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Darrell R. Maddock

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A thesis submitted in partial fulfillment of the requirements
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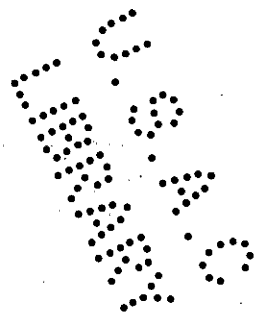

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INTRODUCTION

The purpose of this study has been to determine which species of thrips infest tomato plants and fruits in northern Utah, and to find out which other plants occurring in this area also serve as hosts for tomato-infesting thrips.

Because of the importance of tomato-infesting thrips to the canning industry, it was decided that more complete knowledge of the species of thrips which are found on tomatoes should be obtained. Because most thrips generally have been difficult to control, it was believed that a general knowledge of the plants on which these thrips occur would enable tomato growers to eliminate many such plants from tomato fields and lands adjacent to them, and that such cultivation would tend to decrease thrips populations on tomato fruits and in tomato fields.

In 1941, Dr. G. F. Knowlton, R. S. Roberts and others looked into the problem of thrips occurring in canned tomato products in northern Utah. These workers found that thrips sometimes occur in cavities at the blossom end of the tomato fruit (data unpublished). Since this time, study has been devoted to this problem by entomologists of the United States Department of Agriculture and the Utah Agricultural Experiment Station under the direction of Mr. W. E. Peay, Entomologist, U. S. D. A. Bureau of Entomology and Plant Quarantine.

L. B. Reed in 1943(6) wrote, "The thrips were found to enter the green fruit from the blossom end through small openings to cavities that normally occur in the central core of a small percentage of sound fruits. Sometimes the openings are closed as the tomatoes mature, and the thrips are imprisoned."

The primary interest in thrips on tomatoes in northern Utah is due to their appearance in canned tomatoes and tomato products. The United States Pure Food and Drug Commission has set a tolerance for the number of insect fragments which may occur in canned products shipped in interstate commerce. In former years the main concern of tomato processors was the occurrence of fragments and frass from the tomato fruitworm, Heliothis armigera (Hbn.), in the canned tomato products. During recent years the efficiency of methods for determining insect fragment counts has been increased. This improved sampling procedure has made it necessary for the canners to raise their standards to a very high level. More effective control methods have been developed for tomato fruitworm control, and the number of insect fragments due to this pest has been reduced. However, thrips still constitute a problem in the progress of the canners to further raise quality standards of tomato products.

It has been generally believed that thrips reduce tomato yields by increasing blossom-drop. Severe thrips feeding results in a devitalization of the plant. A silvering of the foliage of tomatoes results from the feeding process which destroys many cells in the outer layers of the plant, reducing the efficiency of the leaves. When such damage is extensive, a reduction in yield and fruit quality also occurs. The market value of tomato fruits for table use is sometimes reduced by off-shaped fruit. Such injury sometimes is the result of thrips injury occurring when the fruits are small. The extent and exact nature of thrips injury to tomato fruit blossoms is not fully understood.

Thrips populations on tomatoes seldom have been considered severe enough to warrant the expense of chemical control. However, during sea-

sons of abundance they may constitute a serious problem to the food processor. The life cycle of thrips also makes their control by the usual chemical means difficult. Thrips pass a "pupal" stage in the ground where they are well protected from the action of insecticides. Their habit of feeding deep in the flowers of the host plants also makes them difficult to kill with contact insecticides which has been the most common method of control up to the present time. Chemicals, generally applied for thrips control on tomatoes up to the time this investigation was well under way, seldom have given results justifying costs of application.

METHODS OF PROCEDURE

Three methods of collecting thrips were used. (1) In the most frequently used method, individual flowers were shaken over a piece of white chart cloth. (2) Flowers and foliage were collected from a certain species of host plant and placed in a modified Berlèse funnel in which the thrips were driven down into a vial filled with alcohol by heat produced by an electric light. (3) An insect net with a finely woven bag was sometimes used to "sweep" plant foliage when a single species of plant occurred in pure stand.

After thrips were collected, they were placed in an alcohol (10 parts), glycerine (1 part), and acetic acid (1 part) mixture and stored until they could be mounted on microscope slides.

Thrips were mounted on microscope slides largely using the following method which was recommended by Mr. J. C. Crawford (2).

The thrips were taken from the preservative and placed in a 10% solution of cold sodium hydroxide. The intersegmental ventral abdominal

integument was punctured to aid the alkali in more quickly reaching the body contents, making it more efficient and faster. Small Terebrantia should remain from 5 to 15 minutes, depending on the color of the integument. Large black Tubulifera require longer. After removal from this caustic solution, the specimens were placed in a solution of acetic alcohol (50% ethanol, 4 parts; glacial acetic acid, 1 part) and allowed to remain for at least 12 hours. The specimens then were transferred to 70% alcohol to remove the acetic acid. The wings, legs and antennae were arranged, then the specimens were placed in a Syracuse watch glass in 95% alcohol and weighted down with a piece of cover glass. Specimens were then allowed to harden at least over-night.

Three small round-bottomed porcelain dishes about 2 1/2 inches in diameter were used. The first contained 95% ethanol; the second, half 95% ethanol and half xylene; and in the third, pure xylene. Specimens were left in dish #1 at least 10 minutes and then transferred to #2. A fine camel's hair brush was used to avoid damaging the specimens when moving them from one dish to another. After one minute they were placed in dish #3 and allowed to remain for 1 to 1 1/4 minutes, depending on the specimen.

A drop of thick balsam was placed on a slide and the specimens from dish #3 were transferred to it. The thick balsam holds the wings and legs outspread. An effort was made to properly arrange the wings, legs and antennae, because these appendages are used extensively in the taxonomy of the thrips. The cover glass was then placed over the balsam. The edge farthest from the head of the thrips was allowed to touch the balsam first. This procedure caused the balsam to flow toward the head and

helped to keep the specimen properly spread. It was often necessary to place a teasing needle or finger at the edge of the cover slip which first touched the balsam in order to prevent it from sliding in that direction. Cover glasses of 12-15 mm. in diameter generally were used as the small size reduces the movement of the specimen when the cover glass is lowered on the balsam. Slides were kept for 2 or 3 days at room temperature before they were placed in a drying oven at about 116°F. (48°-49°C.).

The thrips which were collected from tomatoes were mounted on microscope slides and sent to either Professor J. R. Watson[1], Dr. S. F. Bailey[2], or to Mr. J. C. Crawford[3] for identification. The writer then was able to identify the tomato-infesting species collected from other host plants by comparing them with this identified material and with the aid of available keys.

There has been some difference of opinion among specialists over the names Frankliniella occidentalis (Perg.) and F. moultoni Hood. Thrips collected from tomatoes in 1941 were sent to Dr. Bailey who identified all of them as F. moultoni. Those collected from tomatoes in 1942 and 1943 were sent to the Division of Insect Identification in Washington, where all were identified by Crawford as F. occidentalis. This situation led to some question as to the correct name to apply to the commonest tomato-infesting species of thrips. Pergande erected the species

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occidentalis under the genus Euthrips in 1895 (4,p.152). Karny then renamed this species in a new genus, Frankliniella (7,p.36). Then Hood contended there were two species present on the holotype slide and called the lighter and slightly smaller form F. occidentalis and the larger and darker form F. moultoni (1,p.21). At the present time, Watson and Crawford agree that these two names apply to one species and to it apply the name F. occidentalis (8,3).

Most of the host plants from which thrips were collected were common weeds and crop plants. Professor A. H. Holmgren aided in the identification of the remaining plants.

RESULTS

Fifty-two collections of thrips were made from tomato plants in northern Utah. In a number of these, two or more species of thrips occurred. Frankliniella occidentalis (Perg.) was present in 45 of the 52 collections; Aeolothrips fasciatus (L.), in 18; Thrips tabaci Lind., in 13; Anaphothrips obscurus (Mull.), in 3; and Microcephalothrips abdominalis (Crawf.) in only one of the collections.

Frankliniella occidentalis was found on at least one species of plant in nearly every plant family from which collections were made. The fact that it was not collected from every family may be the result of not extensive enough collections in these particular families. Frankliniella occidentalis was collected from nearly every species of Leguminosae and from every species of Compositae and Solanaceae examined. This species of thrips seems to show some preferance for plants of these three families. Frankliniella occidentalis has such a wide host range

Table 1. A list of host plants of the five species of thrips collected from tomatoes in northern Utah.

Scientific Name	Host Plant Common Name	No. of Collections	No. Times Collected A[1]	B[2]	C[3]	D[4]	E[5]
Acer negundo L.	Boxelder	3[6]	-	-	-	-	-
Achillea millefolium L.	Yarrow	5	-	-	1	-	2
Allium cepa L.	Onion	3	1	-	-	-	3
Althea rosea Cav.	Hollyhock	7	-	-	7	-	-
Amaranthus sp.	Tall Amaranthus	2	-	-	1	-	2
" retroflexus L.	Redroot	2	-	-	1	-	2
Amorpha fruticosa L.	False indigo	2	1	-	1	-	-
Apocynum sp.	Dogbane	1	-	-	-	-	1
Aquilegia canadensis L.	Columbine	1	-	-	1	-	-
Arctium minus Bernh.	Burdock	3	-	-	2	-	-
Artemsia tridentata Nutt.	Black sage	6	1	1	1	-	1
" vulgaris		1	-	-	1	-	-
Ascelpias speciosa Torr.	Milkweed	2	-	-	2	-	-
Asparagus officinalis L.	Asparagus	1	-	-	1	-	1
Aster sp.	Aster	4	1	-	3	-	-
Atriplex rosae L.	Rosescale	2	1	-	-	-	-
Avena sativa L.	Oat	2	1	1	-	-	-
Beta vulgaris	Beet	3	-	-	2	-	-
Betula fontinalis Sargent	Water birch	1	-	-	-	-	-
Brassica nigra (L.)	Black mustard	2	-	-	2	-	2
" oleracea L.	Cabbage	2	-	-	2	-	2
Capsicum frutescens L.	Bell pepper	1	-	-	1	-	-
Carduus lanceolatus L.	Narrow-leafed bull thistle	5	1	-	1	-	-
Chrysanthemum sp.	Daisy	6	1	-	2	-	-
" leucanthemum	Oxeye daisy	1	-	-	-	-	-
Chrysothamnus sp.	Rabbitbrush	15	1	-	4	-	3
" nauseosus (Pall.)	"	4	2	-	4	1	-
" parryi (A. Gray)	"	9	1	-	7	-	1
" viscidiflorus (Hook)	"	3	-	-	2	-	1
Cleome serrulata Pursh.	Rocky Mt. bee plant	1	-	-	1	-	2
Cosmos sp.	Cosmos	1	-	-	-	-	-
Cucumis sativus L.	Cucumber	3	-	-	1	-	1
Cucurbita maxima Duchesne	Squash	2	-	-	2	-	1
" pepo L.	Pumpkin	1	-	-	-	-	-
Cuscuta sp.	Dodder	1	-	-	-	-	-
Cyanoglossum officinale L.	Hound's tongue	1	-	-	-	-	-

1. Aeolothrips fasciatus (L.)
2. Anaphothrips obscurus (Mull.)
3. Frankliniella occidentalis (Perg.)
4. Microcephalothrips abdominalis (Crawf.)
5. Thrips tabaci Lind.
6. The collection data in this table includes those records published by Knowlton and Thomas(5).

Table 1. (Cont.)

Scientific Name	Host Plant Common Name	No. of Collections	No. Times Collected A[1]	B[2]	C[3]	D[4]	E[5]
Dahlia sp.	Dahlia	1	-	-	1	-	-
Daucus carota L.	Wild carrot	4	1	-	-	-	1
Delphinium sp.	Larkspur	1	-	-	1	-	-
Dianthus barbatus	Sweet William	1	-	-	1	-	-
Dipsacus sylvestris Huds.	Teasel	3	1	-	-	-	1
Escholzia californica Chem.	California poppy	1	-	-	-	-	1
Fragaria sp.	Strawberry	1	-	-	-	-	-
Geranium sanguineum	Geranium	2	-	-	1	-	-
Gladiolus sp.	Gladiolus	4	-	-	2	-	-
Grindelia squarrosa Dunal	Gum plant	10	2	-	1	-	1
Gutierrezia sp.	Match brush	7	1	-	2	-	-
Helenium autumnale L.	Sneezeweed	1	-	-	1	-	-
Helianthus sp.		1	1	-	1	-	-
" annuus L.	Sunflower	15	1	-	5	-	-
Hordeum jubatum L.	Squirrel-tail grass	3	-	1	-	-	1
" vulgare L.	Barley	2	2	-	-	-	-
Humulus lupulus L.	Hops	1	-	-	-	-	1
Ipomea purpurea (L.)	Morning glory	4	-	-	1	-	1
Lathyrus odoratus L.	Sweet pea	2	1	-	1	-	-
Lilium tigrinum Ker.	Tiger lily	3	-	-	3	-	-
Lupinus sp.	Lupine	2	1	-	2	-	-
Lycium lamilifolium Mill.	Matrimony Vine	3	-	-	2	-	-
Lycopersicon esculentum	Tomato	52	18	3	45	1	13
Malva rotundifolia L.	Fairy cheeses	2	-	-	1	-	1
Medicago sativa L.	Alfalfa	15	5	-	9	-	4
Melilotus alba Desv.	White sweet clover	3	-	-	2	-	1
" officinalis (L.)	Yellow sweet clover	3	-	-	2	-	1
Mentha spicata L.	Mint	5	1	-	2	-	1
Mentzelia sp.	Mentzelia	1	-	-	1	-	-
Nepeta cataria L.	Catnip	1	-	-	1	-	-
Norta altissimum (L.)	Tumbling mustard	6	1	-	3	-	2
Pastinaca sativa L.	Wild parsnip	3	-	-	2	-	2
Petunia hybrida Vilm.	Petunia	1	-	-	-	-	-
Phaseolus vulgaris L.	Bush bean	3	-	-	3	-	1
Phleum pratense L.	Timothy	2	-	-	-	-	2
Phlox longifolia Nutt.	Phlox	1	-	-	1	-	-
Physalis neomexicana Rydb.	Ground cherry	1	-	-	1	-	-
Pisum sativum L.	Pea	4	-	-	2	-	1
Plantago sp.	Plantago	1	-	-	1	-	-
Portulaca oleracea L.	Purslane	1	-	-	-	-	1
Primula sp.	Primrose	1	1	-	-	-	-

1. Aeolothrips fasciatus (L.)
2. Anaphothrips obscurus (Mull.)
3. Frankliniella occidentalis (Perg.)
4. Microcephalothrips abdominalis (Crawf.)
5. Thrips tabaci Lind.

Table 1. (Cont.)

Scientific Name	Host Plant Common Name	No. of Collections	No. Times Collected A[1]	B[2]	C[3]	D[4]	E[5]
Prunus armeniaca L.	Apricot	1	-	-	1	-	-
" avium L.	Cherry	3	-	-	-	-	-
" domestica L.	Common prune	1	-	-	1	-	-
Pyrus malus L.	Apple	3	-	-	1	-	-
Quercus gambellii Nutt.	Scrub oak	1	-	-	1	-	-
Ranunculus asiaticus L.	Persian buttercup	1	-	-	-	-	-
Ribes aureum Pursh.	Wild yellow currant	1	1	-	1	-	-
Robinia pseudoacacea	Umbrella locust	1	1	-	-	-	1
Roripera nasturtium (L.)	Watercress	3	-	-	-	-	1
Rosa sp.	Rose	3	-	-	2	-	1
" fendleri Crepin	Wild rose	1	-	-	-	-	-
Rudbeckia hirta	Black-eyed Susan	4	-	-	3	-	1
" laciniata	Goldenglow	1	-	-	-	-	-
" occidentalis Nutt.	Niggerhead	4	3	-	3	2	-
Salsola pestifer A.	Russian thistle	2	-	-	1	-	1
Sambucus sp.	Elder	3	1	-	1	1	1
Sarcobatus vermiculatus (Hook)	Greasewood	1	-	-	-	-	1
Setaria glauca	Millet	1	-	-	-	-	-
Solanum melongena L.	Eggplant	2	-	-	2	-	1
" tuberosum L.	Potato	7	-	-	3	-	4
Solidago sp.	Goldenrod	10	-	-	3	-	3
Sophia filipes (Gray)	Tansey mustard	1	1	-	-	-	-
Taraxacum officinale Weber	Dandelion	12	1	-	3	-	1
Tragopogon porrifolius L.	Oyster plant	1	-	-	1	-	-
Trifolium pratense L.	Red clover	5	1	-	3	-	1
Triticum aestivum L.	Wheat	1	1	1	-	-	-
Typha latifolia L.	Cattail	2	-	-	1	-	1
Verbascum thapsus L.	Mullein	5	-	-	1	-	1
Verbena bracteosa Michx.	Verbena	1	-	-	1	-	-
Viola tricolor L.	Pansy	1	-	-	-	-	-
Vitis vinifera L.	Grape	1	-	-	1	-	1
Zea mays rugosa Bonaf.	Corn	4	1	-	3	-	-
Zinnia sp.	Zinnia	3	-	-	2	-	-

1. Aeolothrips fasciatus (L.)
2. Anaphothrips obscurus (Mull.)
3. Frankliniella occidentalis (Perg.)
4. Microcephalothrips abdominalis (Crawf.)
5. Thrips tabaci Lind.

that is may be considered to have no marked host specificity.

Aeolothrips fasciatus is predacious and was also collected on a wide range of plants. It appears that the kind of plant is of less importance than the occurrence of numerous thrips, on which it preys.

Thrips tabaci has approximately as wide a host range as does F. occidentalis. This species also was taken on hosts representing every plant family in which more than one species of plant was examined. Thrips tabaci was collected from potato and eggplant which are close relatives of the tomato and members of the Family Solanaceae. Its frequent occurence on solanaceous plants would indicate that it was not accidental on tomato.

Anaphothrips obscurus was collected from only four different species of plants in addition to tomatoes. Three of these species of plants belonged to the family Graminae; the fourth was a Compositae. This thrips species seems to be host specific to the extent of occurring on plants within the grass family. In the collections made from the composite and tomato, this thrips likely occurred as a winged accidental.

Microcephalothrips abdominalis also was collected four times on plants other than tomatoes. Three collections were made from two different species of plants in the family Compositae. In one instance it was present on Sambucus sp. of the family Caprifoliaceae. This latter collection was probably accidental. Probably abdominalis, like A. obscurus, occurred as an accidental on tomatoes.

CONCLUSIONS

Frankliniella occidentalis, Thrips tabaci and Aeolothrips fasciatus,

the most common species of thrips on tomatoes, have a very wide host range with representatives in almost every family of plants common to northern Utah. The lack of host specificity of these species makes their complete control by weed eradication and selection of neighboring crop plants difficult. However, the abundance of these thrips in an area probably can be materially reduced by more general attention to weed control.

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