

SPIDER MITE WEBBING. V. THE EFFECT OF VARIOUS HOST PLANTS

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SILK
AND
HOST PLANTS
PARASITES
INTERACTIONS

ABSTRACT : Silk production by the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval) was compared on seven host plants (bean, rose, sweet potato, hibiscus, castor bean, cotton and Algerian ivy). Most silk was spun on bean, least on Algerian ivy. A very good correlation was obtained between amounts of web produced and number of eggs deposited on each host plant. The resultant, host-specific regressions are taken to indicate the differential allocation of plant resources to oviposition or to webbing.

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RÉSUMÉ : La production de soie par l'acarier rouge, *Tetranychus cinnabarinus* (Boisduval), a été comparée sur sept plantes hôtes (le haricot, la rose, la pomme de terre douce, l'hibiscus, le ricin, le coton et le lierre algérien). Sur le haricot a été tissé le plus de soie et sur le lierre a été tissé le moins de soie. Une très bonne corrélation a été obtenue entre les quantités de soie produites et le nombre d'œufs déposés sur chaque plante hôte. La régression spécifique des plantes hôtes a été prise comme indicatrice de l'allocation de ressources en vue de l'oviposition ou du tissage.

INTRODUCTION

Spider mites (Acari : Prostigmata : Tetranychidae) are important, sometimes major pests of many cultivated plants. Some members of this family spin webs which are a conspicuous indicator of their presence, besides contributing to plant damage. The biology of spider mites has been extensively studied (VAN DE VRIE *et al.*, 1972), but little is known about their most prominent feature, the silk or webbing. It is in this area of research that the present series of papers is intended to contribute.

In the first part (HAZAN *et al.*, 1974) it was established that low relative humidities promoted webbing, that the number of eggs deposited

by female mites was closely correlated with the amounts of silk produced by these females and that light encouraged webbing. Later (HAZAN *et al.*, 1975a) it was shown that hatch of web-covered eggs was enhanced under very low or very high relative humidities, as compared to de-webbed eggs. Efforts to bring about silk solubilization, and its amino acid composition, were described in another part (HAZAN *et al.*, 1975b).

The experimental animal employed in these studies was the carmine spider mite, *Tetranychus cinnabarinus* (Boisduval), reared and maintained on bean (*Phaseolus vulgaris*). In the present instalment we report on the effect of other host plants on webbing production by this mite.

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of this calculation was presented by HAZAN *et al.* (1974), Table 3.

MATERIALS AND METHODS

Plants : One subsponaneous (castor bean, *Ricinus communis*), bean and five additional cultivated plants were used. The latter were rose (*Rosa hybrida* var. Evergold), sweet potato (*Ipomoea batatas* var. Georgia Jet), Chinese hibiscus (*Hibiscus rosa-sinensis*), cotton (*Gossypium hirsutum* var. SJ2) and Algerian ivy (*Hedera canariensis* var. Variegata). The reasons for their use, and their sources, are detailed elsewhere (GERSON & ARONOWITZ, 1980).

Procedures : Stock cultures of *T. cinnabarinus* were maintained on bean leaves. Young females were transferred onto leaves of new host plants and allowed to feed and oviposit. The resultant eggs were placed on fresh leaves of the appropriate plants and reared to adulthood. Groups of five young mated females were then confined, by means of modified Munger cells (HAZAN *et al.*, 1974) on leaves of the specific plants on which they had developed. The cells were kept under conditions of 24°C and 38 % r.h. and a 14 : 10-hr light-dark cycle. Leaves were changed every day. Eggs and fecal pellets were daily counted; number of pellets observed on the web canopy served as an estimate of silk production (HAZAN *et al.*, 1974), whereas total number of pellets (on web as well as on leaf surface) was used to appraise feeding (GERSON & ARONOWITZ, 1980). Counts continued until all experimental mites (40 on each host plant except bean, on which only 35) had died.

Total amounts of silk spun ("S") on the various plants was computed according to the method of HAZAN *et al.* (1974). Daily survival rates (1_x obtained from GERSON & ARONOWITZ, 1980) were multiplied by the mean daily number of fecal pellets counted on the mites' webbing on each of the experimental plants (s_x). The resultant $1_x s_x$ signified the amount of silk produced on day x. The sum of all $1_x s_x$ was total average silk production, "S", on any of the plants. A detailed example

RESULTS

Amounts of silk spun by *T. cinnabarinus* were considerably affected by the various host plants. Mites on bean produced most webbing, those on sweet potato coming a far-removed second (Table 1, column A). Mites kept on rose and on hibiscus constituted a third group, those on castor bean and on cotton a fourth, and Algerian ivy induced least silk to be spun. Mites webbed longest on bean, while those on Algerian ivy ceased on the twelfth day already (Fig. 1). Most web was produced, on all host plants, on day 8 ± 2 days.

TABLE 1. — Average amounts of silk (estimated as pellets on webbing) spun by females of the carmine spider mite on seven host plants. Column A : Total amount produced per female (= "S") (identical letters next to numbers indicate means which do not differ at the 5.0 % level, according to a multiple range test). Column B : Amount spun for every four eggs deposited (based on data in Fig. 2).

Host Plant	A (= "S")	B
Bean	117.7 a	2.9
Rose	40.7 c	2.7
Sweet potato	56.6 b	4.7
Hibiscus	39.6 c	4.8
Castor bean	22.0 d	4.2
Cotton	23.0 d	3.2
Algerian ivy	9.6 e	5.3

Upon comparing daily amounts of silk spun by *T. cinnabarinus* with daily amounts of food intake and oviposition (data from GERSON & ARONOWITZ, 1980), very significant correlations were consistently obtained on all host plants (Table 2). The specific relationship between webbing and oviposition (data source as above) was explored for all host plants (Fig. 2), and appropriate regressions calculated for each host.

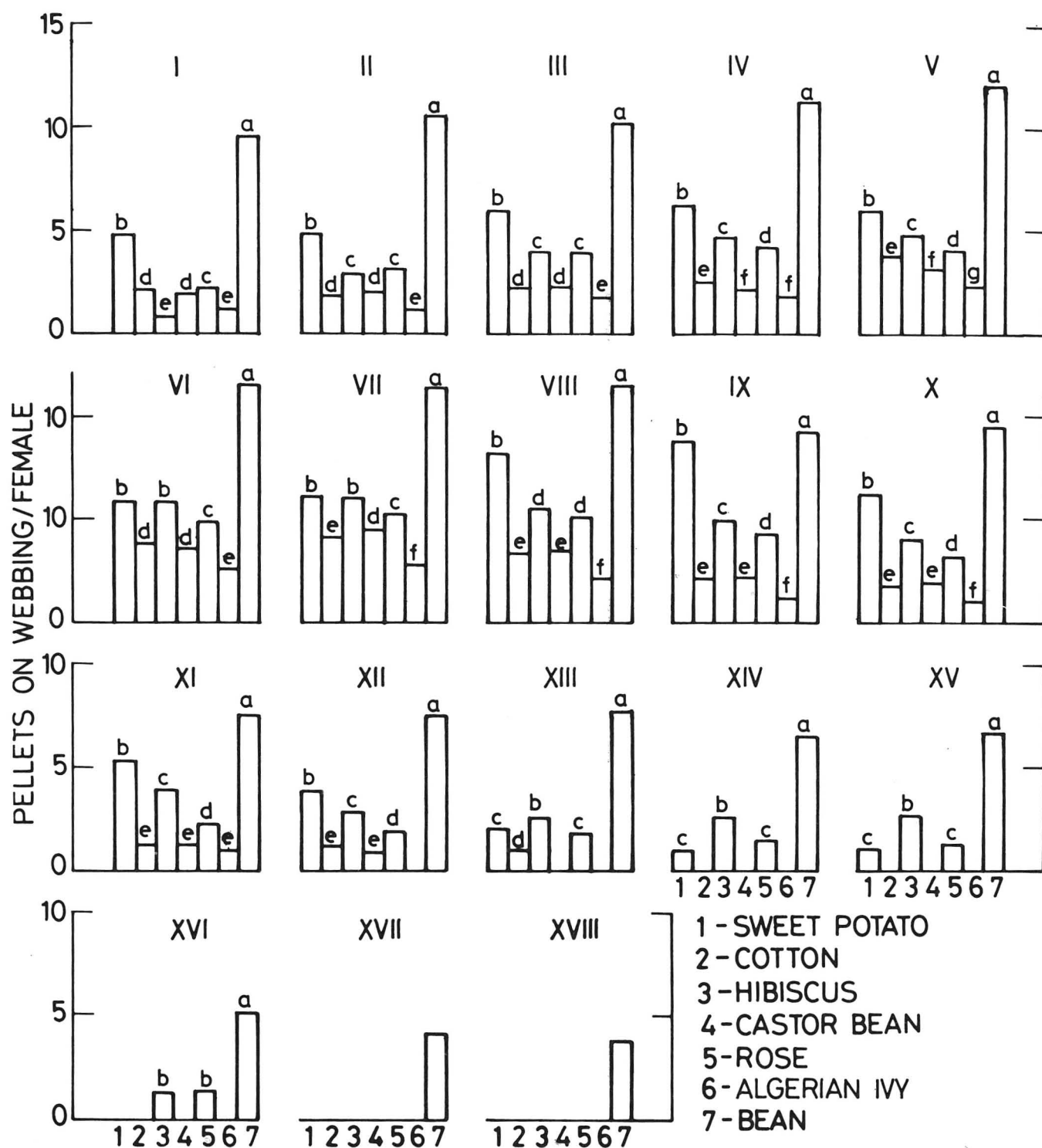


FIG. 1. — Silk production (estimated as pellets on webbing) of *T. cinnabarinus* during successive days (I-XVIII) on seven host plants. (Identical letters on columns indicates means which do not differ according to a multiple range test at the 5 % level).

DISCUSSION

The pattern of silk production by the carmine spider mite on the various host plants was quite similar to that observed in regard to oviposition and feeding (GERSON & ARONOWITZ, 1980). The highly significant correlations obtained (Table 2) show that three host-induced traits, namely net reproduction rate, feeding and webbing, were similarly influenced by the host plants. Although the nutritive quality of the hosts probably affected oviposition and webbing, it must be borne in mind that mites may spin copiously without feeding (HAZAN *et al.*, 1974). This, and the different effect of rose on oviposition and webbing (GERSON & ARONOWITZ, 1980 and Table 1), suggest that although host quality is probably of paramount importance in influencing webbing, spinning may also be affected by other factors.

TABLE 2. — Correlations between the intrinsic rate of increase (R_0), the feeding (F, expressed as total pellet production) and the webbing (S, estimated as pellets on webbing) of *T. cinnabarinus* on seven host plants (F and S data from GERSON and ARONOWITZ, 1980).

Host plant	R_0 and F	R_0 and S	S and F
Bean	0.973	0.969	0.986
Rose	0.939	0.925	0.977
Sweet potato	0.976	0.951	0.980
Hibiscus	0.920	0.884	0.944
Castor bean	0.937	0.885	0.920
Cotton	0.974	0.994	0.979
Algerian ivy	0.957	0.955	0.968

The amount of silk spun per every four deposited eggs was calculated from the data of Fig. 2, including the host-specific a and b values. (The value of four eggs was used in order to stay within the range of observed data). The results (Table 1, column B) indicate that each

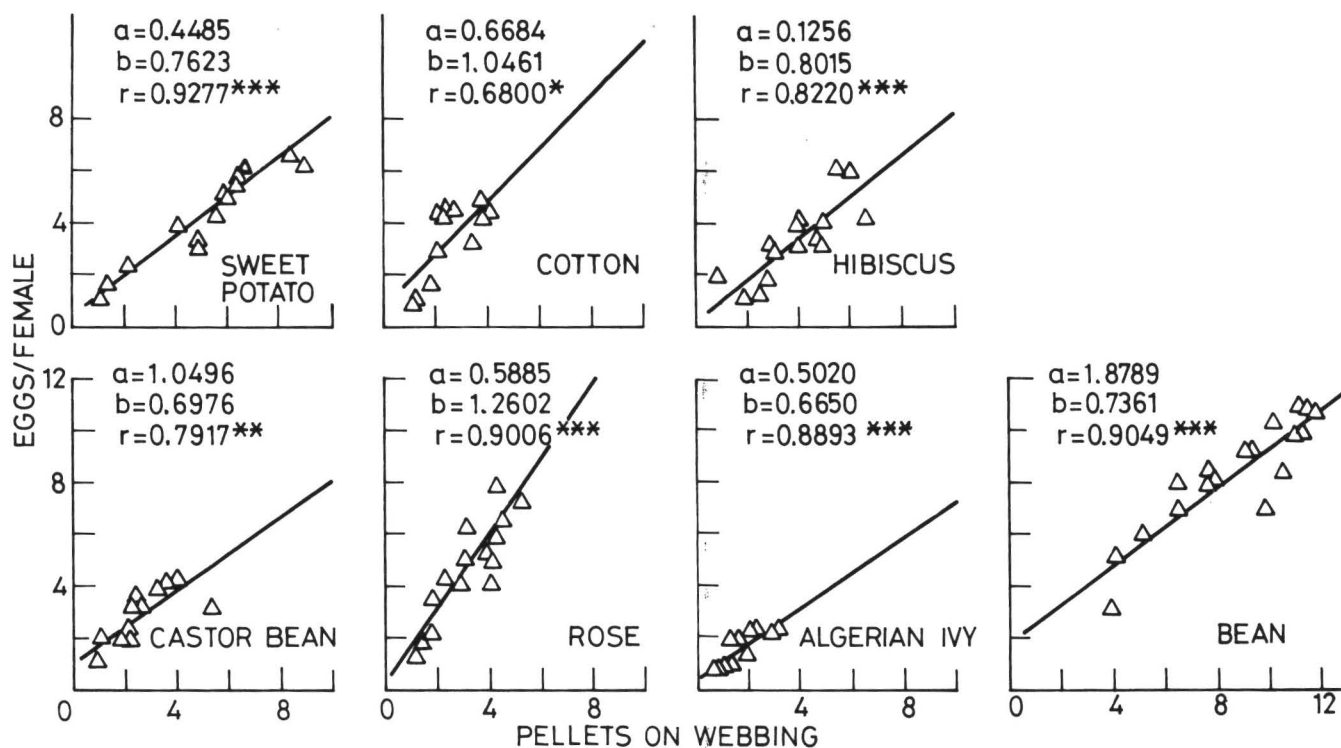


FIG. 2. — Relationship between silk production (estimated as pellets on webbing) and egg deposition by *T. cinnabarinus* on seven host plants.

plant had its specific effect on this ratio, but the nature of the effect is obscure. Mites on bean deposited five times as many eggs as on cotton, yet the amounts of web spun per every four eggs (web/4 eggs) was rather similar on these plants. On the other hand, mites on rose and on sweet potato produced a similar number of eggs (70.3 and 61.9 respectively), yet the web/4 eggs ratio was quite different.

Very little is known about factors affecting spider mite webbing (except relative humidity and substrate vestiture). Nutrient quality of the host plants was strongly implicated in the present study; it is rather significant that the two best host plants, bean and rose, had the lowest web/4 eggs ratios, whilst Algerian ivy, the worst host, had the highest (Table 1, column B). This suggests that on better hosts relatively more resources are allocated by the mite to egg production than to webbing, and vice versa on less suitable plants. Another host characteristic which is known to affect webbing is leaf surface vestiture (VAN DE VRIE *et al.*, 1972). Specific leaf surface features probably interacted with specific nutrient qualities and resulted in the specific webbing values obtained.

The largest amounts of silk were produced by *T. cinnabarinus* under very low relative humidities (HAZAN *et al.*, 1974). And yet, small phytophagous animals, like this mite, would be expected to perform best under high humidity condition. This apparent paradox may be explained as an adaptation for maintaining large, webbing colonies on plants. The females of *T. cinnabarinus* are rather prolific, each depositing well over one hundred eggs on the average, while also spinning abundant amounts of silk. For both products the mites require quantities of nitrogenous substances. Low humidities promote food ingestion, concentration and digestion by several *Tetranychus* spp. (BOUDREAUX, 1958); more nutrients for the silk thereby also become available.

Once established, a growing spider mite colony must cope with the problem of space for all its members. Webs temporarily meet this need, being the place where non-feeding mites rest between meals.

Were *T. cinnabarinus* a moisture-prefering animal, it would not be inclined to move up into the web which, being somewhat removed from the leaf's surface, provides a drier micro-habitat. The mite's physiology and behavior thus appear to have been modified by and for the webbing. The specific, host-mediated allocation of resources to web or to eggs, as postulated above, further indicates physiological modifications to the spinning of silk.

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