

Colonization and Intraplant Distribution of *Thrips tabaci* (Thysanoptera: Thripidae) on Cabbage

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ABSTRACT To examine temporal aspects of *Thrips tabaci* Lindeman, colonization of cabbage, uninfested cabbage plants were placed adjacent to wheat, oat, and alfalfa fields on a weekly basis from July to October during 1983 and 1984. These cabbage plants were colonized by *T. tabaci*, with highest oviposition coinciding with emigration of *T. tabaci* adults from the adjacent field or forage crop. To examine within-plant colonization of cabbage, plants were sampled for 20 consecutive weeks in 1982. Individual leaves were excised, washed in 70% ethanol to remove thrips, and the thrips were identified. Only *T. tabaci* colonized cabbage and, before head formation, *T. tabaci* adults were most commonly found on the developing meristem, while larvae were most abundant on frame leaves. Once head formation began, thrips populations increased rapidly within the head and remained high until harvest. *T. tabaci* larvae, pupae, and adults were found in the first 11 layers of mature heads.

THE ONION THRIPS, *Thrips tabaci* Lindeman, has become a major pest of cabbage in upstate New York and other areas of the Great Lakes (Shelton et al. 1982). On cabbage, thrips injury appears as a bronze discoloration and rough texture on the leaves. Before the planting of cabbage, *T. tabaci* larvae and adults are present on a number of different cereal and forage crops in New York (unpublished data). In our previous work, we investigated the movement of *T. tabaci* adults in time and space by utilizing sticky traps placed above the crop canopies of wheat, oats, alfalfa, red clover, and cabbage. Our evidence indicated that the time of thrips movement into cabbage fields was a function of the temporal and spatial arrangement of these cereal and forage crops. However, these studies did not examine aspects of the ability of *T. tabaci* to locate and colonize cabbage plants. To manage thrips populations in cabbage, this information is needed.

Herein, we report the results of experiments to determine the ability of migrating *T. tabaci* adults from wheat, oats, and alfalfa to colonize adjacent cabbage plants, and the within-plant distribution of *T. tabaci* on cabbage throughout the growing season.

Materials and Methods

Seasonal Colonization. The seasonal colonization of cabbage by *T. tabaci* that originate from field and forage crops was examined in the following manner. Starting in late April of 1983 and 1984, 75-100 seeds of cabbage, 'Hinova', were planted each week for 14 consecutive weeks. This cultivar was chosen because previous work indicated it was highly susceptible to thrips (Shelton

et al. 1983). Plants were grown in plastic pots (15-cm diam) and maintained under metal Halide lamps and a 16:8 (L:D) photoperiod in the greenhouse, and watered and fertilized as needed. This procedure provided us with at least 70 healthy plants of the same age (12- to 16-leaf stage) per week throughout the experimental period and reduced the effect of plant age between weeks.

From July to October in 1983 and 1984, these uninfested cabbage plants were placed within fields of wheat, oats, and alfalfa. Cabbage plants remained in the field for 1 week and then were replaced by new uninfested cabbage plants of the same age. Three fields each of wheat, oats, and alfalfa were utilized in both years in Ontario County, New York. Three potted cabbage plants were placed within the perimeter of each of the nine fields. The plants were placed in a line, 2-3 m apart, and the pots were staked to prevent them from falling over. The cereal or forage crop foliage within a 1-m diameter adjacent to the potted plants was cut to avoid any direct contact with the cabbage.

Three pots containing cabbage plants were also placed on an ca. 3-ha lawn at the New York State Agricultural Experiment Station. This area was mowed weekly and was not in proximity to any cereal or forage crop and, hence, served as a baseline for comparison with the other crops. To monitor adult *T. tabaci* populations in all fields, one sticky trap (a white, inverted styrofoam cup with a 425-cm² surface coated with Tanglefoot) was placed next to each group of three plants. Traps and cabbage plants were replaced weekly and larvae and adults observed on cabbage plants in the field were collected and placed in labeled vials containing 70% ethanol. The plants, vials, and traps

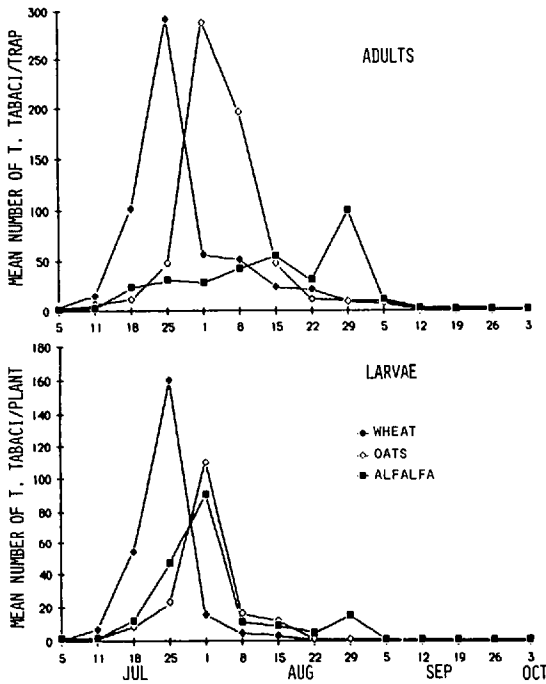


Fig. 1. Mean numbers of *T. tabaci* adults per trap and larvae per plant. Date indicates collection date of traps and plants, Ontario County, New York, 1983.

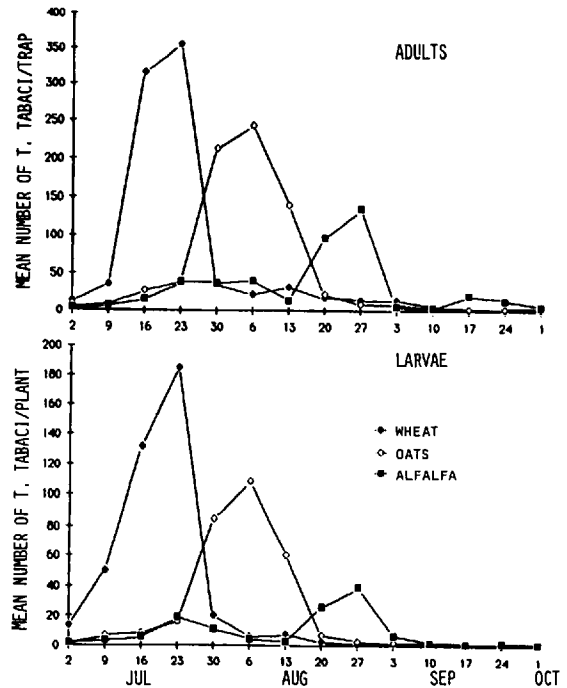


Fig. 2. Mean numbers of *T. tabaci* adults per trap and larvae per plant. Date indicates collection date of traps and plants, Ontario County, New York, 1984.

were returned to the laboratory where the thrips from the vials and the sticky traps were enumerated and identified. The cabbage plants were placed in a large walk-in chamber (16:8 photoperiod and 25°C) in such a way that adjacent plants were not in contact at any time. Utilizing the development times for *T. tabaci* reported by Harris et al. (1936) and Lall and Singh (1968) (6 days for egg hatch at 25 and 23.4°C, respectively, and development time of the larvae, 6.1 days at 25°C and 5.5 days at 23.4°C, respectively), we counted the number of larvae per plant 2 weeks after the plants were placed in the chamber. According to the previously mentioned studies on development of *T. tabaci*, most of the viable eggs should have hatched within the first week and the maturing larvae would not have left the plants to pupate. Thus, our counts, although not an exact measure of oviposition intensity, are a good estimate of the ability of *T. tabaci* to colonize cabbage plants during the season in relation to the adjacent crop.

Within-plant Population Structure. The within-plant population structure in cabbage was examined by dissection of cabbage plants on a weekly basis using the following procedure. In 1982, 'Hinova' were hand-transplanted at the New York State Agricultural Experiment Station Vegetable Research farm near Geneva, N.Y., on 2 July. The plot was adjacent and downwind to a field of winter wheat that had been drilled in September of 1981. This spatial arrangement was a deliberate attempt to increase the likelihood of the cabbage

becoming infested by *T. tabaci*. The cabbage plot consisted of 70 cabbage plants in the four- to five-leaf stage at the time of transplanting. Plants were arranged in four rows, with interplant distances of 64 cm and 1.5 m between rows. Each cabbage plant was randomly assigned a number from 1 to 70. Each leaf on every plant was marked with a number indicating its order of appearance (see Andalaro et al. 1983). New leaves were marked weekly throughout the season. Three plants were sampled per week for 20 consecutive weeks beginning on 12 July. Samples were collected by carefully removing each plant leaf at its base, noting the leaf number (and, hence, location on the plant), and placing each leaf in a separate container with 70% ethanol. This procedure was done for all the frame, meristem, wrapper, and head leaves throughout the season. The containers were returned to the laboratory where the ethanol was filtered through a Nytex screen (85 μ m, Tetko, Elmsford, N.Y.). The Nytex screen was then observed with a microscope, and the thrips were enumerated and identified. To monitor the adult thrips population in the cabbage field, three sticky traps were changed weekly, and the number of adult thrips enumerated and identified.

Results and Discussion

Seasonal Colonization. The results of the investigation of the seasonal colonization of cabbage plants are presented in Fig. 1 and 2. In 1983,

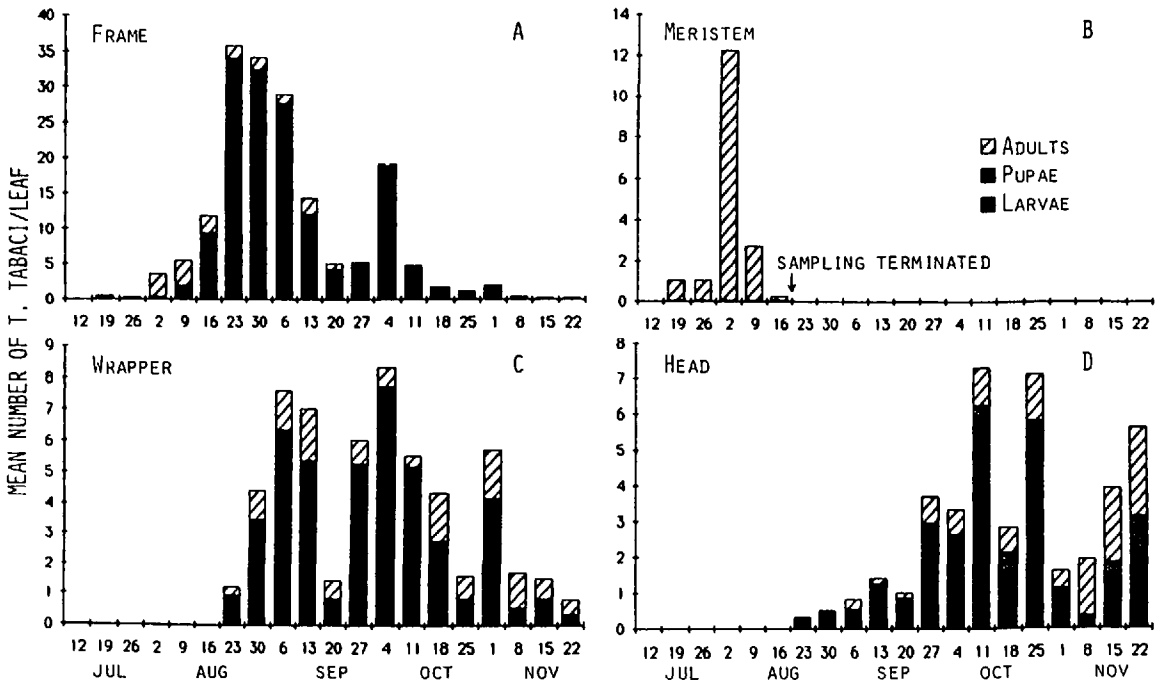


Fig. 3. Mean number of *T. tabaci* per leaf by date on cabbage frame (A), meristem (B), wrapper (C), and head leaves (D), Ontario County, New York, 1982.

catches of adults from each crop show distinct population trends (Fig. 1). The peak catches of adult *T. tabaci* occurred in wheat in the week ending 25 July and in oats in the week ending 1 August. Larvae reared from cabbages adjacent to these crops had population trends that paralleled the adult catches, indicating that adults were leaving wheat and oats and ovipositing on cabbage. The migration from wheat and oats was well correlated with the senescence and harvesting of these two cereal crops. Two wheat fields were harvested the week of 18–25 July and one the week of 25 July–1 August. All three oat fields were harvested the week of 1–8 August. The trap catches of adults

in alfalfa indicated a prolonged flight period through July and August with a peak on 29 August. Peak oviposition in alfalfa occurred the week ending 1 August, with another small rise at the end of August. One alfalfa field was never cut during the experimental period but two alfalfa fields were cut the week of 22–29 August. In the lawn area, the thrips population was very low; the trap catch never exceeded four adults per trap per week, and the number of larvae emerging from the cabbage plants never exceeded four. The numbers of adults and larvae on all cabbage plants during the weekly exchange of plants were minimal in both years and are not reported herein.

In 1984, the populations of adult *T. tabaci* captured in the field crops (Fig. 2) followed the same general trends as in 1983. Larva population trends followed very closely the adult population trends in wheat, oats, and alfalfa, indicating that *T. tabaci* adults were leaving these cereal and forage crops and ovipositing on cabbage. As in 1983, there appeared to be a close association between the maturation and harvesting of these field crops and the emigration of thrips from them. Two wheat fields were harvested the week of 16–23 July and one the week of 23–30 July. All three oat fields were harvested the week of 6–13 August. One alfalfa field was cut the week of 13–20 August, one the following week (20–27 August), and one the week of 10–17 September.

Within-plant Population Structure. The data for the within-plant population structure of *T. tabaci* are presented as colonization of plant parts

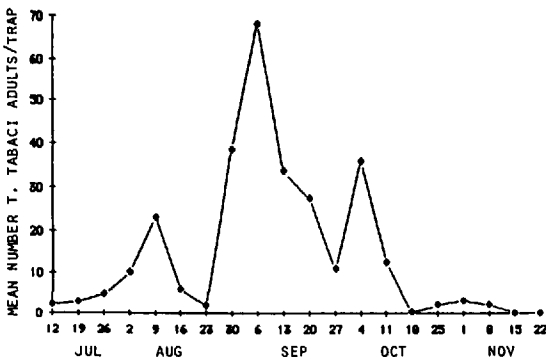


Fig. 4. Mean number of *T. tabaci* adults per trap in cabbage adjacent to wheat field, Ontario County, New York, 1982.

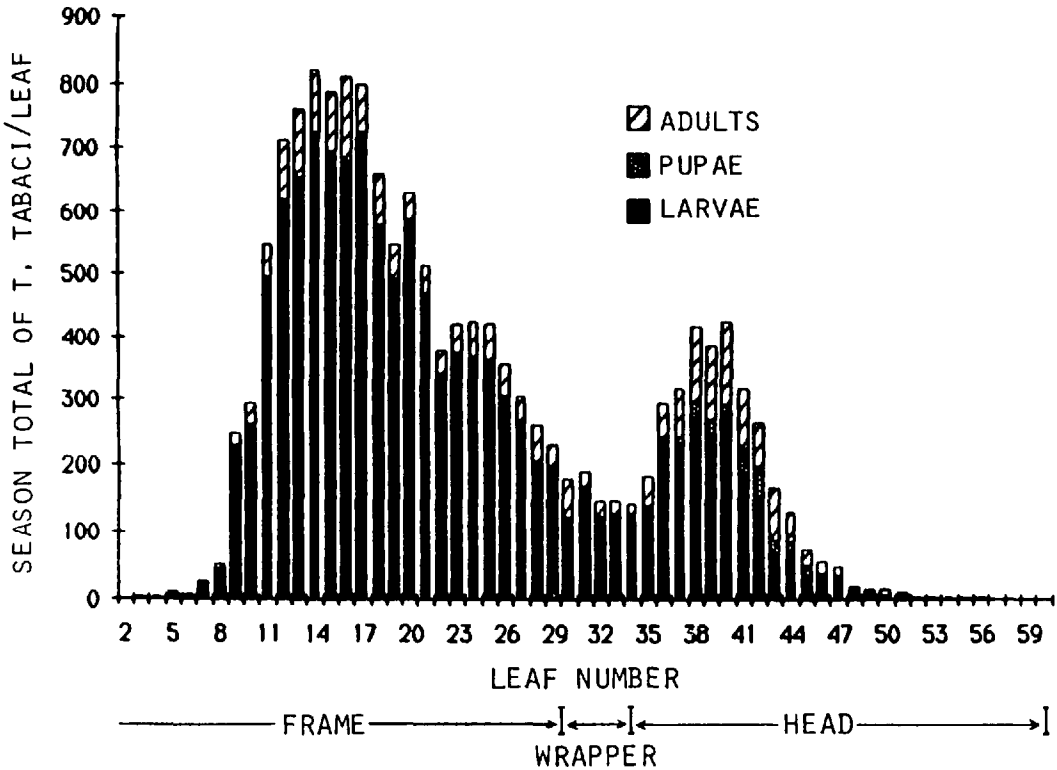


Fig. 5. Seasonal total of *T. tabaci* per leaf on cabbage plants, Ontario County, New York, 1982.

by date (Fig. 3). A description of cabbage growth is useful for explaining the within-plant distribution of *T. tabaci*. Early leaves form from the apical meristem and then unfold to become frame leaves. Approximately 50 days after transplanting, cupping occurs, in which the last leaves generated from the apical meristem form a soft sphere. Subsequently, rapid leaf production from the apical meristem continues to occur within this sphere and the head fills in. *T. tabaci* adults colonized the cabbage plants within several weeks of transplanting. Through the season, only *T. tabaci*, *Anoplothrips obscurus* (Müller), and *Frankliniella tritici* (Fitch) were found on the plants. These last two species were found only on the frame leaves and in very low numbers, and did not colonize the plants.

T. tabaci adults and larvae were first collected on the frame leaves and within the meristem on 19 July (Fig. 3 A and B). The adults collected within the meristem peaked on 2 August, which corresponded with the harvest of the adjacent wheat field on 30 July. It is interesting to note that this peak adult population on 2 August did not result in a large larva population in the meristem 2 weeks later. Instead, the rapid increase in the larva population occurred in the following weeks on the frame leaves, with a peak of ca. 35 larvae per plant frame leaf on 23 August. Cabbage heads began to develop in the latter half of August and

the first true cabbage heads were collected on 23 August. Once cabbage heads were present, we considered the meristem to be part of the head and its thrips counts were included with those of the head. The wrapper leaves (four leaves surrounding the head) were colonized at head formation and, except for 2 weeks, *T. tabaci* populations remained above five per leaf per plant from 30 August through 1 November (Fig. 3C). Infestation within the head was the last to occur but remained the longest (Fig. 3D). Even on 22 November, there were still about six thrips per head leaf. On the frame and wrapper leaves, larvae were the predominate stage, while adults were the dominant stage on the meristem. Larvae, adults, and pupae were found only on the head leaves.

Three distinct peaks were recorded on sticky traps (Fig. 4). The first peak, during the week of 2-9 August, followed the harvest of the adjacent wheat field on 30 July. The second peak (30 August-6 September) followed the buildup of the *T. tabaci* population on cabbage and may have been the result of the dispersal of adults from the first generation on cabbage. The third peak (27 September-4 October) may have been the dispersal of the second generation produced on cabbage or the overwintering generation (unpublished data).

The distribution of *T. tabaci* by leaf through the sampling period is shown in Fig. 5 as the season total number of thrips per leaf. The distribu-

tion of thrips by leaf was the result of several phenomena that were taking place within the different areas of the plant. The small numbers recorded for leaves 1-10, and especially 1-5, were the result of the early senescence of these leaves. The large population on leaves 11-17 through the season may be due to two factors. First, these leaves remain in good condition on the plant for the majority of the growing season. Second, for most of the growing season these leaves are in a horizontal position on the plant. Thrips on the undersurface of these leaves (the usual site of thrips) will be sheltered from rain, a major mortality factor for thrips. Populations on the wrapper leaves were lower than on frame leaves 9-29 and head leaves 34-42. These wrapper leaves serve as a transition between frame and head leaves, and tend to afford little protection from foul weather when they only loosely enfold the head. Populations increased from wrapper to head leaves, and this appears to be the result of reproduction occurring within the head or, at least, the increased survivorship within the head. In either case, it appears that on this cultivar of cabbage *T. tabaci* are most abundant late in the season on leaves 36-43 within the head. *T. tabaci* adults were found as deep in the heads as leaf 56, or 11 layers (two leaves per layer).

Our previous studies indicated that the arrival of *T. tabaci* in cabbage fields was synchronized with their emigration from wheat, oat, red clover, and alfalfa fields (unpublished data). The present studies indicate that *T. tabaci* adults leaving these cereal and forage crops actually colonize cabbage plants. From these studies, we conclude that *T. tabaci* adults leave these field crops when they become senescent or are harvested and oviposit on nearby cabbage plants. Once *T. tabaci* adults land on the young cabbage plants, adults will most likely be found on the developing meristem and frame leaves, while larvae will be most abundant on the frame leaves. Whether the larvae that are found

on the frame leaves originate from oviposition within the meristem and remain on the leaves as they unfold and become frame leaves, or whether they are the result of oviposition on the frame leaves themselves, remains unclear. Once *T. tabaci* gets into the head, subsequent generations are produced and this increases thrips injury and contamination at harvest. It is unlikely that all the thrips can be removed from the heads when cabbage is brought to market, and the damage and the thrips themselves may be noticeable to the consumer. Depending on the cultivar, cupping begins about the 24-leaf stage. Once cupping begins, thrips in the developing head region are more sheltered from insecticide sprays. To prevent initial infestation and subsequent generations within the head, insecticide sprays will be most effective if applied just before cupping if thrips are present (unpublished data).

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