To the Graduate Council:

I am submitting herewith a thesis written by Susan Corsaro entitled "Effects of Two Mulches, Yellow Sticky Board Traps, and Acephate upon Abundance of Hyadaphis erysimi (Kltb.) on Cabbage." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant and Soil Science.

David L. Coffey

David L. Coffey, Major Professor

We have read this thesis
and recommend its acceptance:

Paris L. Lambdin

Charles D. Pless

Accepted for the Council:

L. Evans Roth

Vice Chancellor
Graduate Studies and Research

X

EFFECTS OF TWO MULCHES, YELLOW STICKY BOARD TRAPS, AND ACEPHATE UPON ABUNDANCE OF *HYADAPHIS ERYSIMI* (KLTB.) ON CABBAGE

A Thesis

Presented for the

Master of Science

Degree

The University of Tennessee, Knoxville

Susan Corsaro

June 1980

ACKNOWLEDGMENTS

The author wishes to express her sincere appreciation to the following:

Dr. David Coffey, her major professor, for his support through her time as a graduate student;

Dr. Paris Lambdin and Dr. Charles Pless, for serving on her graduate committee and for their time and constructive suggestions;

Allan K. Stoner, for information by letter on his work in Beltsville, Maryland;

The U.S.D.A. Science and Education Administration in Beltsville, Maryville, for identification of the aphid studied in this experiment;

Her parents, for their interest and love throughout her life;

Her husband, for his encouragement and patience;

The people of Christ Chapel in Knoxville, for their support and concern during her time in Knoxville.

ABSTRACT

Aluminum foil mulch, azure blue paper mulch, yellow sticky boards, and acephate insecticide were evaluated for control of the turnip aphid, *Hyadaphis erysimi* (Kltb.) on cabbage.

In the 1978 fall test, the foil mulch, yellow sticky boards, and acephate all significantly (P=0.05) suppressed the aphid population. Acephate reduced aphid numbers more than the other treatments. In the 1979 spring test, rainfall suppressed the aphid population throughout the growing season, and no significant differences occurred among treatments.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Because of the ever-increasing awareness of problems inherent with the use of insecticides (e.g., long-lasting residues, hazards to the environment, build-up of insect immunity in monoculture), the need for alternative methods of insect control is evident. One such method is based on the study of insect behavioral patterns.

Behavioral studies of aphids (and other Homopterans) have revealed that they respond to light of various wavelengths (Cartier, 1964 and 1966; Kieckhefer et al., 1976; Kring, 1967 and 1970). The purpose of this study was to investigate how aphid reaction to color can be used in the field as a control measure to protect cabbage from damage by *Hyadaphis erysimi* (Kltb.), the turnip aphid. Three non-chemical treatments using reflected colors were compared to both an insecticide treatment and an untreated check. Hopefully, data from studies such as this one can be incorporated into pest management programs.

CHAPTER II

LITERATURE REVIEW

Aphid Biology and Behavioral Responses to Color

Aphids cause a general chlorosis and curling effect on plant hosts by "sucking out" the nutrient sap stream. Damage is intensified by their rapid reproduction and growth. Many species are responsible for transmission of disease-causing pathogens from plant to plant. They are able to attach themselves at one plant location by injecting a tubelike stylet into a phloem sieve tube, which allows hydrostatic pressure of the phloem sap to bring food to the insects. This system negates the problem of further foraging (Kennedy and Fosbrooke, 1973). For these reasons, aphids have high rates of food ingestion as compared to chewing insects, measured as both fresh food/fresh insect weight and as dry food/dry insect weight (Kennedy and Stroyan, 1959).

Aphids would be a much greater problem than they are were it not for numerous enemies. Predators include ladybird beetles, lacewings, and syrphid larvae. Parasites include braconid wasps and chalcid wasps (Borror et al., 1976). Evidence that one of the two parasites above has visited is the transformation of the healthy aphid into an aphid "mummy" (Figure 1).

Insecticides which have effectively controlled the turnip aphid, *Hyadaphis erysimi* (Kltb.), are nicotine, pyrethrins, diazinon, rotenone, lindane, parathion, and phorate (Chand et al., 1971).

Some early studies concerning aphids' behavior in reaction to reflected colors centered around the efforts of researchers to create

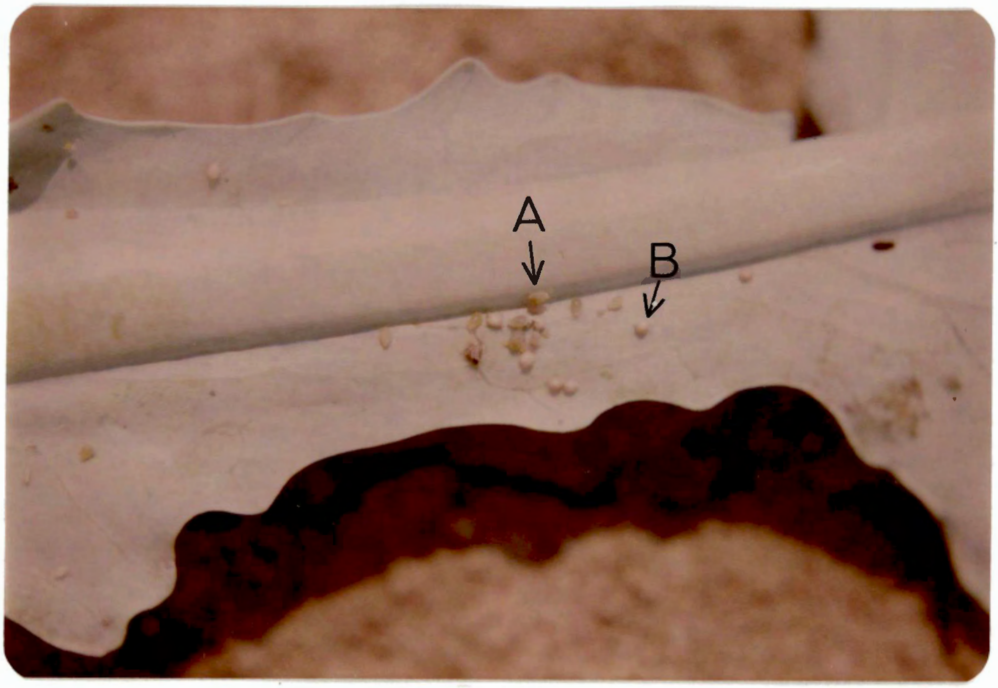

Figure 1. A, Healthy Apterous Turnip Aphids; B, Aphid Mummies.

a favorable environment in which to rear aphids in vitro. Jean Jacques Cartier (1966), using a multi-colored test chamber, observed that the pea aphid, Acyrthosiphon pisum (Harris) was attracted to yellow and orange light over blue, green, or red. Results were similar for alate and apterous adults and for nymphs of both the pea aphid and the potato aphid, Macrosiphum euphorbiae (Thomas). Growth responses of aphids on a chemical diet , measured by weight, were in direct correlation to color preferences. In another study, Cartier (1964) observed that some biotypes of the pea aphid preferred orange light, while others chose yellow.

In a flight chamber developed by Kring (1967), members of three aphid species alighted more often on pure yellow than on any other hue ranging between yellow and orange, and between yellow and green. In a similar test (Kieckhefer et al., 1976), three out of four species of cereal aphids were attracted to yellow over red, green, and blue when set free in a "preference chamber". These three also had greater longevity and reproduction when reared in yellow light than when reared in any other color including white.

Color discernment by aphids in their natural environment functions as a process of distinguishing sky from soil and vegetation (Kring, 1972; Lewis and Siddorn, 1972). Kennedy et al. (1961) based their field studies on previous evidence of Moericke (1950) that aphids respond to two basic color perceptions: wavelengths between 500-640 nanometers (greens, yellows, oranges), and wavelengths under 500 nanometers (blues, violets, ultraviolet). They measured the relative energy at specific wavelengths between 300-640 nm of various plant leaves and soils. Both vegetation and soils reflected considerably more light over 500 nm, in contrast to the short wavelengths of the sky. It is in this manner that the aphids can distinguish between the sky and the ground. Kennedy et al. (1961) suggested that plants are finally selected because of their higher proportion of wavelengths in the yellow region, compared to soils. Also, they determined from alightment catches that aphids are able to discriminate between two types of vegetation. Cabbage aphids, Brevicoryne brassicae (Linne), were found to rest on sugar beets twice as often as they rested on cabbage, even though cabbage is a common host, and the sugar beet is not a preferred host. Reflectance curves revealed that sugar beets had a larger long/short wavelength ratio (energy between 500-640 nm/energy between 300-500 nm). In a similar experiment, the green peach aphid, Myzus persicae (Sulzer) chose brussels sprouts over peach trees of equal size by a factor of three to one. Again, the plant with the larger long/short wavelength ratio was preferred for alightment, regardless of feeding preference.

Aphid behavior, based on perception of light in two wavelength regions, changes during flight. When alate aphids take off, they are attracted to short-wave light (in nature, sky), which results in high, distance flying. Eventually, their attraction turns to long-wave reflections, which brings them to the vegetation and soil on the ground (Kennedy et al., 1961; Lewis and Siddorn, 1972). Near the ground cover, the aphids make repeated alightments until a proper host is found (Kennedy et al., 1961).

Kring (1970) suggested that because malnourished or diseased plants tend to be yellower than healthy plants, they will actually be chosen more often for alightment. Taylor and Palmer (1972) found that yellow attracts dicotyledon-feeding aphids, while grass-feeders do not demonstrate this behavioral trend.

Yellow Traps

Moericke (1957) first developed a trap for measuring the abundance of aphids flying over an area in the field. He painted metal pans yellow, and poured in water containing detergent. Once aphids touched the water, they were trapped, and could be counted. Kring (1970) found that yellow pan traps always captured more aphids than similar pans of other colors.

Moericke (1955) found that yellow pan water traps on soil caught more aphids than did pans surrounded by yellow, white, blue, or black cloth. He postulated that aphids were attracted to the small amount of ultra-violet light remitted by soils, and suggested that a similar reaction to ultra-violet reflectance in spray residue on plants actually attracts a greater number to sprayed plants than to non-sprayed plants.

Cohen and Marco (1973) evaluated the use of sticky yellow polyethylene sheets to attract and trap aphids in pepper plots. Diseases, caused by aphid-transmitted viruses were greatly reduced in the sticky sheet plot, as compared to the untreated check. Sticky yellow boards, 12 inches square, were successful in controlling whiteflies on tomato plants and chrysanthemums in greenhouses (Anon., 1979a). All adults were captured in 48 hours. Whiteflies, which are closely related to aphids, are also strongly attracted to yellow.

Sheet Mulches

Aluminum foil mulch has been tested on some crops as an aphid repellent. Aluminum was found to reflect the sky's light, which confused the insects with "two skies", and caused them to change their flight direction away from the plants (Kring, 1964 and 1970). When Kring (1970) surrounded a yellow pan water trap with similar aluminum pan traps, no aphids were captured. He believed that the aluminum pans repelled the aphids away from the area, and tested this repellency around plants in the field. His aluminum foil mulch caused a reorientation and avoidance reaction in flight.

Squash plants mulched with aluminum foil resulted in a 93% reduction of the number of aphids captured compared to the check, and watermelon mosaic virus was greatly decreased (Smith and Webb, 1969). In a separate experiment, yields in foil-mulched squash plots were over six times greater than in plots sprayed with parathion.

Not all foil mulch trials have been successful. Shands and Simpson (1972) reported little repellency effect of aluminum foil laminated on paper on three aphid species in potato plots in Maine. Attempts to combine aluminum with plastic sheets have been generally unsuccessful. Johnson et al. (1967) mulched rows of gladioluses with three types of foil mulches. Embossed foil laminated on paper became dirty when dust was caught in the tiny indentations. Aluminized polyethylene lost its finish. However, plots with smooth foil laminated on paper had 90% less aphids than the untreated check, and a proportionate decrease in cucumber mosaic virus occurred. Wolfenbarger and Moore (1968) also found more repellency with laminated aluminum foil on paper than with laminated aluminized polyethylene in their work with mulched tomatoes and squash. Chalfant et al. (1977) surrounded yellow summer squash with polyethylene sprayed with aluminum, and noted that although aphid numbers were reduced, the spray was slowly lost from the plastic sheets. Gladiolus leaves sprayed with aluminum led to the same results, and addition of a sticker-spreader stunted the plants (Smith and Webb, 1969).

Aluminum foil sheets have been compared with plain polyethylene sheets as reflective mulches. George and Kring (1971) found that while foil on summer squash plots reduced aphid numbers by 98% and doubled yields over the check, that black plastic provided almost no control. Toscano et al. (1979) found that aluminum-coated paper used as reflective mulch reduced green peach aphids on zucchini by 96% as compared to a 68% reduction by white polyethylene sheets. However, both treatments yielded 45% more squash than the check.

In 1978, Stoner (Anon., 1979b) found that aluminum embossed on black polyethylene and aluminum bonded to paper reduced aphid populations on muskmelon 90% and 96%, respectively, as opposed to polyethylene sheets. However, the plots with plain polyethylene had greater yields, probably due to the warm soil temperature created by the plastic.

Brown paper was investigated as a mulch by Courter and Obeker (1964). A persistent problem of weeds germinating through the paper was a deterrent to the success of this method. The paper was deteriorated after ten weeks.

Acephate

Acephate is a broad spectrum organophosphate insecticide. It has been found effective on cabbage to control cabbage loopers

(Chalfant et al., 1973; Creighton and McFadden, 1975), imported cabbageworms (Creighton and McFadden, 1975), and several aphid pests (Farm Chemicals Magazine, 1980; Harding, 1973).

Acephate has low oral and dermal toxicities (acute oral LD_{50} of technical, male rat, is 945 mg./kg), with residual activity or from 10 to 15 days (Farm Chemicals Magazine, 1980). It has no major harmful effects on soil microflora or their activities (Focht, 1974), and is compatible with Bacillus thuringiensis (Morris, 1977).

CHAPTER III

MATERIALS AND METHODS

Experiments were conducted in fall 1978 and spring 1979 on Etowah silt loam at the University of Tennessee Plant Science Field Research Laboratory at Knoxville. Recommended fertilization practices were followed. Supplemental irrigation was necessary during the first week of the fall test. The five treatments were arranged in a randomized complete block replicated four times. Cabbage plants (cv. 'All Seasons') were grown in the greenhouse in Jiffy 7's®, then transplanted to the field on August 24, 1978, and April 19, 1979.

Treatments were: aluminum foil laminated on paper mulch, azure blue paper mulch, yellow sticky board traps, acephate insecticide spray (75SP), and an untreated check. Each plot contained three rows of six plants, with rows spaced 101.6 cm. apart and plants spaced 45.7 cm. apart within the rows. Three-meter fallowed alleys were left between plots on all four sides.

At transplanting, three-meter strips of 76 cm. wide mulch were placed on designated rows and soil placed along the edges. X-shaped slits were cut into the mulches and plants inserted into the soil beneath. The blue mulch was prepared from pink, 40-weight butcher's paper coated with Sherwin-Williams 'Azurite' flat latex paint.

Sticky boards (Figure 2) were 17.8 cm. x 40.6 cm. x 0.3 cm. brown masonite boards coated twice with Sears 'Lemon Yellow Bright' semi-gloss latex paint (color code 051/89345) on one side and painted dark brown on the other side. Stakes to hold the sticky boards were

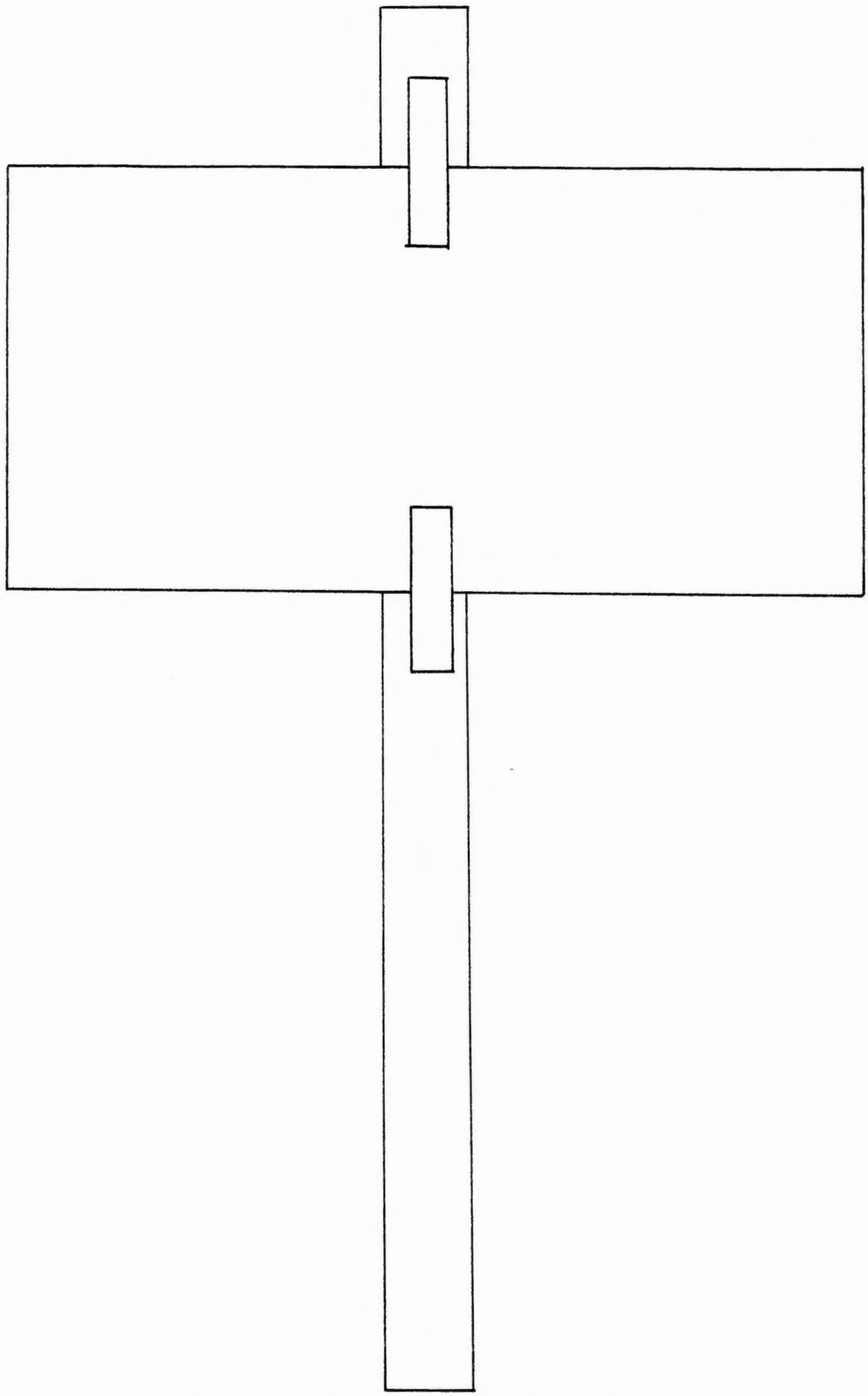

Figure 2. Sticky Board Apparatus, x 1/3.

2.5 cm. x 3.8 cm. x 66.0 cm. Two clothespins were stapled onto each of the wider sides, which allowed two boards to be attached. Stakes were inserted into the ground 15.2 cm., so that the bottom edges of the boards were 22.9 cm. above-ground. The same boards and stakes were used both years.

Each sticky board plot contained two stakes per row, totalling six stakes, or twelve sticky boards, per plot. Stakes were located between plants one-two and five-six in the outer rows, and between plants two-three and four-five in the inner row. A duplicate set of boards provided for easy weekly exchange. One set was coated with Tack-Trap®, a commercial insect-trapping compound, and carried to the field on four custom-made carriers (Figure 3). The switch was made and the other set was brought to the lab. The aphids were counted, and the boards were cleaned with xylene or gasoline. Prepared boards were set up at planting, and the first switch was made one week before counting was initiated.

In the fall test, acephate (0.85 kg. AI/ha.) was sprayed on the designated plots two days after the first aphid count, and again as soon as the mean aphid number per plot reached 120 (week 5). In the spring, low aphid numbers precluded any spraying.

Counts of alate, apterous, and mummified aphids on the cabbage plants were taken weekly, September 6, 1978 through October 25, 1978 and May 16, 1979 through June 13, 1979, when weather permitted. In the fall test, all ladybird beetle species were counted. The two end plants of each row were not included for counting. Four of the twelve plants and four of the twelve sticky boards in each plot were randomly chosen for insect counts each week.

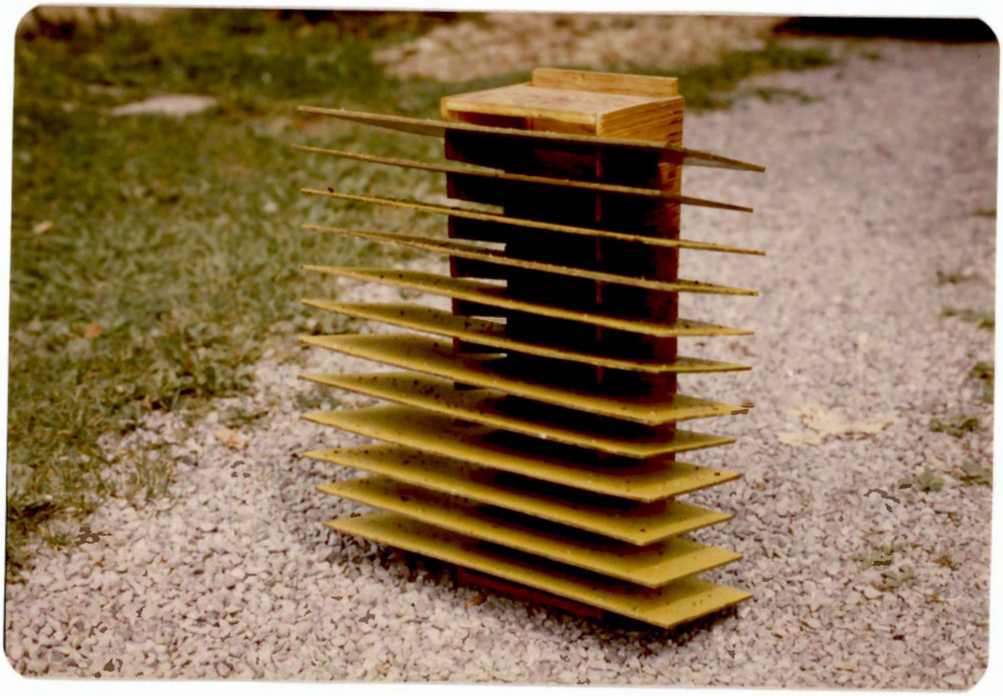

Figure 3. Sticky Boards on Carrier.

In the fall experiment, all alate aphids on the four plants were counted. Apterous aphids were counted up to 300 per plant. Due to the increase of aphid numbers towards harvest (October 11 through October 25) only two plants per plot were used. In the spring, apterous aphid numbers never reached 300 per plant. When dead, stunted or rabbit eaten plants occurred, adjacent healthy plants were used for records instead.

Air temperature measurements were taken in the spring, using minimum-maximum thermometers in two plots of the blue paper mulch, aluminum foil mulch, and untreated check plots. Thermometers were left out May 7 through May 8 with their bulbs 5.0 cm. above ground level. Insect counts were analyzed by analysis of variance and means were separated by Duncan's New Multiple Range Test. Yields were measured for the spring experiment only.

CHAPTER IV

RESULTS

Experiment 1, Fall 1978

After transplanting in August, several days of hot, dry weather occurred that resulted in an 11% (40 of 360 plants) mortality rate. A total of fifteen plants died in the sticky board plots, two in the aluminum foil mulch plots, nine in the acephate, eight untreated check, and six with the azure paper mulch. All were replaced. Presumably the soil under the aluminum foil sheets was both cooler and more moist than the soil of the other plots (Kratky, 1976), which may account for the higher survival rate of these plants during hot conditions in August.

The aluminum foil mulch suppressed the aphid population for five weeks. However, an increase in aphid numbers began on October 11 and continued throughout the remainder of the growing season (Figure 4). This increase in aphid numbers may be due to an increased area of the foil being covered by the growing plants (Figure 5) or because of the aphids' high fecundity rate.

The sticky boards were also partially obstructed due to the increased vegetation (Figure 6), but they maintained a more suppressive effect on the aphid numbers compared to the foil treatment, throughout the growing season. The mean weekly numbers of aphids per plot counted on the boards ranged between 18 (October 11) and 341 (September 6), (Figure 7).

The azure blue paper mulch was intended to disorient the aphids as they approached a landing by mimicking the sky's color, and thus to keep

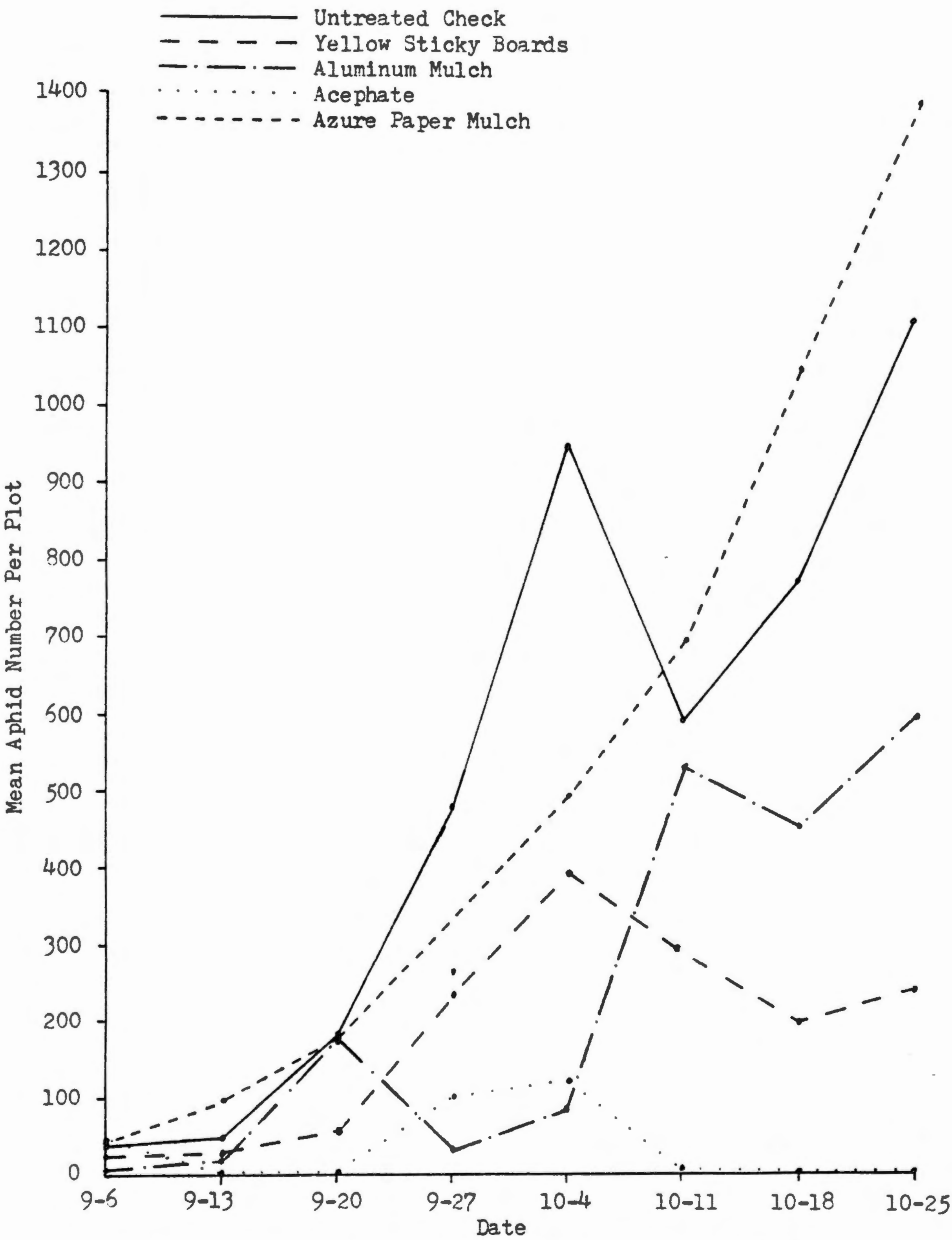

Figure 4. Effect of Two Sheet Mulches, Yellow Sticky Boards, and Acephate on Aphid Populations (Alate and Apterous), Experiment 1, Fall 1978.

Figure 5. Comparison of Early and Late Season Cabbage Over Aluminum Foil Mulch.

Figure 6. Comparison of Early and Late Season Cabbage in Sticky Board Plots.

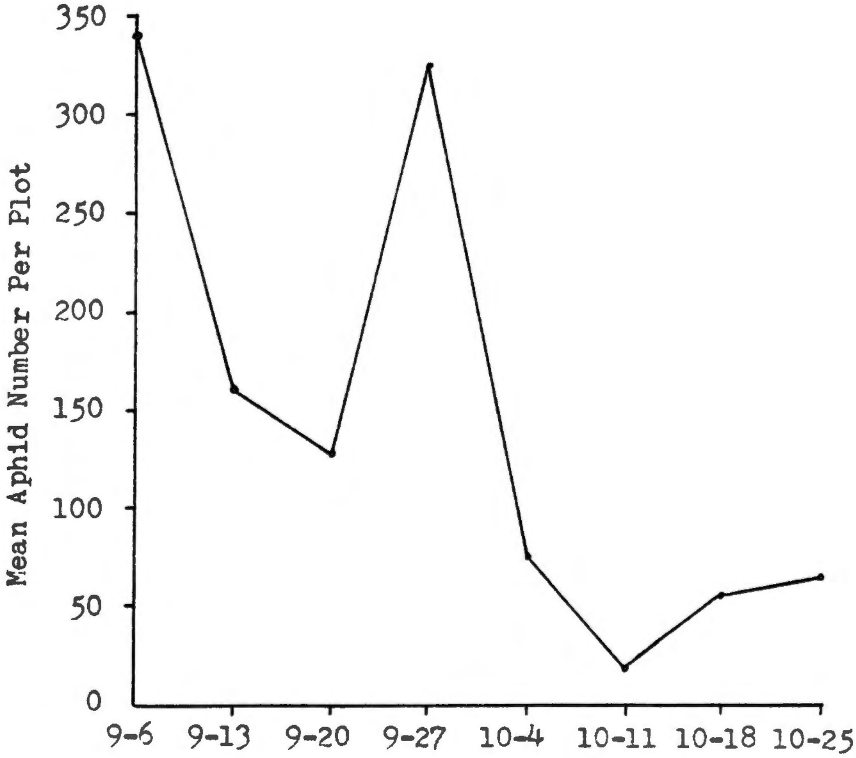

Figure 7. Number of Alate Aphids Captured on Sticky Boards, Experiment 1, Fall 1978.

them in flight, but aphid numbers in the azure mulch treatment were not significantly different from the untreated check (Table 1).

The ladybird beetle numbers on plants in the sticky board treatment were significantly higher than those in the acephate plots (Table 2), but not significantly higher than the other treatments. The numbers of mummified aphids per treatment were directly related to the total numbers of aphids present. Numbers on the sticky board, aluminum mulch, and acephate treatments were significantly lower than on the other two treatments, but not significantly different from one another (Table 2).

The foil mulch, sticky boards, and acephate treatments all had significantly less aphids (season totals) present on the cabbage plants than the untreated check or the azure mulch treatments (Table 3).

Experiment 2, Spring 1979

In the spring 1979 test, the contrast of mean numbers of aphids counted among the treatments was not as distinctive as in the fall 1978 experiment because totals were lower in all cases. Only the aluminum foil sheets still had an obvious effect (Figure 8). Aphid numbers were influenced by a higher than normal rainfall, totalling 23.2 cm. between May 9 and June 16 (the six weeks directly affecting the experiment). Low aphid numbers occurred throughout the growing season and acephate was not evaluated. No count was made on May 23 because of heavy rain.

Moore (1978) noted a negative correlation between the numbers of potato aphids present on tomatoes and amount of rainfall. This correlation was confirmed in the spring experiment of this study (Figure 9).

Table 1. Effect of Two Sheet Mulches, Yellow Sticky Boards, and Acephate on Aphid Numbers on Cabbage, Experiment 1, Fall 1978.

Treatment	Mean Total of Alate and Apterous Aphids Per Plot							
	Sept. 6	Sept. 13	Sept. 20	Sept. 27	Oct. 4	Oct. 11	Oct. 18	Oct. 25
Untreated Check	32 a*	43 ab	179 a	473 a	944 a	582 ab	763 ab	1103 a
Yellow Boards	32 a	19 b	57 a	237 ab	395 bc	290 ab	199 bc	240 bc
Aluminum Mulch	5 a	12 b	174 a	32 b	85 c	528 ab	454 abc	592 b
Acephate	47 a	1 b	1 a	104 b	122 bc	6 b	0 c	0 c
Azure Paper Mulch	40 a	91 a	182 a	262 ab	488 b	688 a	1036 a	1386 a

*Means in a column not followed by same letter are significantly different (P=0.05), Duncan's New Multiple Range Test.

Table 2. Effect of Two Sheet Mulches, Yellow Sticky Boards, and Acephate on the Number of Ladybird Beetles and Mummified Aphids on Cabbage, Season Totals, Experiment 1, Fall 1978.

	Mean Insect Number Per Plot	
Treatment	Ladybird Beetles	Mummified Aphids
Untreated Check	19 ab*	249 ab
Yellow Boards	34 a	11 c
Aluminum Mulch	14 ab	58 bc
Acephate	3 b	3 c
Azure Paper Mulch	22 ab	298 a

*Means in a column not followed by same letter are significantly different (P=0.05), Duncan's New Multiple Range Test.

Table 3. Effect of Two Sheet Mulches, Yellow Sticky Boards, and Acephate on the Number of Aphids on Cabbage, Season Totals, Experiment 1, Fall 1978.

	Mean Aphid Number Per Plot		
Treatment	Alate	Apterous	Total
Untreated Check	107 ab*	4010 a	4117 a
Yellow Boards	25 b	1443 bc	1468 b
Aluminum Mulch	97 ab	1784 b	1881 b
Acephate	7 b	275 c	282 b
Azure Paper Mulch	423 a	3749 a	4172 a

*Means in a column not followed by same letter are significantly different (P=0.05), Duncan's New Multiple Range Test.

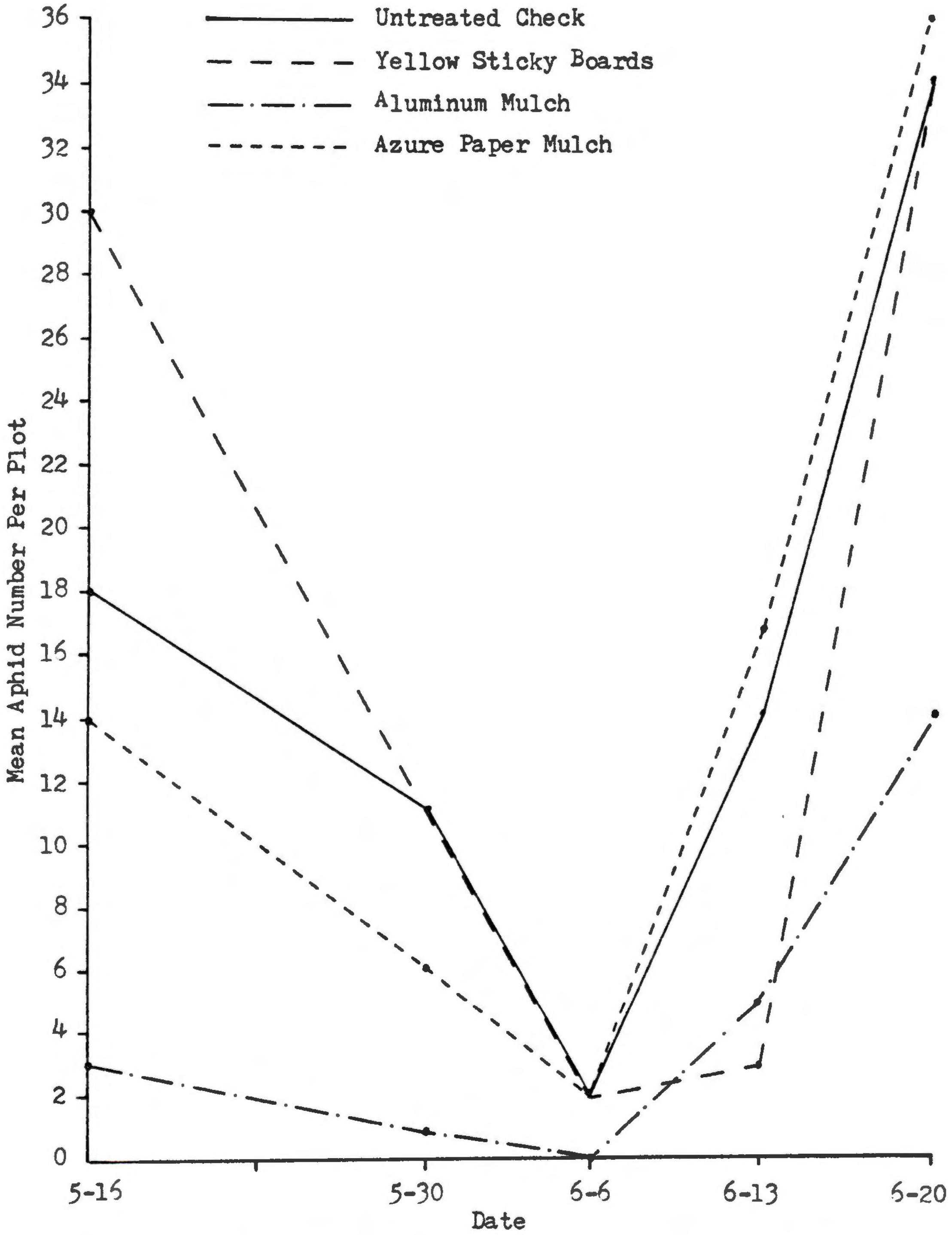

Figure 8. Effect of Two Sheet Mulches and Yellow Sticky Boards on Aphid Populations (Alate and Apterous), Experiment 2, Spring 1979.

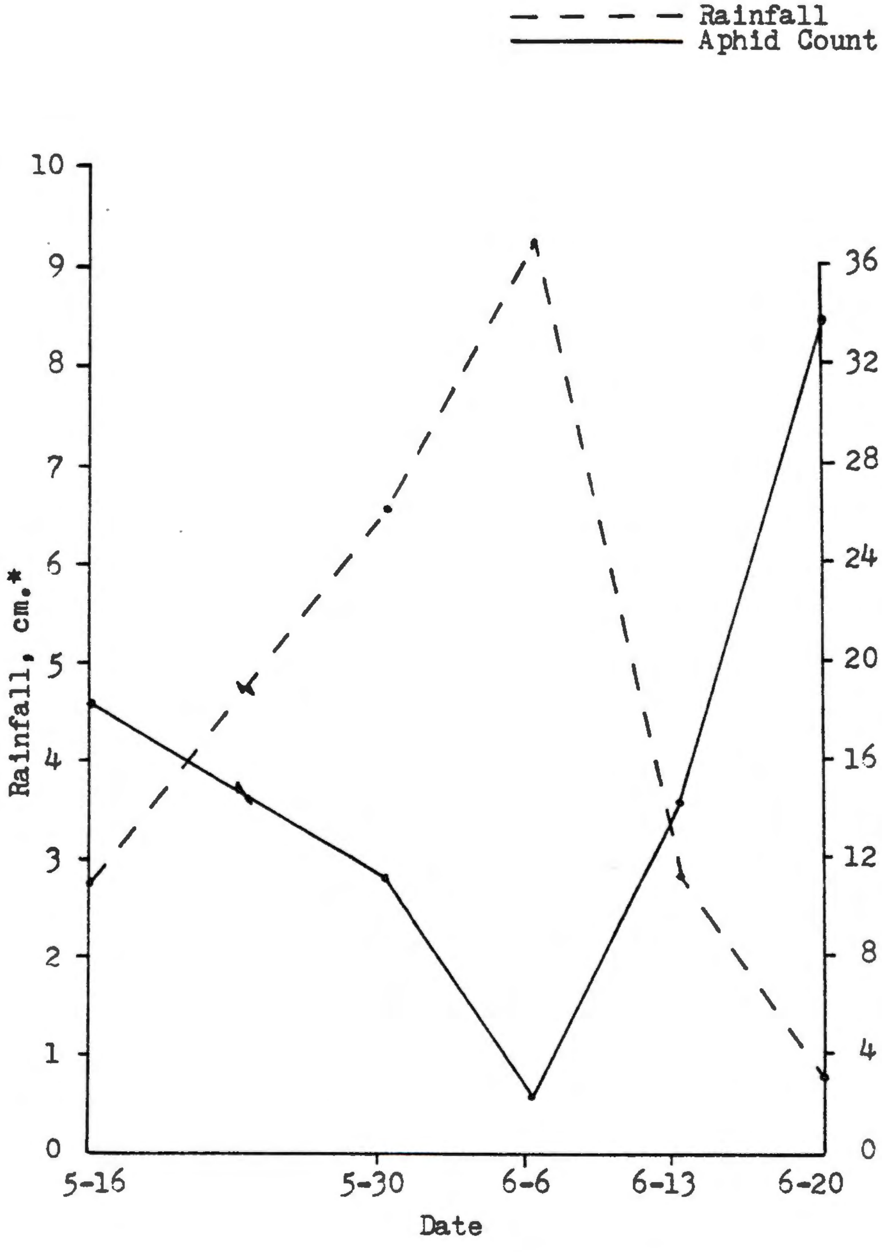

Figure 9. Effect of Rainfall on Aphid Populations (Alate and Apterous) in Untreated Check, Experiment 2, Spring 1979.

*Total rainfall during past seven days.

The numbers of aphids on cabbage in the sticky board plots were greater than those in the untreated check plots, which is in contrast to results from the fall test. This may be because of wind and rain protection by the boards, which prevented the insects from being washed off the plants as easily as they were on the other treatments. The numbers of aphids on cabbage plants, even in the sticky board treatment, were low and irregular compared to the fall experiment. The numbers of aphids stuck on the boards were also less than in the fall.

There were no significant differences among treatments in 1979 for total aphids for the season (Table 5).

A heavy infestation of the imported cabbageworm, *Pieris rapae* (L.) (Figure 10) and cabbage looper, *Tichoplusa ni* (Hübner) occurred in both fall and spring tests. Stoner (Anon., 1979 and personal communication) also found considerable cabbageworm and cabbage looper damage on his foil-mulched cabbage plants, and noted no repellent effect on these larvae.

During the spring rains, both mulch sheets retarded evaporation of water from the drenched soil around the plants. At harvest, the unmulched check plots had the greatest yield (Table 6).

Both mulch treatments endured well through the seasons, even in the rains. Deterioration was not a problem, and only one weed, honeyvine milkweed, *Ampelamus albidus* (Nutt.), consistently pushed up through both sheets, especially the foil mulch.

Table 4. Effect of Two Sheet Mulches and Yellow Sticky Boards on Aphid Numbers on Cabbage, Experiment 2, Spring 1979.

	Mean Total of Alate and Apterous Aphids Per Plot				
Treatment	May 16	May 30	June 6	June 13	June 20
Untreated Check	18 ab*	11 a	2 a	14 a	34 a
Yellow Boards	30 a	11 a	3 a	3 a	34 a
Aluminum Mulch	3 c	1 b	0 a	5 a	14 a
Azure Paper Mulch	14 bc	6 ab	.2 a	17 a	36 a

*Means in a column not followed by same letter are significantly different (P=0.05), Duncan's New Multiple Range Test.

Table 5. Effect of Two Sheet Mulches and Yellow Sticky Boards on the Number of Aphids on Cabbage, Season Totals, Experiment 2, Spring 1979.

	Mean Aphid Number Per Plot		
Treatment	Alate	Apterous	Total
Untreated Check	10 ab	68 a	78 a
Yellow Boards	16 a	64 a	80 a
Aluminum Mulch	5 b	17 a	22 a
Azure Paper Mulch	9 ab	65 a	74 a

*Means in a column not followed by same letter are significantly different (P=0.05), Duncan's New Multiple Range Test.

Figure 10. Imported Cabbageworm Larva and Damage.

Table 6. Yield of Cabbage Treated With Two Sheet Mulches and Yellow Sticky Boards, Experiment 2, Spring 1979.

Treatment	Yield, Per Plot[a]: Mean Number of Marketable Heads[b]	Yield, Per Plot[a]: Mean Weight, Kg.
Untreated Check	3.5	9.5
Yellow Boards	2.5	6.1
Aluminum Mulch	3.5	8.6
Azure Paper Mulch	2.8	5.9

[a]Four randomly chosen heads per plot.
[b]Heads at least 10.2 cm. in diameter.

CHAPTER V

SUMMARY AND DISCUSSION

In the fall 1978 experiment, aluminum foil mulch, yellow sticky boards, and an acephate spray were all significantly superior to the untreated check for control of the turnip aphid on cabbage. Azure blue paper mulch was not an effective aphid repellent. Acephate performed better than any of the non-chemical treatments evaluated for aphid control. The foil mulch suppressed aphid populations better than did the sticky boards through the first five weeks, but this trend was reversed in the latter half of the season. With high rainfall and low aphid numbers in the spring, none of the treatments had a significant effect on aphid totals when compared to the untreated check.

Based on this investigation, acephate was the most effective treatment evaluated for turnip aphid control on cabbage. It also controlled imported cabbageworm and cabbage looper larvae.

The non-chemical treatments did have some important advantages when compared to acephate. They were non-toxic, and therefore, did not inhibit attack by predators and parasites, which aid in a natural control process (Table 2). The mulches functioned as weed control agents near the plants. Kratky (1976) found that foil sheets decrease soil temperature. Fall cabbage fatality statistics in this study support that finding. He also noted that foil sheets reflect sunlight onto the plants. Stoner (personal communication) found that aluminum sheets in addition to insecticide spray increased cabbage yields over a treatment using only insecticide.

The yellow sticky board and aluminum mulch treatments evaluated in this experiment functioned by preventing the alightment of aphids. This control technique can be important for reduction of diseases caused by aphid-carried viruses. According to George and Kring (1971) aluminum foil mulch can be especially useful to seed-production companies which need to produce virus-free seed.

REFERENCES CITED

REFERENCES CITED

Anonymous. 1979a. Sticky boards snag pests. The Grower. 51:30B.

Anonymous. 1979b. Synthetic mulch improves yield, repels insects. HortScience. 14:109.

Borror, Donald J., Dwight M. DeLong, and Charles A. Triplehorn. 1976. An Introduction to the Study of Insects. 4th ed. Holt, Rinehart, and Winston, N.Y. 852 p.

Cartier, Jean Jacques. 1964. Pea aphid behavior: colour preference on a chemical diet. Can. Entomol. 96:1240-1243.

Cartier, Jean Jacques. 1966. Aphid responses to colors in artificial rearings. Bull. Entomol. Soc. Amer. 12:378-380.

Chalfant, R.B., W.G. Genung, and R.B. Workman. 1973. Control of the cabbage looper in Florida and Georgia. J. Econ. Entomol. 66:276-277.

Chalfant, R.B., C.A. Jaworski, A.W. Johnson, and D.R. Sumner. 1977. Reflective film mulches, millet barriers, and pesticides: effects on watermelon mosaic virus, insects, nematodes, soil-borne fungi, and yield of yellow summer squash. J. Amer. Soc. Hort. Sci. 102:11-15.

Chand, Nasib, M.L. Saini, and H.R. Krueger. 1971. Persistent toxicity of formothion and phorate to mustard aphid on Brassica plants. J. Econ. Entomol. 64:517-520.

Cohen, S. and S. Marco. 1973. Reducing the spread of aphid-transmitted viruses in peppers by trapping the aphids on sticky yellow polyethylene sheets. Phytopathology. 63:1207-1209.

Courter, J.W. and N.F. Obeker. 1964. Comparison of paper and polyethylene mulching on yields of certain vegetable crops. J. Amer. Soc. Hort. Sci. 85:526-531.

Creighton, C.S. and T.L. McFadden. 1975. Cabbage caterpillars: Efficacy of chlordimeform and Bacillus thuringiensis formulations. J. Econ. Entomol. 68:57-60.

Farm Chemicals Magazine. 1980. Farm Chemicals Handbook. Meister Publ. Co.

Focht, D.D. and H. Joseph. 1974. Microbial activity in soils treated with acephate and Monitor. J. Environ. Qual. 3:327-328.

George, William L., Jr. and James B. Kring. 1971. Virus protection of late-season summer squash with aluminum mulch. Conn. Agric. Exper. Sta., New Haven. Circ. 239.

Harding, James A. 1973. Green peach aphid: Field trials with newer insecticides on cabbage and spinach. J. Econ. Entomol. 66:459-460.

Johnson, George V., Arthur Bing, and Floyd F. Smith. 1967. Reflective surfaces used to repel dispersing aphids and reduce spread of aphid-borne cucumber mosaic virus in gladiolus plantings. J. Econ. Ent omol. 60:16-18.

Kennedy, J.S. and I.H.M. Fosbrooke. 1973. The plant in the life or an aphid, p. 129-140. In H.F. vanEmden (ed.) Symposia of the Royal Entomological Society of London: Number Six--Insect/Plant Relationships. Blackwell Scientific Publications, Oxford. 215 p.

Kennedy, J.S., C.O. Booth, and W.S. Kershaw. 1961. Host finding by aphids in the field. III. Visual attraction. Ann. App. Biol. 49:1-21.

Kennedy, J.S. and H.L.G. Stroyan. 1959. Biology of aphids. Ann. Rev. Entomol. 4:139-160.

Kieckhefer, R.W., D.A. Dickman, and E.L. Miller. 1976. Color responses of cereal aphids. Ann. Entomol. Soc. Amer. 69:721-724.

Kratky, B.A. 1976. Effect of polyethylene and aluminum foil mulches at three plant populations on yields of glasshouse tomatoes. Trop. Agric. 53:57-62.

Kring, James B. 1964. New ways to repel aphids. Frontiers Plant Sci. Conn. Agric. Exp. Sta., New Haven. 17:6-7.

Kring, James B. 1967. Alighting of aphids on colored cards in a flight chamber. J. Econ. Entomol. 60:1207-1210.

Kring, James B. 1970. Response of aphids to color and light. Frontiers Plant Sci. Conn. Agric. Exp. Sta., New Haven. 23:6-7.

Kring, James B. 1972. Flight behavior of aphids. Ann. Rev. Entomol. 17:461-492.

Lewis, T. and J.W. Siddorn. 1972. Measurement of the physical environment, p. 235-274. In H.F. vanEmden (ed.) Aphid Technology. Academic Press, Inc., N.Y. 344 p.

Moericke, V. 1950. Uber das Farbsehen der Pfirsichblattlaus (<u>Myzodes persicae</u> Sulz.). Z. Tierpsych. 7:265-274.

Moericke, V. 1955. Neue Untersuchungen über das Farbsehen der Homopteran. Proc. 2nd Conf. Potato Virus Diseases. Lisse-Wageningen, p. 68.

Moericke, V. 1957. Der Flug von Insekten über pflanzenfreien und pflanzenbewachsenen Flachen. Z. Pflkrankh. 64:507-514.

Moore, Sheila Mae. Evaluation of systemic insecticide-nematicides for the control of aphids and for the effect on selected non-target organisms on tomato in East Tennessee. M.S. thesis, Univ. of Tenn., Knoxville, 1978.

Morris, O.N. 1977. Compatibility of 27 chemical insecticides with Bacillus thuringiensis var. Kurstaki. Can. Entomol. 109:855-864.

Shands, W.A. and Geddes W. Simpson. 1972. Effects of aluminum foil mulches upon abundance of aphids on, and yield of potatoes in northeastern Maine. J. Econ. Entomol. 65:507-510.

Smith, Floyd F. and Raymon E. Webb. 1969. Repelling aphids by reflective surfaces, a new approach to the control of insect-transmitted viruses, p. 631-639. In Karl Maramorosch (ed.) Viruses, Vectors, and Vegetation. Interscience Publishers, N.Y. 666 p.

Taylor, L.R. and J.M.P. Palmer. 1972. Aerial sampling, p. 189-234. In H.F. vanEmden (ed.) Aphid Technology. Academic Press, Inc., N.Y. 344 p.

Toscano, Nick C., Jeff Wyman, Ken Kido, Hunter Johnson, Jr., and Keith Mayberry. 1979. Reflective mulches foil insects. Calif. Agric. 33:17-19.

Wolfenbarger, D.O. and W.D. Moore. 1968. Insect abundances on tomatoes and squash mulched with aluminum and plastic sheetings. J. Econ. Entomol. 61:34-37.

VITA

Susan Corsaro was born in Paterson, New Jersey on June 22, 1950. She attended New Jersey elementary schools and graduated from Boonton High School, N.J. in June 1968. She entered Wheaton College, Illinois the following September and received a B.A. in sociology in June 1972.

Following graduation she worked for four years at various jobs and as a volunteer with Mennonite Voluntary Service. In September 1976, she entered the University of Delaware, and graduated in June 1977 with a B.S. degree in agriculture.

In September 1977, she began studies at the University of Tennessee, Knoxville, and graduated in June 1980 with a Master of Science degree in agriculture. The author is a member of Gamma Sigma Delta and Phi Kappa Phi.