Studies on the relative susceptibility of varieties and germplasm lines of sesame to infestation by *Tribolium castaneum* (Herbst) (Coleoptera: Tenebrionidae)

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Abstract

Growth and development of red flour beetle *Tribolium castaneum* (Herbst) on wheat flour and nine varieties and three germplasm lines of sesame was studied at 30±2°C under laboratory conditions. Development from first instar larvae to adult was fastest on sesame line ES 22 and slowest on TM V6 taking 37.9±0.6 and 57.1 ±0.2 days respectively. Survival to adulthood ranged from 81.7% on wheat flour, 61.8% on ES 22 to 32.5% on TM V6.

Weight loss due to insect activity was higher on white-seeded lines TMV 2, SVPR 1 and ES 12 than on black, or brown, seeded varieties. It was concluded that, except for ES 22 and SI 250, susceptibility to infestation by *T. castaneum* was mainly attributed to the oil content and colour of the testa.

Introduction

Sesame seeds and its cake in storage are attacked by many storage pests causing losses to weight of produce and its germinability (Mahadevan 1988). Sesame seeds are attacked by the rice moth (*Corcyra cephalonica* (Stainton)), the red flour beetle (*Tribolium castaneum* Herbst), the khapra beetle (*Trogoderma granarium* (Herbst)) and the almond moth (*Cadra cautella* (Wlk.)) in India and Brazil; *Cryptolestes pusillus* Schon and *Oryzaephilus mercator* (Fauvel) in Africa; and *Tribolium confusum* Duv. in Uganda and Africa. Among the different storage pests, *T. castaneum* and *C. cephalonica* are cosmopolitan pests, causing additional damage (the latter by way of webbing) (Srivastava 1964; Mookherjee and Bose 1967). Different varieties of seeds show varying susceptibility to storage insects infesting them.

In Tamil Nadu, nine varieties and three germplasms of sesame have been developed which include varieties resistant to *Antigastra catalaunalis* (ES 22, ES 12 and SI 250) as well as high yielding varieties (TMV 3, TMV 2 and SVPR 1). Since the relative susceptibility of these varieties and germplasms to stored product insects had not been investigated, the present study was undertaken to determine the susceptibility of nine varieties and three germplasms to infestation by the beetle, *Tribolium castaneum*, an important storage pest of sesame in Tamil Nadu.

Materials and Methods

Sesame varieties, TMV 1, 2, 3, 4, 5 and 6, CO 1, SVPR 1 and Paiyur 1 and three germplasms ES 22, 12 and SI 250, harvested during the rainy season 1992, were obtained from the Regional Research station, Vridhachalam and Paiyur and Cottom Research Station Srivilliputtur, Tamil Nadu. Varieties, TMV 2, SVPR 1 and ES 12 were white seeded and the others were uniformly brown or black in colour and were not generally distinguishable from one another.

Culture of *T. castaneum* was maintained on the whole wheat flour with 5% yeast powder at 30 ± 2°C. The eggs of the beetle were extracted as per the methodology given in Figure 1.

Growth parameters of *T. castaneum* on varieties and germplasms of sesame.

Sound seeds of sesame were disinfested in an oven at 55°C for 2 hours before use. Fifty one day old eggs were placed in 250 mL conical flasks containing 30 g of whole seeds, and their growth and development compared with that in wheat flour. For proper aeration, the mouth was plugged with absorbant cotton. Each seed material was replicated thrice.

Observations on larval and pupal periods, weight/pupa, per cent pupation, average developmental period, weight/adult and per cent adult emergence were made.

Indices for varieties and germplasms of sesame

Various indices — larval–pupal index, pupal weight index and adult weight index (Deshmukh et al. 1982), adult emergence index (Tripathi et al. 1982), developmental index (Prasad and Bhattacharya 1975), general growth index (Pant and Dang 1969) and Howes growth index (Howe 1971) — were computed by using wheat flour as the standard.

Finally, a suitability index was calculated by taking the average of the above seven indices.

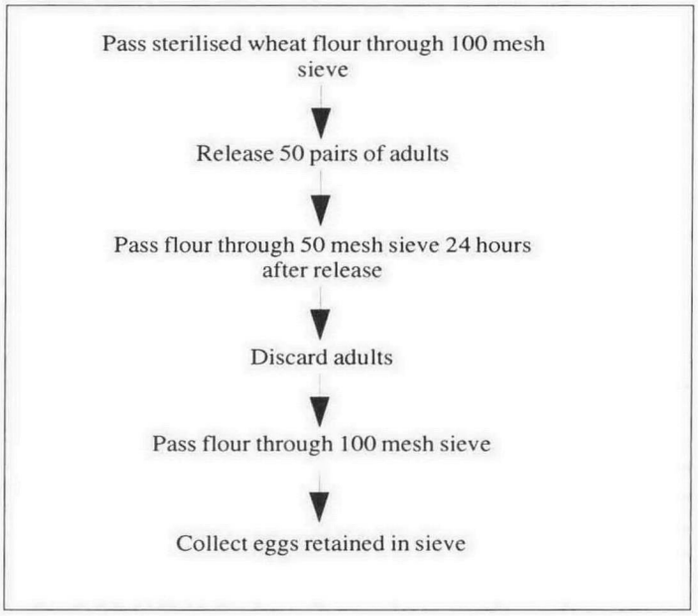

Fig. 1. Flow chart for extracting eggs of *T. castaneum*.

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Sex ratio

Emerged adults were sexed based on the presence of a shallow, oval pit with erect golden yellow hairs on the venter of the fore femur of the male (Hinton 1942).

Losses and viability

Loss due to infestation was estimated by weighing the developed adult during feeding activity, and the viability of seeds was determined by performing a germination test at the end of the completion of the first generation.

Results

Out of nine varieties and three sesame lines tested, ES 22, TMV 2, SI 250, ES 12, TMV 5 and SVPR 1 were highly susceptible to *T. castaneum* while TMV 6 and CO 1 were least susceptible.

Growth and development of *T. castaneum*

The larval development was fastest in ES 22, lasting 25.70 ± 0.44 days and slowest in TMV 6, lasting 43.45 ± 0.38 days (Table 1), which in turn influenced the average developmental period. The developmental period of *T. castaneum* on various seed materials of sesame ranged from 37.90 ± 0.59 to 57.10 ± 0.25 days, which differed significantly among samples. White seeded sesame TMV 2, ES 12 and SVPR 1 had fairly low developmental period, ranging from 38.55 ± 0.81 to 40.60 ± 0.71 days while wheat flour recorded the developmental period of 34.85 ± 0.81 days. There was not much difference among different varieties and germplasms in the pupal period, however, it ranged from 6.95 ± 0.04 to 8.20 ± 0.03 days.

The pupa and adult gained the maximum weight when the grubs were reared on wheat flour (3.12 ± 0.65 mg/pupa and 3.81 0.73 mg/adult). In susceptible seed materials, weights ranged from 2.15 ± 0.48 to 2.25 ± 0.73 mg/pupa and 2.75 ± 0.52 to 2.98 ± 0.72 mg/adult, while in other seed materials, the range was 1.78 ± 0.77 to 1.99 ± 0.38 mg/pupa and 2.13 ± 0.51 to 2.73 ± 0.34 mg/adult.

The lowest pupation was recorded on TMV 6 (46.3%) which was significantly different from other seed materials, followed by CO 1 (53.4%), Paiyur 1 (62.7%) and TMV 3 (63.7%). The highest per cent pupation was recorded on TMV (72.7%) which was on par with ES 22 (72.1%), ES 12 (72.1%) and SI 250 (71.9%).

Adult emergence ranged from 32.5% in TMV 6 to 61.8% in ES 22. The adult emergence obtained on TMV 6 differed significantly from other seed materials. On the other hand, Paiyur 1, TMV 5, TMV 4 and TMV 1 did not differ significantly. Highest adult emergence of 81.7% was obtained on wheat flour (Table 1).

Indices for varieties and germplasms of sesame

All indices of growth and development of *T. castaneum* indicated that ES 22, TMV 2, SI 250, ES 12, TMV 5 and SVPR 1 were highly susceptible to infestation, whereas TMV 6 and CO 1 were resistant to feeding.

Howes growth index on various seed materials ranged from 0.026 and 0.047, being lowest on TMV 6 and highest on ES 22 (Table 2). Suitability index ranged from 0.686 to 1.135, and was greater than 1 on wheat flour and ES 22, while others which were less preferred by *T. castaneum* recorded less than 1.

Sex ratio

Unsuitability of grains favoured males, which outnumbered females on TMV 6 (2.10:1), CO 1 (2.00.1), TMV 1, TMV 3, TMV 4 and Paiyur 1 (1.50:1), SVPR (1.30:1), TMV 5 and ES 12 (1.12:1), while in others females dominated (Table 2).

Losses and viability of seeds

The highest loss in weight (12.9, 12.8 and 12.8%) was sustained by white seeded sesame TMV 2, SVPR 1 and ES 12 while the lowest (5.2%) was recorded on TMV 6 which was significantly different from other seed materials. After completion of the first generation, the viability of seeds ranged from 41.7 to 66.7% on various varieties and germplasms of sesame (Table 3).

Discussion

T. castaneum showed a preference for ES 22, TMV 2, ES 12 and SI 250 over other seed materials of sesame for feeding. The varieties and germplasms of sesame showing short developmental period were preferred and are therefore more likely to be infested under normal conditions of storage. TMV 6 was resistant to infestation with the highest developmental period of 57.10 ± 0.25 days. Maximum development period was also recorded on N 32 (54.2 days) and shortest of 42.6 days on JT 7 (Sachan and Chandel 1991). The insects reared on groundnut germplasm took less time than those reared on sesame (Singh 1985).

Adult emergence was hindered in resistant varieties, TMV 6 and CO 1, which were significantly different from each other. Appreciably better adult emergence was recorded on sesame, 68.99% on whole seeds and 88.47% on crushed seeds (Urs and Mookherjee 1966) In the present study, it seems probable that the sesame testa provided the main resistance to infestation in the apparently resistant varieties TMV 6 and CO 1. Williams and Mills (1980) also reported that undamaged pericarp is a factor in resistance of sorghum varieties to damage by weevils.

Weight of the adult ranged from 2.13 ± 0.51 to 2.98 ± 0.72 mg/adult in different sesame seed materials. In contrast to this, Sachan and Chandel (1991) and Singh (1985) recorded the maximum adult weight of 0.51 mg/adult and 0.51 mg/adult on JT 7 and PT 303 respectively.

The values of Howes growth index ranged from 0.026 to 0.046 and was the highest in wheat flour (0.055). The present study is supported by Sachan and Chandel (1991) who recorded Howes growth index, ranging from 0.048 to 0.085 with 0.658 in standard Murag–1. The values for the suitability index agree with the findings of Sachan and Chandel (1991) who recorded maximum and minimum of 1.094 and 0.777 for C 6 and TMV 3 respectively, whereas, in the present study, it was 1.135 and 0.686.

Interestingly, the suitability index had an influence on the sex ratio and the susceptible host favoured females, which outnumbered males. The resistant varieties TMV 6 and CO 1 were found favourable to male, recording 2.10:1 and 2.00:1 male:female. This result supports the findings of Sachan and Chandel (1991) who recorded more numbers of males on N 32 and TMV 3 and an equal number of males and females on TC 25, whereas in the present study, no variety or germplasm recorded a balanced sex ratio.

White seeded sesame TMV 2, ES 12 and SVPR 1 were highly susceptible to infestation when compared to brown or black seed, recording 12.9, 12.8 and 12.8% weight loss respectively (Table 3). White seeded varieties are rich in oil content which in turn become more susceptible to the attack of

Table 1. Growth parameters of *T. castaneum* on sesame varieties and germplasms

	Larval period (days)	Pupal period (days)	Weight/pupa (mg)	Pupa (%)	Average developmental period (days)	Weight /adult (days)	Adult (%)
TMV 1	31.97±0.85	7.60±0.04	1.81±0.50	(53.70)cde	44.65±0.31	2.58±0.55	(40.69)d
TMV 2	26.10±1.18	6.90±0.08	2.15±0.48	(58.52)b	38.55±0.81	2.86±0.81	(48.85)c
TMV 3	31.76±0.93	7.65±0.03	1.99±0.38	(52.95)e	44.60±0.28	2.55±0.75	(39.67)de
TMV 4	32.05±0.40	7.45±0.06	1.93±0.48	(54.95)cd	45.95±0.97	2.53±0.84	(40.51)d
TMV 5	32.15±0.88	7.60±0.08	1.95±0.75	(53.35)de	44.80±0.83	2.73±0.34	(40.68)d
TMV 6	43.45±0.38	8.20±0.03	1.78±0.77	(42.88)g	57.10±0.25	2.13±0.51	(34.76)f
CO 1	41.00±0.73	7.70±0.05	1.81±0.81	(46.95)f	53.70±0.89	2.34±0.78	(37.34)e
Paiyur 1	34.77±0.51	7.70±0.05	1.88±0.73	(52.36)e	47.30±0.55	2.65±0.58	(40.69)d
SVPR 1	28.76±1.31	7.15±0.08	2.01±0.70	(55.49)c	40.60±0.71	2.85±0.63	(48.65)c
ES 22	25.70±0.44	6.95±0.04	2.24±0.51	(58.08)b	37.90±0.59	2.95±0.53	(51.83)b
ES 12	26.60±0.97	7.20±0.03	2.25±0.73	(58.12)b	38.60±0.75	2.75±0.52	(50.30)bc
SI 250	26.85±1.36	6.90±0.05	2.23±0.81	(57.99)b	38.75±0.33	2.98±0.72	(50.22)bc
Wheat flour	22.15±0.57	6.45±0.08	3.12±0.65	(67.11)a	34.85±0.81	3.81±0.73	(64.78)a
CD (P=0.05)				1.87**			2.33**

Notes: Figures in parentheses are arcsin values.
Means followed by same letters are not significantly different (P=0.05).
** Significant at 5 and 1% level.

Table 2. Indices for the development of *T. castaneum* on sesame varieties and germplasms.

Variety/ germplasm	Larval-pupal index[a]	Pupal weight index[b]	Adult weight[c]	Adult emergence[d]	Developmental index[e]	General growth index[f]	Howe's growth index[g]	Suitability index[h]	Sex ratio Male:Female
TMV 1	0.723	0.580	0.677	0.52	1.281	2.030	0.036	0.835	1.50:1
TMV 2	0.867	0.689	0.751	0.69	1.106	2.785	0.045	0.990	0.95:1
TMV 3	0.725	0.638	0.669	0.50	1.279	2.006	0.036	0.836	1.50:1
TMV 4	0.724	0.619	0.664	0.52	1.319	2.090	0.035	0.853	1.50:1
TMV 5	0.719	0.625	0.717	0.52	1.286	2.003	0.036	0.964	1.25:1
TMV 6	0.554	0.571	0.559	0.39	1.638	1.066	0.026	0.686	2.10:1
Co 1	0.685	0.580	0.614	0.45	1.541	1.302	0.029	0.746	2.00:1
Paiyur 1	0.673	0.603	0.696	0.52	1.357	1.803	0.034	0.812	1.50:1
SVPR 1	0.796	0.644	0.748	0.69	1.165	2.361	0.043	0.921	1.30:1
ES 22	0.876	0.718	0.774	0.76	1.088	2.805	0.047	1.135	0.77:1
ES 12	0.846	0.721	0.721	0.72	1.108	2.711	0.046	0.972	1.12:1
SI 250	0.847	0.715	0.782	0.72	1.112	2.678	0.046	0.985	0.99:1
Wheat flour	–	–	–	–	–	3.828	0.055	1.941	0.75:1

[a]Larval pupal Index — Average larval period on wheat flour (days) / Average larval period on test material (days) × Average pupal period on wheat flour (days) / Average pupal period on test material (days)

[b]Pupal weight index — Average pupal weight on test material (mg) / Average pupal weight on wheat flour (mg)

[c]Adult weight index — Average adult weight on test material (mg) / Average adult weight on wheat flour (mg)

[d]Adult emergence index — Adult emergence on test material (%) / Adult emergence on wheat flour(%)

[e]Developmental index — Average developmental period on test material (days) / Average developmental period on wheat flour(days)

[f]General growth index — Population(%) / Average larval period (days)

[g]Howe's growth index — log adult emergence (%) / Average developmental period (days)

[h]Suitability index — Sum of all indices on test material / 7

Table 3. Reaction of sesame varieties and germplasms to *T. castaneum*

Variety/germplasm	Weight loss (%)	Germination (%)
TMV 1	10.9 (19.32)e	50.9 (45.51)de
TMV 2	12.9 (21.01)g	43.2 (41.07)gh
TMV 3	11.8 (20.09)f	50.9 (45.52)de
TMV 4	10.2 (18.58)d	50.7 (45.39)e
TMV 5	8.2 (16.64)c	52.6 (46.47)d
TMV 6	5.2 (13.12)a	66.7 (54.76)a
CO 1	8.0 (16.43)c	61.9 (51.89)b
Paiyur 1	7.1 (15.39)b	60.4 (48.36)c
SVPR 1	12.8 (20.92)g	47.8 (43.74)f
ES 22	13.5 (21.52)f	42.1 (40.57)g
ES 12	12.8 (20.92)g	41.7 (40.19)gh
SI 250	12.2 (20.40)f	40.6 (39.55)h
CD (P = 0.05)	0.41**	0.93**

Notes: Figures in parentheses are arcsin values.
Means followed by same letters are not significantly different (P=0.05).
**Significant at 5 and 1% level..

T. castaneum (Directorate of Oilseeds Research 1988). Germination of the seeds was reduced considerably due to the destruction of the germ portion of seeds. The viability of different varieties and germplasms ranged from 41.7 to 66.7%.

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