count	West Side Station No.									East Side Station No.								
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8
June	G[1]	C[2]	R[3]	G	P[4]	R	G	C	R	G	R	R	R	R	G	S[5]	M[6]	P
24	-	17	50	52	30	9	-	4	3	7	-	-	-	-	-	-	-	99
25	-	15	10	5	5	2	-	2	0	5	-	13	10	-	-	-	25	15
29	15	7	10	75	5	5	-	10	-	2	-	2	4	12	4	-	4	10
July																		
1	12	8	5	12	18	1	-	6	-	2	1	0	3	0	0	-	7	10
6	10	8	6	30	0	0	5	14	1	1	1	0	1	0	0	-	3	1
8	3	3	3	3	3	1	3	8	0	0	0	0	5	1	1	1	2	-
13	5	9	2	0	0	0	0	10	0	0	0	0	0	0	0	0	2	0
15	1	4	1	3	2	3	2	8	0	0	1	1	0	0	0	0	1	3
17	2	3	5	0	4	0	0	0	0	0	0	0	0	0	0	1	1	0
20	2	2	1	3	12	0	1	7	0	0	0	0	0	0	0	1	0	0
22	1	3	2	0	5	0	1	4	0	0	0	0	1	0	0	0	0	0
24	1	3	3	1	1	0	2	2	0	1	1	0	0	0	0	0	0	0
27	4	4	6	3	1	1	1	2	0	0	0	0	0	0	0	0	0	0
29	4	2	1	1	3	0	3	4	0	0	0	0	0	0	0	0	0	0
31	4	1	1	1	1	0	0	1	0	0	0	0	0	0	0	-	-	-
Aug.																		
4	7	4	3	0	0	4	1	8	1	0	0	0	0	1	0	2	8	2
7	2	5	0	0	0	2	0	3	0	0	0	1	0	1	0	0	0	0
11	4	4	0	0	2	0	0	3	0	0	1	0	0	0	0	-	-	-
17	7	7	0	0	3	0	0	5	0	0	2	1	0	2	2	-	-	-
25	7	0	8	0	5	5	5	2	1	6	6	2	0	1	1	-	-	-
26	0	0	1	0	2	0	0	0	0	0	1	0	0	0	0	-	-	-
Sept.																		
3	5	5	7	3	5	3	0	5	0	0	1	1	0	0	0	-	-	-
11	5	10	4	0	2	1	2	10	0	2	3	3	6	8	6	-	-	-
20	20	5	5	0	4	8	3	15	0	0	3	0	4	2	0	-	-	-
28	8	1	4	0	5	5	1	5	0	0	0	0	3	2	0	-	-	-
Oct.																		
13	6	8	10	0	20	1	2	5	2	10	7	7	10	7	5	-	-	-

MALATHION (West side)

DIAZINON (East side)

MALATHION (East side)

DIAZINON (West side)

[1]G - Grocery
[2]C - Creamery
[3]R - Restaurant
[4]P - Poultry Plant
[5]S - Swimming Pool
[6]M - Mill

Malathion - West side 24 June thru 24 July
East side 27 July thru 13 October

Diazinon - East side 24 June thru 24 July
West side 27 July thru 13 October

Table 9. Temperatures, Average Percent-Relative Humidity and Precipitation From June 1 to October 31, 1954. Stillwater, Oklahoma.

	June				July				August				September				October			
D[1]	M[2]	M[3]	H[4]	P[5]	M[2]	M[3]	H[4]	P[5]	M[2]	M[3]	H[4]	P[5]	M[2]	M[3]	H[4]	P[5]	M[2]	M[3]	H[4]	P[5]
1	80	52	29		99	71	29		96	72	41		100	66	15		79	65	78	T
2	79	58	20	.12	102	74	21		97	66	27	.97	103	67	43		90	68	43	.24
3	71	51	28		101	73	23		103	67	13		105	71	9		92	73	44	
4	78	46	28		101	74	25		102	76	26		101	73	13		93	71	35	
5	84	52	38		101	71	22		102	80	29		99	65	20		90	56	61	
6	87	65	53		104	75	22		100	80	28		101	68	19		69	46	76	.13
7	83	68	25	T[6]	106	77	34		103	75	29	T	93	71	25	.05	79	52	35	.03
8	90	66	41		101	71	31	T	82	70	46	.27	97	63	20	T	81	59	37	
9	91	65	36	.17	104	74	22		94	63	20		89	64	33	.29	89	63	30	
10	91	70	32		106	76	21		103	65	9		83	59	9		89	68	36	
11	93	72	32		110	77	12		105	69	10		86	55	12		86	73	48	
12	92	72	89	1.60	111	77	12		103	82	14		93	55	7		86	59	28	.44
13	91	62	28		112	76	19		102	72	21		97	60	3		90	62	49	
14	91	71	22		113	80	15		105	75	20		94	61	26	T	84	50	-	
15	83	62	62	.48	105	81	32		105	78	24		100	64	16		64	39	-	
16	90	62	41		109	76	18		106	81	22		100	65	18		72	37	-	
17	94	68	39		109	79	18		105	81	24		95	65	39		86	48	-	
18	94	72	32		111	82	20		103	79	21		99	69	27		86	52	-	
19	94	73	38		108	82	26		103	81	30		102	69	34		84	54	29	
20	92	74	34		107	75	27		98	72	31	T	102	80	23		76	54	34	
21	94	72	33		104	77	32		100	72	22		80	58	12		72	57	48	
22	99	73	96		108	83	28		99	80	62		84	46	19		69	52	61	.60
23	100	72	31		107	78	32		97	74	77	.63	85	50	25		68	50	47	
24	98	72	28		103	75	38		97	71	22		90	54	17		67	54	42	
25	98	74	30		105	78	39		100	72	21		89	56	30		72	56	63	.09
26	96	73	28		98	79	34	.03	103	74	20		91	62	37		70	45	64	T
27	96	71	33		100	71	24		105	75	14		94	67	30	T	52	35	60	
28	97	70	25		99	73	38		104	75	19		94	70	43	.60	66	38	-	T
29	98	68	25		102	75	35		106	72	12	T	93	73	80	.02	65	43	20	
30	98	71	68	.12	97	73	47		105	72	20	.06	75	66	89	T	60	29	21	
31					95	75	47		96	69	21						57	29	27	
Total Precipitation				2.49				0.03				1.93				0.96				1.53

[1]Date [2]Maximum Temperature [3]Minimum Temperature [4]Relative Humidity (5:00 p.m.)
[5]Precipitation in Inches [6]Trace, too small an Amount to Measure
Maximum and Minimum Temperatures in Degrees F.

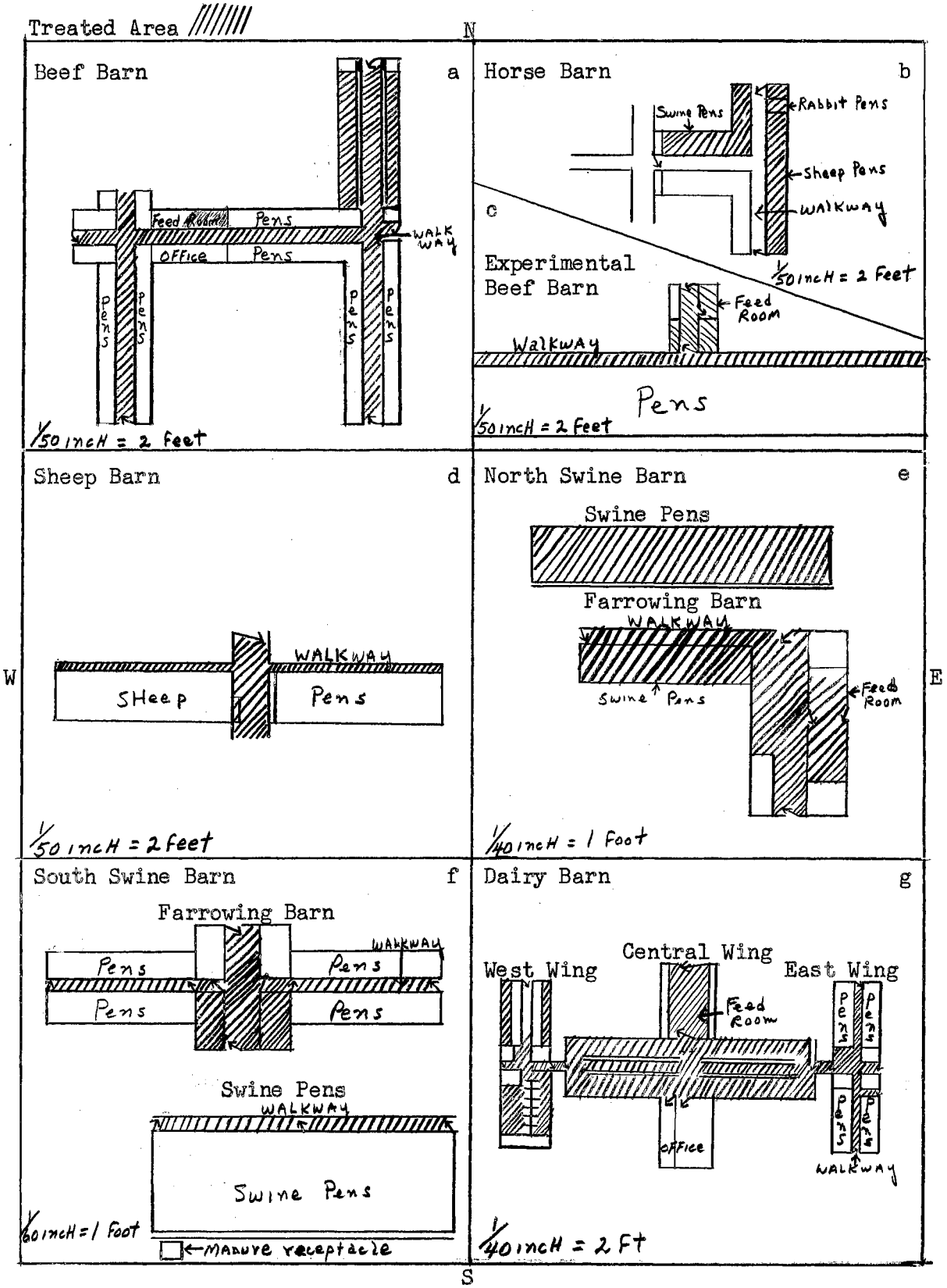

Figure 1. Floor Plans of the Oklahoma A. and M. College Barns Showing Treated and Untreated Areas with Organic Phosphate Sugar Baits. Stillwater, Oklahoma, Summer, 1954.

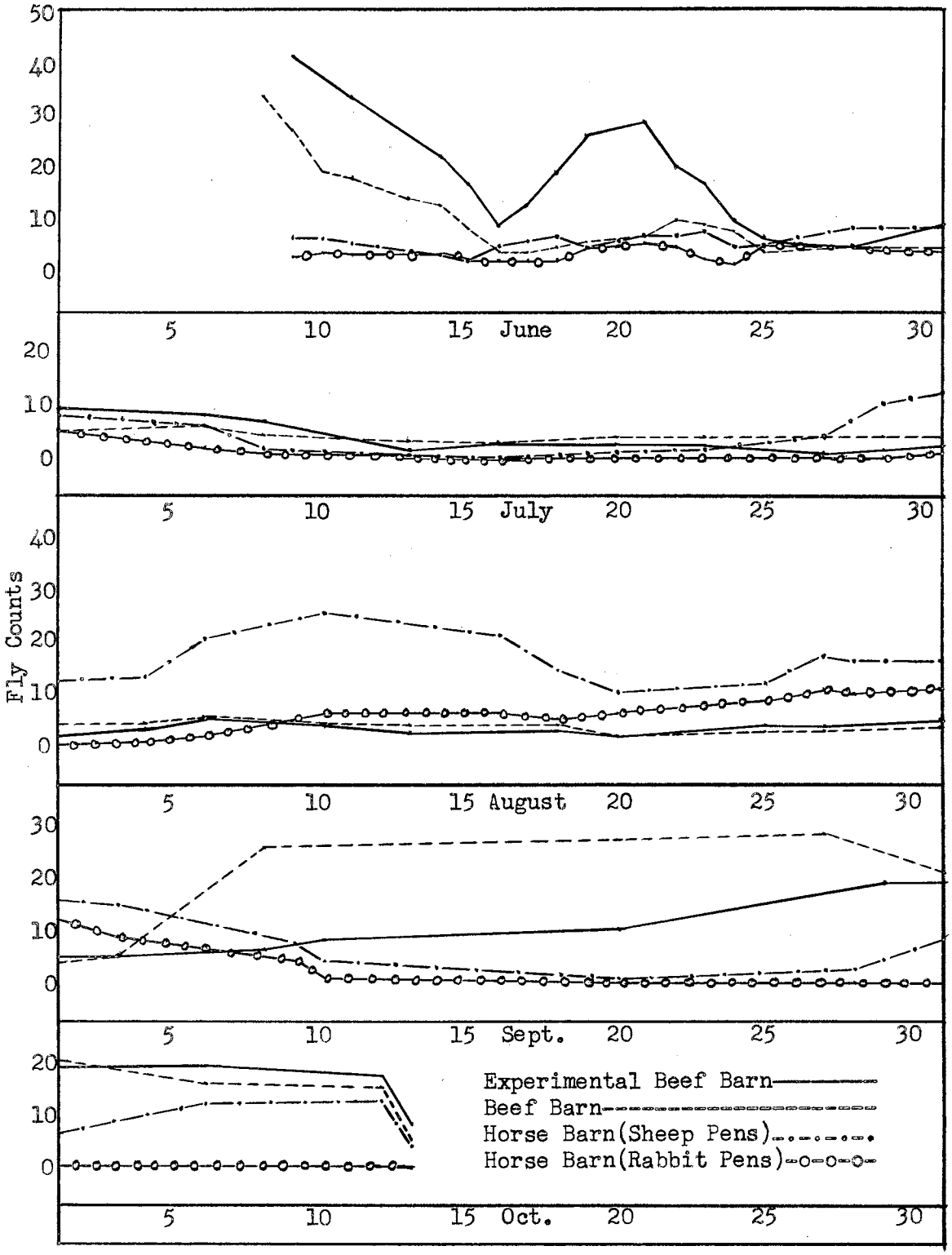

Figure 2. Comparison of Visual Fly Counts in Barns Treated with Dry Sugar Baits. Summer, 1954. Oklahoma A. and M. College, Stillwater, Oklahoma.

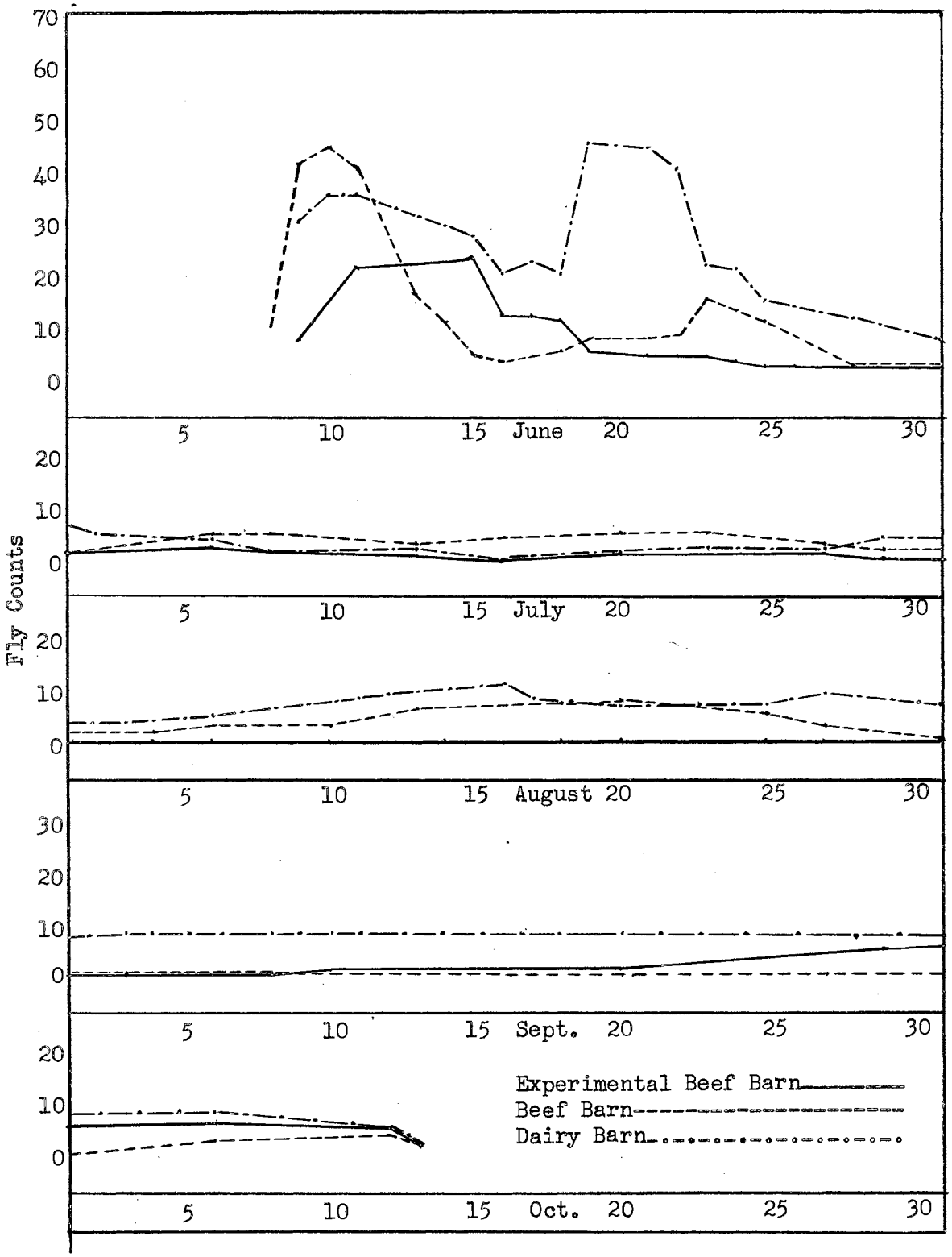

Figure 3. Comparison of Visual Fly Counts in Feed Rooms of Barns Treated with Dry Sugar Baits. Summer, 1954. Oklahoma A. and M. College, Stillwater, Oklahoma.

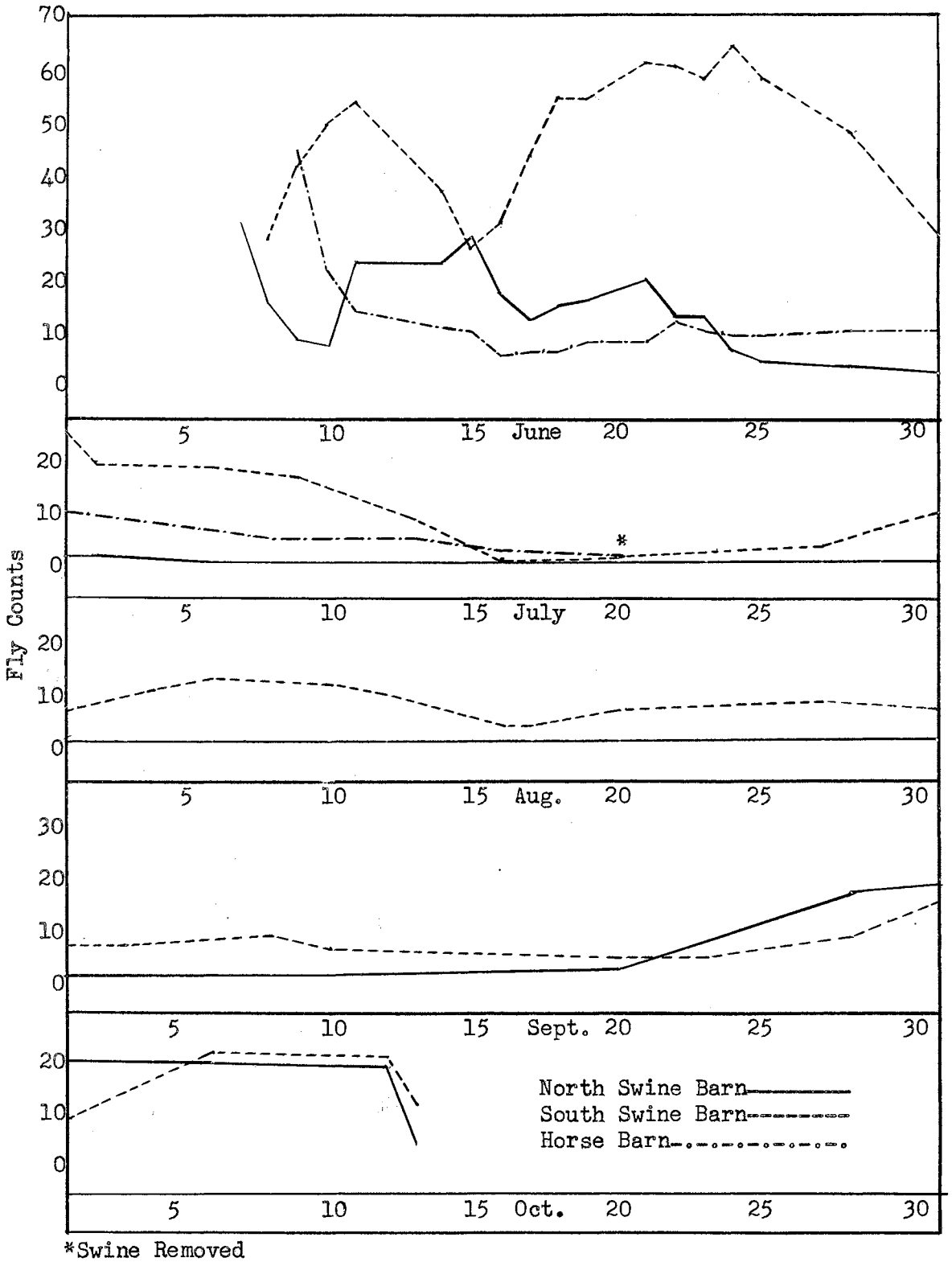

Figure 4. Comparison of Visual Fly Counts in Swine Pens Treated with Dry Sugar Baits. Summer, 1954. Oklahoma A. and M. College, Stillwater, Oklahoma.

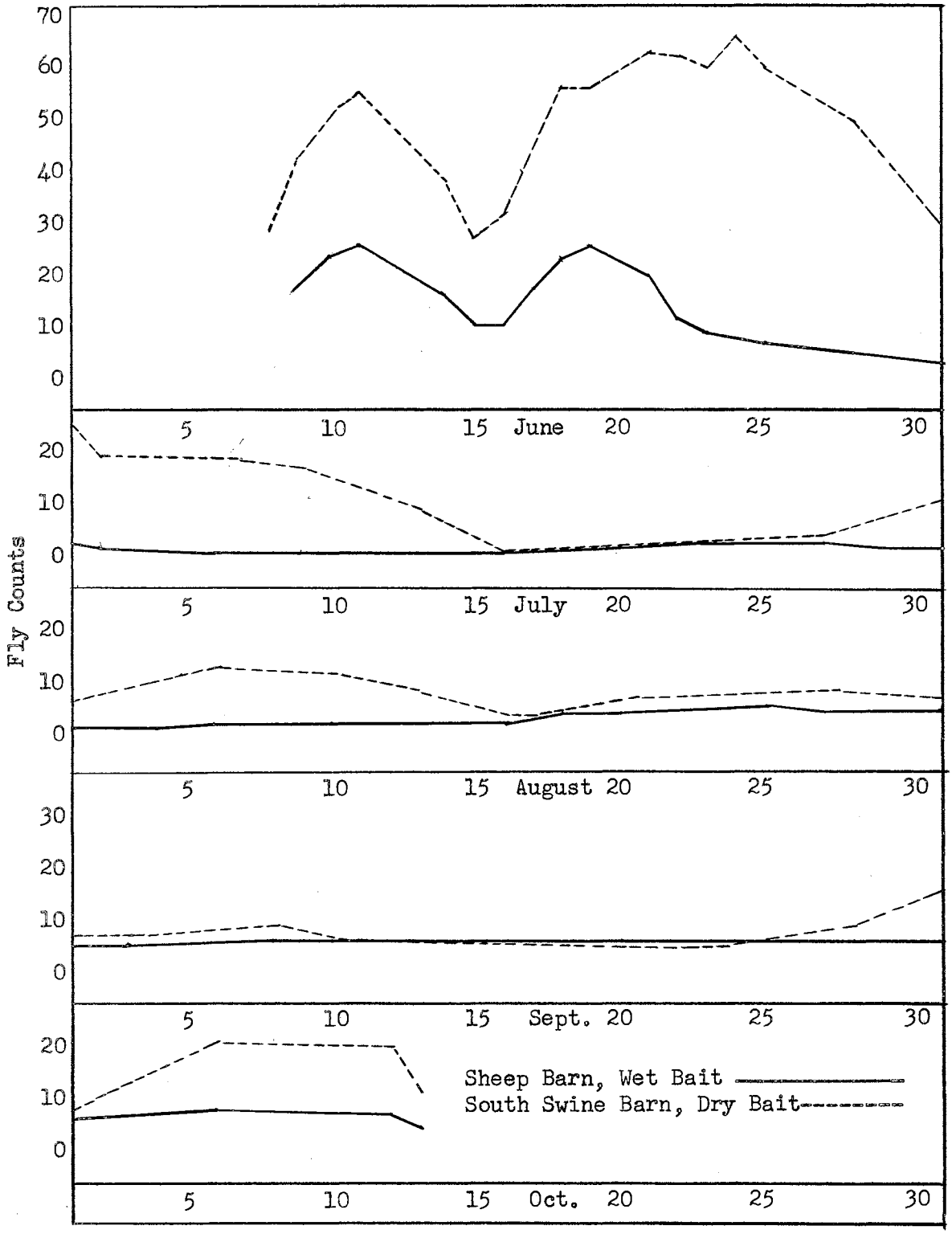

Figure 5. Comparison of Visual Fly Counts in Barns Treated with Wet and Dry Sugar Baits. Summer, 1954. Oklahoma A. and M. College, Stillwater, Oklahoma.

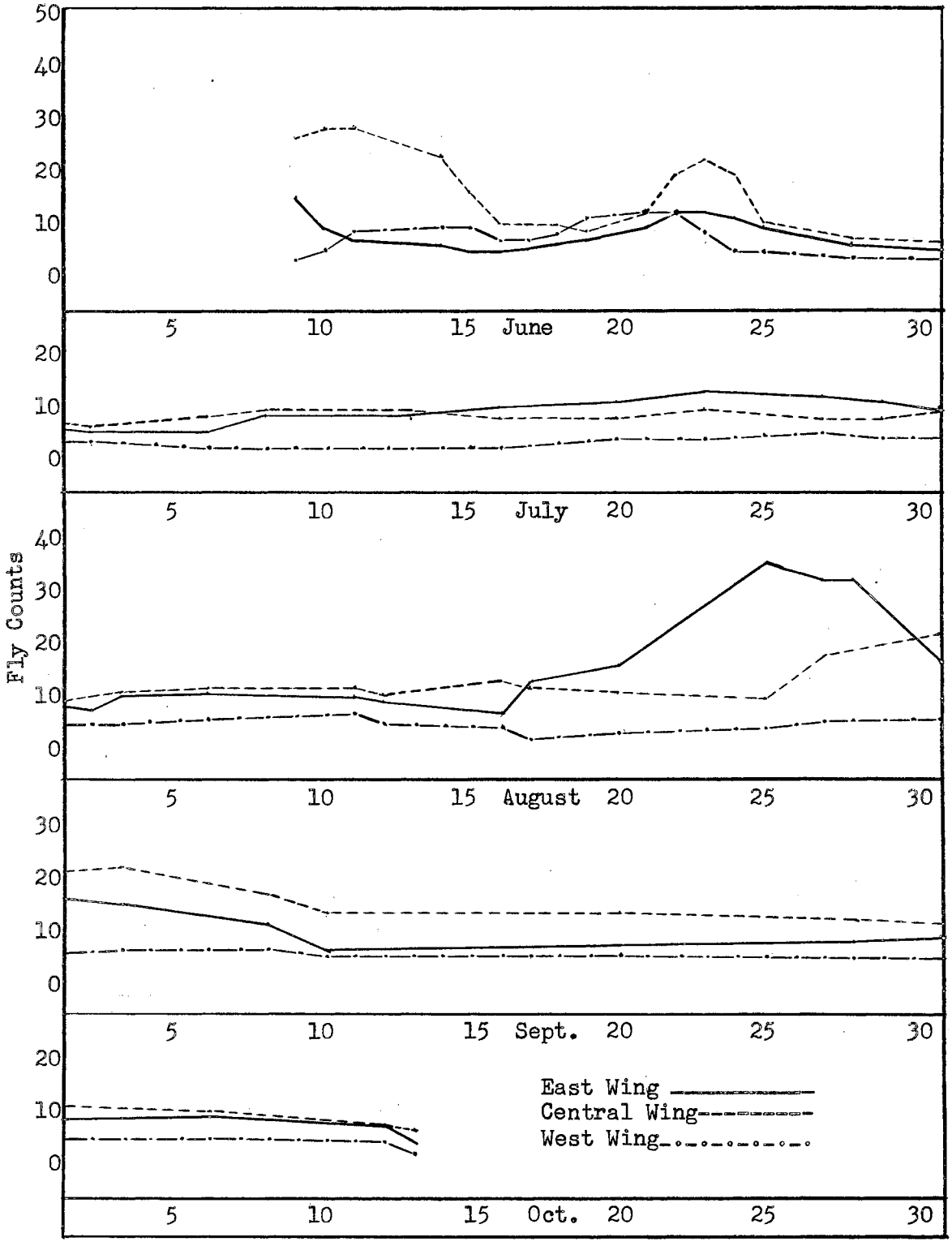

Figure 6. Comparison of Visual Fly Counts in the Dairy Barn After Treatment with Dry Sugar Baits. Summer, 1954. Oklahoma A. and M. College, Stillwater, Oklahoma.

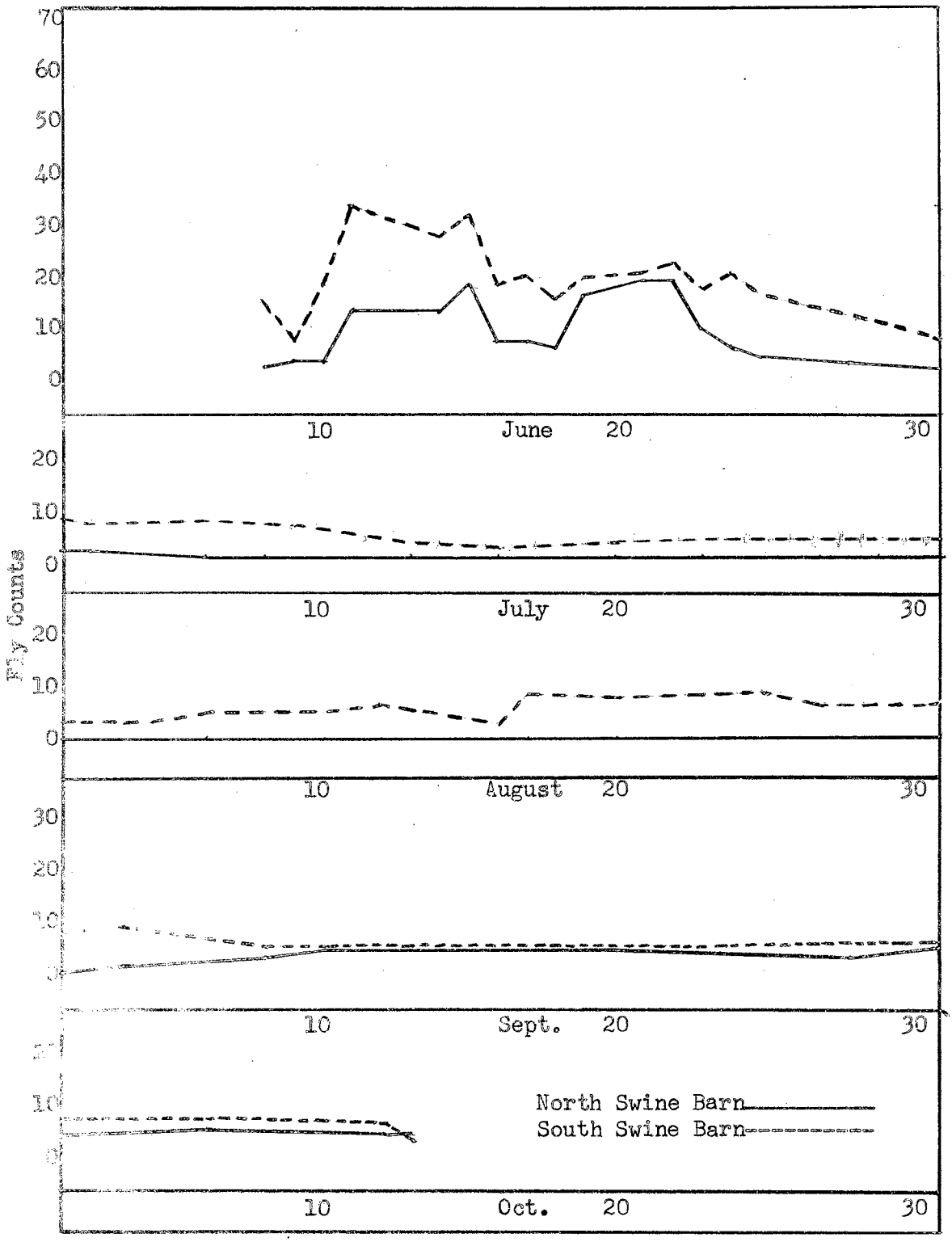

Figure 7. Comparison of Visual Fly Counts in Farrowing Pens Treated with Dry Sugar Baits. Summer, 1954. Oklahoma A. and M. College, Stillwater, Oklahoma.

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