

Pollination potential of thrips (Insecta: Thysanoptera) in some Solanaceous plants

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Abstract. Pollination by two species of flower thrips in six Solanaceous plants (four perennials and two seasonal) were studied. The results highlight the role of thrips in both self and cross pollination of these flowers. The findings also suggest that in view of the stigmatic surface in all the flowers being at a higher level than the anthers, there is more entomophily. Data relating to the population dynamics of thrips as well as the pollen load of thrips are also included.

Keywords. Thrips; pollination; Solanaceae; pollen load; stigmatic receptivity.

1. Introduction

The pollination potential of thrips though recognised as early as 1914 by Shaw in sugarbeet and by Annand (1926) in such cultivated crops as sugarbeet, alfalfa, plum and daisy, further confirmation of their active involvement in pollination is referable to the contributions of Hagerup (1950) on *Calluna* and *Erica* (Hagerup and Hagerup 1953), Billes (1941) on cacao by *Frankliniella* Odland and Porter (1941) on *Capsicum annuum*, Carlson (1964) on onion and Ananthakrishnan *et al* (1981, 1982 and 1984) on Asteraceae (= Compositae). Except for the work of Odland and Porter (1941) cited above on the role of thrips in the pollination of *Capsicum annuum*, no further information is on record on the other members of Solanaceae. Pollination by thrips and the production of viable seeds in the members of Solanaceae can be correlated with the degree of stigmatic receptivity preceded by the porous dehiscence of the anther, besides the ability of thrips to enter the bud itself. Information presented here highlights the role of thrips in the pollination of *Solanum melongena* Linn, *S. xanthocarpum* Schrad and Wendl, *S. torvum* Swartz, *S. trilobatum* Linn, *S. nigrum* Linn. and *C. frutescens* Linn.

2. Materials and methods

Periodic weekly collections of thrips over one year period (March 1984 to February 1985) were made from 20 flowers of the Solanaceous plants referred to and record kept of the population fluctuations and the pollen load by counting the number of pollen grains attached to various parts of the body. Dispersal of thrips from flower to flower was observed by marking them with gilt powder. A comparative assessment of the efficiency of pollination by various agents was estimated in terms of seed setting on the

basis of 3 sets of experiments (i) hand pollination, (ii) pollination by thrips alone and (iii) natural condition where all the other foraging insects played a significant role. The various stages of flower formation have been conveniently grouped into 3 categories viz the bud stage (1–2 days old), the open flower stage (3–4 days old) and the older flower which are on the verge of falling off (5–6 days old), hereafter referred to as stages I, II and III respectively. The receptive areas of the stigma in all the 3 categories of flowers were scanned with the aid of a scanning electron microscope. Investigations on the mode of attachment of pollen grains on the various parts of the body of thrips were made by etherising the specimens carrying pollen grains and dried in a critical point dryer. The specimens were later fixed on to an aluminium stub using a double adhesive tape and was coated with gold with an ion coater and later observed using the scanning electron microscope. Micrographs were taken using Hitachi Scanning Electron Microscope (Model S 415A) under 15 KV emission current.

3. Observation and results

Flowering in both *S. melongena* and *C. frutescens* is restricted to the months of February–May and July–November with both cultivated during the same time in adjacent plots. Such hosts like *S. torvum*, *S. xanthocarpum*, *S. trilobatum* and *S. nigrum* are perennials. Of the two flower infesting species *Frankliniella schultzei* (Trybom) and *Taeniothrips major* Bagnall, the latter is notable for its absence in *C. frutescens* and *S. torvum* while *F. schultzei* appeared to be the dominant species in all the host plants (figures 1 and 2).

Abundance of these anthophilous thrips species is mainly determined by the flowering season of the host plants, availability of their flowers and also the effect of temperature, rainfall and relative humidity (table 1). An optimal temperature (28–32°C), moderate rainfall (upto 50 mm) and high humidity (above 80%) tend to build-up populations, while heavy rains drastically reduce them. Table 1 also reveals that occasional rains would induce the populations to oscillate.

The continuous availability of different habitable host plants within the same vicinity possibly prevented the complete decline of the population during the rainy season and at the time of non-availability of the flowers in some of these plants. In the case of seasonal crop plants the maximum population was observed between September–October during the first cropping season and in March–April during the second cropping season (figure 2). Population of *F. schultzei* was at its maximum within the flowers of *S. xanthocarpum* (350 ± 8 individuals per 20 flowers) and the least was seen in *S. torvum* (55 ± 2.38 individuals per 20 flowers) among the perennial plants (figure 1). The maximum number of *Taeniothrips major* was observed on *S. trilobatum* (132 ± 2.90 individuals per 20 flowers) and the least in *S. xanthocarpum* (80 ± 1.45 individuals per 20 flowers) (figure 1). A slight preponderance of the population of *T. major* over *F. schultzei* was observed in the flowers of *S. nigrum* and *S. trilobatum* for a very short duration (only in September). In *S. xanthocarpum* the phenomenon of dominance was very evident with *F. schultzei* numbering around 350 ± 8 individuals per 20 flowers while the number of individuals of *T. major* was only of the order of 70 ± 2 individuals per 20 flowers. Among the seasonal crop plants *F. schultzei* was dominant throughout except in the second crop of *S. melongena* where *T. major* dominated in the month of May (figure 2). Intercrop and interfloral migration of thrips

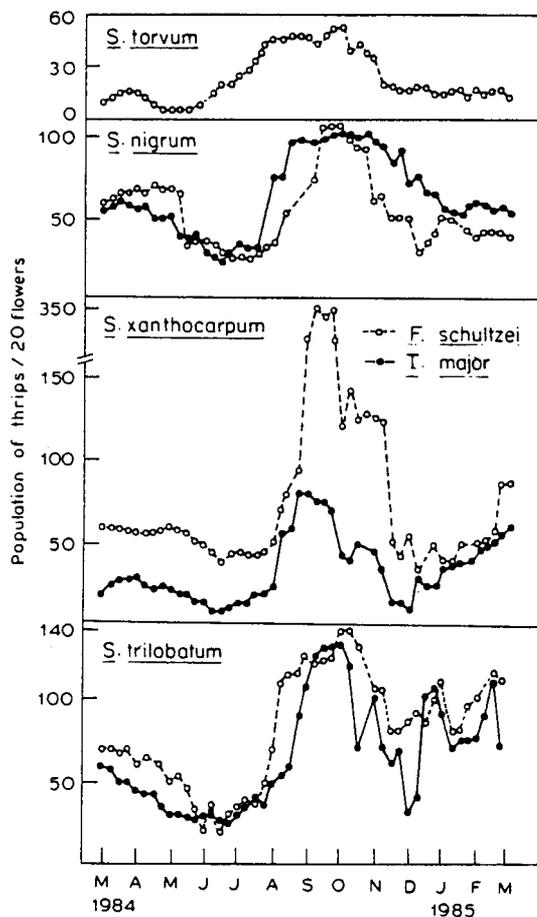


Figure 1. Population dynamics of *F. schultzei* and *T. major* on different perennial solanaceous host plants.

was also occasionally observed, mainly attributable to the type of floral availability which in turn provides shelter and food for sustenance.

3.1 Pollen load

A comparison of the pollen carrying capacity of larval and adult *F. schultzei* revealed that the maximum pollen was carried by the larvae than the adults in all the stages of the flower. As against the interfloral movements of adult thrips, the larvae restricted their movement and were found within the flower usually moving between the nectaries and the stigmatic lobe. Besides depicting the maximum and minimum pollen load of adults and larvae of *F. schultzei* (figure 3) the graph also indicate the average pollen load. The maximum pollen load of 79 ± 5 pollen grains was recorded on the body of the larvae in the flowers of *S. melongena* and the least number of pollen grains were found

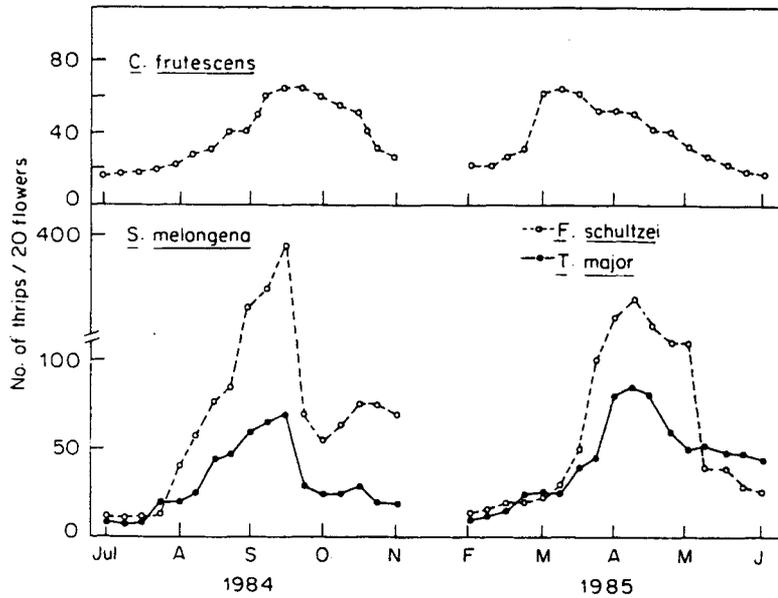


Figure 2. Population dynamics of thrips in seasonal solanaceous crops (*C. frutescens* and *S. melongena*) for two cropping seasons.

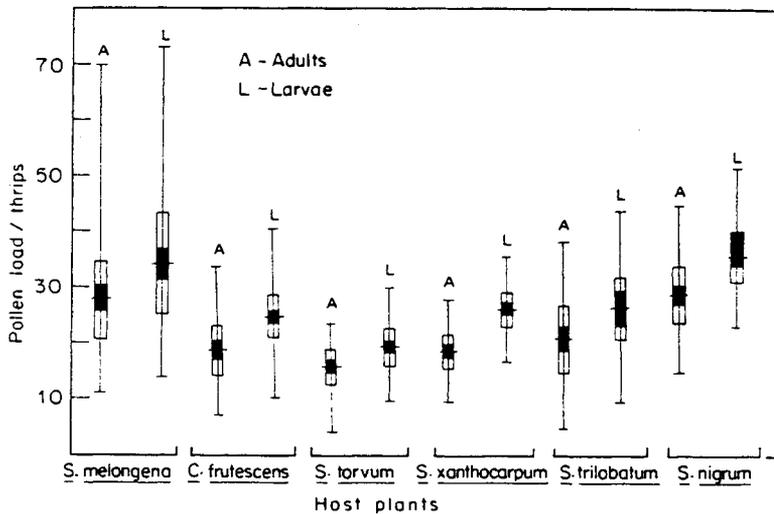


Figure 3. Graph depicting the pollen load of *F. schultzei* (Adults and Larvae) on different solanaceous host plants. The lower peaks indicate the minimum pollen load. The higher peaks indicate the maximum pollen load. The rectangle indicates the standard deviation and the shaded region depicts the standard error. The line bisecting the rectangle indicates the mean pollen load.

Table 1. Population dynamics of thrips along with abiotic factors.

Months	Abiotic factors		Rainfall mm	Rh (%)	Population of thrips on different hosts						
	Average maximum temp °C	Average minimum temp °C			<i>S. xanthocarpum</i>		<i>S. trilobatum</i>		<i>S. nigrum</i>		<i>S. torum</i>
					1	2	1	2	1	2	
March 84	31.07	24.28	0.6	79.16	58.00 ± 0.40	25.25 ± 1.90	69.00 ± 1.00	54.50 ± 2.56	65.75 ± 0.75	58.50 ± 0.85	13.25 ± 1.38
April	34.23	26.37	1.4	78.95	56.00 ± 0.70	27.00 ± 1.75	62.75 ± 1.30	41.75 ± 1.97	67.75 ± 1.03	53.50 ± 1.55	10.00 ± 2.20
May	34.79	27.87	—	80.85	50.50 ± 2.30	19.50 ± 1.70	44.75 ± 5.25	28.75 ± 0.75	51.25 ± 8.85	42.50 ± 3.20	5.75 ± 0.75
June	37.87	27.66	11.7	70.64	46.00 ± 2.40	11.75 ± 1.18	26.25 ± 3.80	28.25 ± 1.18	32.25 ± 2.28	32.25 ± 2.28	15.75 ± 2.84
July	33.96	24.79	35.4	80.80	44.00 ± 0.57	17.50 ± 1.44	40.00 ± 3.49	35.00 ± 2.04	28.75 ± 1.49	38.50 ± 5.54	33.25 ± 4.45
August	35.98	26.04	1.5	76.98	76.00 ± 9.90	55.00 ± 11.33	102.50 ± 10.54	63.25 ± 9.15	51.25 ± 5.56	85.50 ± 6.08	49.00 ± 0.58
September	33.66	25.62	338.5	81.76	322.50 ± 18.80	75.00 ± 2.04	122.50 ± 1.04	126.25 ± 2.39	93.75 ± 9.52	97.00 ± 1.15	50.00 ± 2.04
October	31.72	24.39	11.7	81.82	127.50 ± 4.40	45.25 ± 2.28	128.75 ± 8.26	101.15 ± 14.50	101.75 ± 1.18	97.25 ± 3.20	44.25 ± 2.39
November	28.27	22.63	273.50	83.20	84.75 ± 22.40	26.25 ± 7.18	92.50 ± 7.72	75.00 ± 8.52	85.25 ± 3.75	55.75 ± 3.87	35.75 ± 5.45
December	28.68	21.22	50.00	81.78	47.25 ± 3.60	22.50 ± 4.30	90.00 ± 3.58	69.25 ± 19.54	68.75 ± 2.39	39.25 ± 4.35	19.00 ± 0.58
January 85	28.32	21.65	51.8	77.92	44.75 ± 3.30	38.00 ± 0.91	91.25 ± 7.68	78.50 ± 4.17	60.00 ± 2.04	47.50 ± 1.44	16.75 ± 1.18
February	30.27	21.65	—	80.14	78.25 ± 7.00	50.00 ± 1.97	108.75 ± 3.15	86.25 ± 8.59	68.00 ± 0.72	43.25 ± 1.18	17.75 ± 1.03

1 *Frankliniella schultzei* (Trybom 1910).

2 *Taeniothrips major* Bagnall 1916.

Mean ± Standard error.

on the adults within the flowers of *S. trilobatum* (4 ± 1). The pollen load on the body of *F. schultzei* may range from 13–79 on *S. melongena*, 8–41 on *C. frutescens*, 4–30 on *S. torvum*, 10–36 on *S. nigrum*, 4–45 on *S. trilobatum* and 15–52 on *S. xanthocarpum* and the exact mode of pollen attachment is indicated in figures 4A–C. On the body of the larvae the maximum pollen attachment was observed on the lateral sides of the abdomen and on the last abdominal segments (figure 4C), while in the adults of

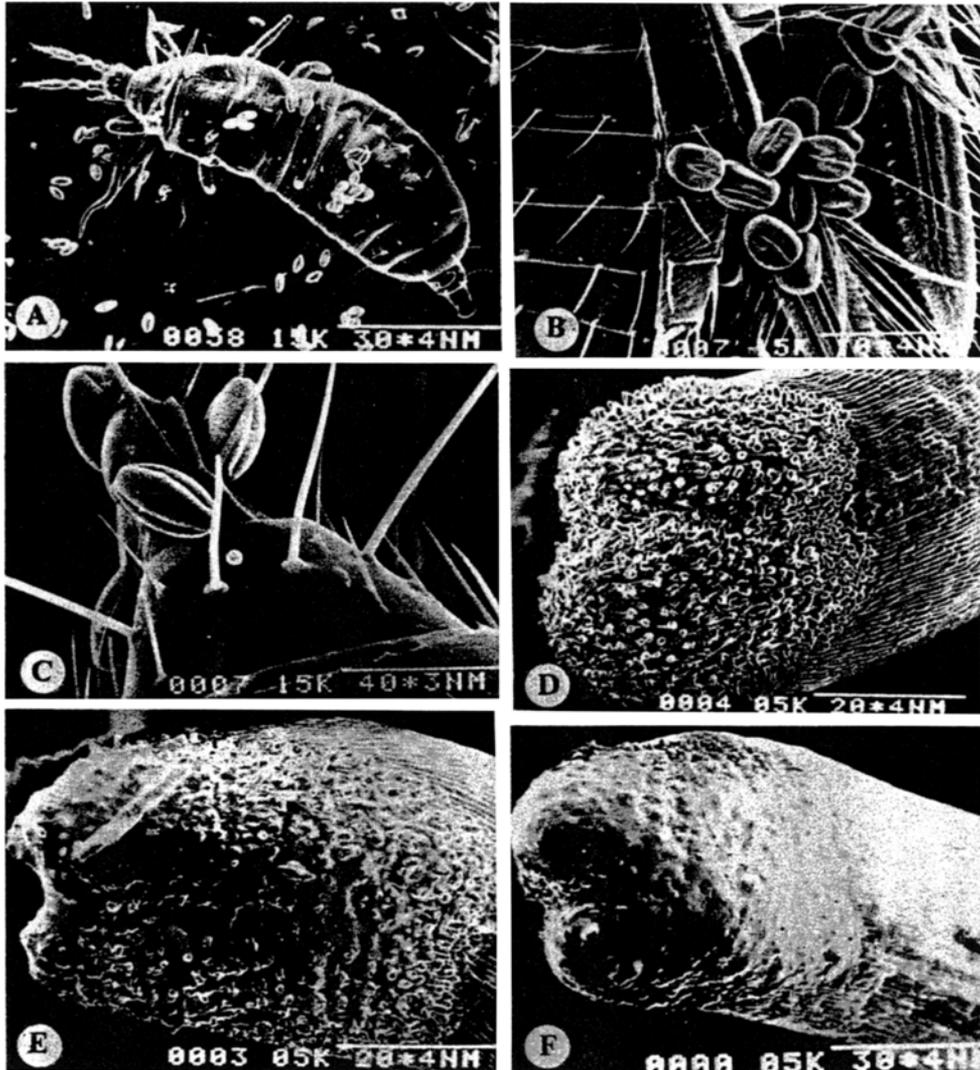


Figure 4. Scanning electron micrographs. A. Pollen grains attached to the body of the larva of *F. schultzei*. B. Pollen grains attached to thorax and wing fringes of the adults of *F. schultzei*. C. Pollen grains attached to the abdomen and the last abdominal segment of *F. schultzei*. D. Stage I (bud) stigma of *S. torvum* with closely packed papillae. E. Stage II stigma of *S. torvum* with a sticky stigmatic surface and uniformly spread papillae. F. Stage III stigma of *S. torvum* with widely spaced out papillae on the dry stigmatic surface.

F. schultzei it was maximum on the thorax and wing fringes (figure 4B).

On the basis of scanning electron micrographs of *S. torvum* (as a representative of the Solanaceous species studied) the nature of the stigmatic surface during the 3 stages of the flower as earlier defined was studied. *S. torvum* flowers are protandrous in nature and the porous dehiscence of the anther occurs between the third and fourth day after the formation of the floral bud. The maturation of gynoecium coincides with the straightening and lengthening of stigma, which by then is at its peak of receptivity and the surface of the stigmatic lobe had evenly spaced out papillae in contrast to the stage I (bud) stigma where the papillae appear to be very crowded (figure 4D). Similarly the stage II stigma seemed to be more sticky than the other two stages probably due to the exudation of the stigmatic surface which incidentally reaches its peak during this stage (figure 4E). The population dynamics of thrips revealed that the maximum number of individuals (both the adults and larvae) were found during the same period. Stage III stigmatic surface showed widely spaced out papillae on its surface and the surface appeared to be completely dry (figure 4F).

The 3 experiments on the comparative assessment of the efficiency of pollination resulted in seed setting of 90 %, 93 % and 97 % respectively. The significant aspect of these experiments was that pollination by thrips alone accounted for 93 % which is comparable with the other two sets of experiments.

It is an accepted concept that in solanaceous flowers if the stigma is of the same length or is shorter than the stamens, then self pollination occurs along with poricidal dehiscence (Vogel 1978). Hence in order to ascertain the above view, the distance between the stamens and the stigma was calculated in all the flowers and in all of them the stigma was located above the stamens and the distance was 1.4 ± 0.22 mm in *S. melongena*, 4.55 ± 0.20 mm in *S. torvum*, 4.00 ± 0.29 mm in *S. xanthocarpum*, 6.00 ± 0.20 mm in *S. trilobatum*, 0.20 ± 0.017 mm in *S. nigrum* and 1.50 ± 0.167 mm in *C. frutescens*. Based on these observation it is concluded that cross pollination or self pollination by the help of insects could be a common phenomenon in the above flowers.

4. Discussion

The coadaptation of the flower and insects involves the mechanism of pollen transfer based on the behavioural patterns of the pollinator. The 'adaptive spectrum' of thrips and the flower focus attention on aspects such as availability of food, stigmatic exudation and other favourable microenvironment within the corolla providing suitable ovipositional site enabling the emerging larvae to be dusted with pollen in their movement from the base of the flower on to the anther or stigma of the flower. The solanum type of 'pollen flowers' (flowers that offer surplus of pollen as reward to their visitor instead of nectar) are all oligandrous with most of their anthers enlarged and showy and also capable of producing excess pollen that are mostly sessile (by neotenic shortness of filaments) and poricidal. The powdery pollen are released in small portions as a 'cloud' and depending on the movement of the pollinator, the various regions of its body are dusted with pollen. Apart from the sticky and viscous pollen kitt which makes the pollen grains adhere, the sticky stigmatic secretions or additional sticky substances further improves the pollen adherence to the insect. The architecture of the pollen wall coupled with the setal arrangements on the body of thrips also aid in pollen attachment to various sites of the body.

Among the various *Solanum* spp. studied in those species in which the stigma is identical in length as the stamens, self pollination readily occurs. Pursglove (1968) has reported about 16% of cross pollination in *C. frutescens*. In other species in which the stigma projects beyond the anther, it is supposed that pollination is facilitated either by the stigma curving downwards to bring it in line with the falling pollen or by the flower dropping so that the pollen falls on the stigma or perhaps by the aid of insect vectors (Knuth 1908; Stevenson and Clark 1937). Kakizaki (1924 as reported by Free 1970) found that *Solanum* plants grown in cages without insects produced no fruits. This observation along with the results of the 3 experiments substantiates the view that insect visits appeared necessary for the transfer of the pollen on to the stigma, if the stigmatic receptive surface projects beyond the level of the anthers. The present study also shows that in all the flowers taken for the investigation the stigma is located at a higher level than the anthers, and most probably the transfer of the pollen from the anther to the stigma is mainly done by thrips and especially the larvae which confine their movements only within one flower. On the other hand a slight degree of cross pollination is also effected by the adults making short flights from one flower to another besides being drifted by the wind. Thrips are generally considered to be a homogenous type of pollinator confining to one species of plant and only pollen of that species can be found on the body at a time. Hence this study of solanaceous plants highlights the role of thrips as effective pollinators accounting for both self and cross pollination, with the larvae engaged in a larger percentage of self pollination with the adults occasionally playing the role of cross pollinator.

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