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The Rate of Natural Increase of Red Spider Mite When Reared on Okra

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ABSTRACT

The red spider mite, *Tatranychus macfarlanei* Baker and Pritchard hitherto recorded as a minor pest, is now on the verge of acquiring a pest status inflicting appreciable damage to vegatable and fiber crops in South and Central Gujarat. The rate or multiplication of *T. macfarlanei* was studied when reared on okra leaves under laboratory conditions at 29.67°C average temperature and 87.30 % average relative humidity. The maximum female birth (mx = 6.18) was on 11th day of pivotal age. Under a given set of conditions and food supply, its population was able to multiply on leaves. A Ro-net reproductive rate of 30.74 female/female/generation in a generation time of 14.02 days was observed. The intnisic rate of natural increase (rm) was 0.2443 female/female/day. In the stable age-distribution, 93 % contribution was made by immature stages including egg, larva, protonymph and deutonymph.

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INTRODUCTION

The red spider mite, *Tetranychus macfarlanei* Baker and Pritchard, a little known species has now assumed a greater importance, causing appreciable damage to okra, brinjal and cotton in South and Central Gujarat (Jose and Shah, 1989; Rai *et al*,1991). There are a few reports on host range of this mite in India and abroad (Gupta, 1985). It was observed abundant on okra during summer, 1989. It generally prefers the lower side of the leaf. Feeding by this mite results in the appearance of chlorotic spots which merge to form bigger patches. Studies on its biology and development have been reported (Jose and Shah, 1989b), but, no information is available on the aspects of the reproductive potential of this mite pest. The construction of life table is vital to the description and understanding of the population dynamics of species. This studies also determine the contribution of various stages of the pest in population growth/trend.

The present contribution deals with the rate of multiplication in the population of *T. macfarlanei* when reared on okra host.

MATERIALS AND METHODS

The initial culture of *T. Macfarlanei* was started by collecting a large number of mites in April, 1989, from okra fields around the Agriculture Research Farm of Gujarat Agricultural University, Navsari and reared

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continuously in laboratory to obtain pure mass culture and constant supply of materials for different studies. To construct life fecundity tables, ten colonies each of six newly moulted females and three new males obtained from stock culture were released on okra leaves. Next morning, the number of eggs laid were counted and marked for subsequent development and these adults were removed from the leaf. After hatching, all the larvae were reared individually on okra leaf bit (2 x 2 cm). Each leaf bit was placed on an absorbent 7 x 5 cm filter paper cushioned with a 8 x 6 x 0.4 cm pad of cotton in petri-dish (15 cm diameter and 1 cm height). A thin layer of lincline was applied peripherally to confine the mite to the leaf bits. The cotton and ansorbent were wet daily with water to maintain the leaf bits in turgid condition. The leaf bits were replaced every alternate day to avoid leaf deterioration and consequent poor nutrition. Observations on hatching, larval, nymphal and adult development and age-specific mortality in larvae, protonymphs, deutonymphs and adults were made twice daily. For determining age-specific fecundity (mx), all the adults (female) emerging on a particular day were transferred to fresh okra leaf bit and reared individually for egg laying to determine the age-specific fecundity. Each female was provided with a male for mating. The average fecundity on subsequent days was noted every day untill all the females died. As the sex ratio (male : female) was 1 : 6.5 (based on 150 adults), the number of female births (mx) at each age interval was worked out keeping in view this ratio. Parthenogenetically, all females invariably gave rise to male progeny.

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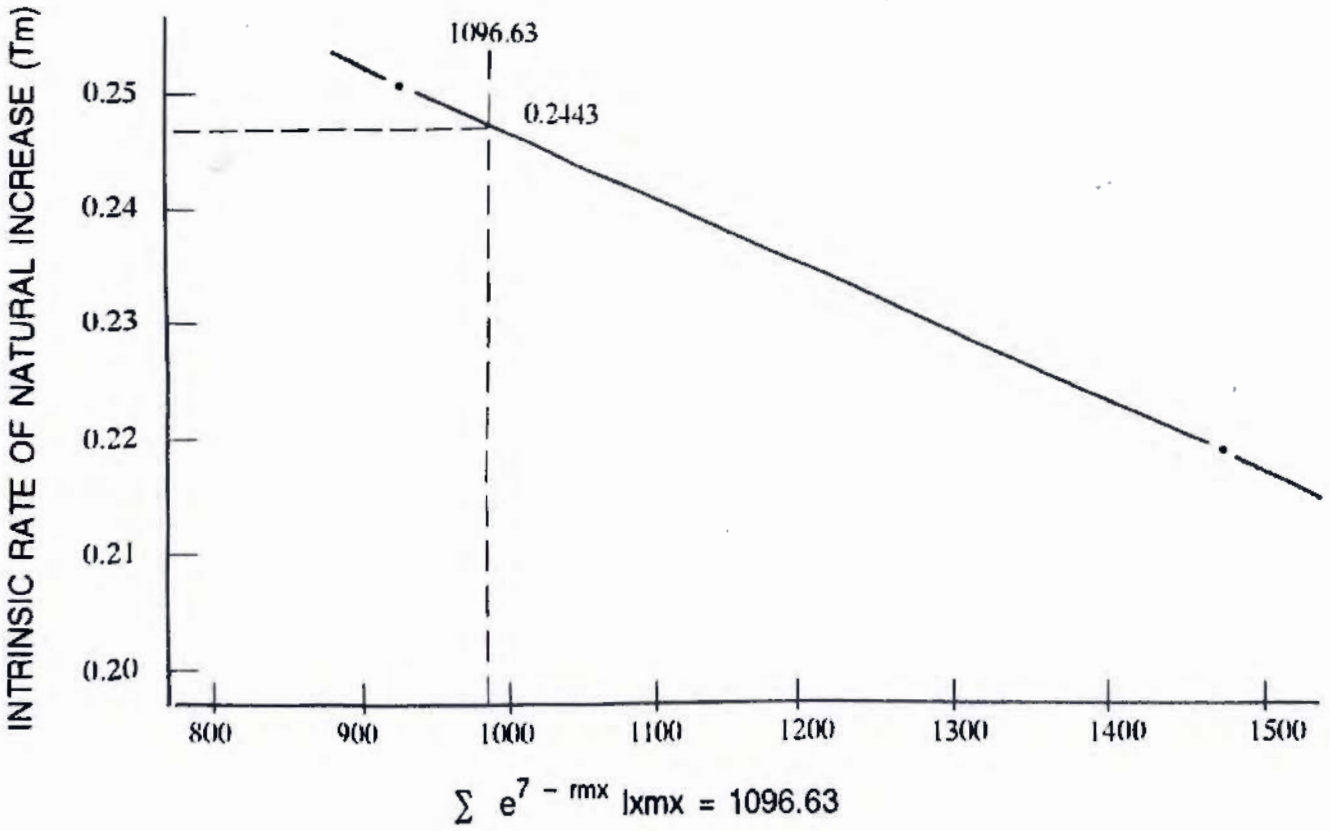

Fig. 1. : Determination of the intrinsic rate of increase of Tetranychus macfarlanei on okra.

Birch(1948), elaborated by Howe (1953) and Atwal and Bains (1974) were used for construction of life table. The values of X (pivotal age in days), 1x (survival of females at different age intervals) and mx (number of female progeny per famale) were claculated from the data in life-table. The number of individuals surviving at each age-interval was recorded and also the mean number of female offspring produced at each age interval was calculated. The intrinsic rate of increase (rm), net reproductive rate (Ro) and mean generation time (T) were the basic population parameters used to assess the population growth in the laboratory. The true value of rm was calculated by taking two trial values arbitrarily selected on either side of it, differing in second decimal place, by interpolation method (Birch, 1948; Watson, 1964). Tables were then constructed with the column x and 1 x m x for each trial rm. The two trial values of $\sum e^{7-rmx}$. 1 x m x were then ploted on the horizontal a x i x against their respective arbitrary rm's on the vertical axis with line drawn from the desired value of $\sum e^{7-rmx}$. 1 x m x = 1096.63. The point of intersection gave the value of true rm accurate to the four decimal places (Fig.1). The stable age-distribution (% distribution of various age groups) was worked out with the knowledge of rm and the age-specific mortality of the imature as well as mature stages when grown in limited space. All the observations on growth parameters for construction of life-fecundity table were taken under laboratory condition at 29.67°C average temperature and 87.30 per cent average relative humidity during July-August.

TABLE 1

Life table and age-specific fecundity for *Tetranychus macfarlanei* **on okra.**

Pivotal age (days) (x)	*Life table for female birth (lx)*	*Age schedule for female birth*		
		mx	*lxmx*	*Lxmx*
1.	*2.*	*3.*	*4.*	*5.*
0-9	0.6875	Immature stages		
10	0.6875	2.180	1.498	14.987
11	0.6875	6.180	4.248	46.736
12	0.6875	4.727	3.249	38.997
13	0.6875	4.818	3.312	43.060
14	0.6875	4.273	2.937	41.127
15	0.6875	3.364	2.312	34.691
16	0.6875	3.364	2.312	37.004
17	0.6875	1.818	1.249	21.247
18	0.6875	0.636	0.437	7.870
19	0.6875	0.273	0.187	3.566

1.	2.	3.	4.	5.
20	0.5625	3.111	1.749	34.998
21	0.5625	2.445	1.375	28.881
22	0.5625	4.222	2.374	52.247
23	0.4375	1.429	0.625	14.379
24	0.4375	0.429	0.187	4.504
25	0.3125	1.200	0.375	9.375
26	0.2500	4.250	1.062	27.625
27	0.1875	3.000	0.562	15.187
28	0.1875	2.000	0.375	10.500
29	0.1875	1.000	0.187	5.437
30	0.1875	0.667	0.125	3.751
31	0.1875	0.000	0.000	0.000
			Ro = Σxmx = 30.737	Σxmx.x = 496.169

RESULTS AND DISCUSSION

Both sexes of *T. macfarlanei* consisted of egg, larva, protonymph, deutonymph and adult. At the end of larval and each nymphal instar, there was short quiscent phase in which mites anchored and moulted to the succeeding stage. Usually, this behaviour is normal and common to almost all tetranychids.

The maximum durations of egg, larva, protonymph and deutonymph were 4,2,2 and 1 days respectively. Observations on pre-oviposition, oviposition and fecundity were also recorded. Data on the survival of the female progeny at egg x are presented in table 1. The survival of the immature stages (lx) from egg to the adult stage on okra leaf was 68.75 per cent. The maximum contribution (mx=6.18 female-births) in the life cycle was made by female on 11th day of pivotal age i.e. on 2nd day of adult emergence. The survival of females declined from 10th day after emergence as an adult i.e. on 19th day of the pivotal age (lx = 0.6250). The net reproductive rate (RO) representing the total female births were 30.737. Thus, the population of *T.macfarlanei* would be able to multiply 30.737 times per generation on okra leaves. The results obtained intrinsic rate of increase (rm) and finite rate (λ) and mean generation time are presented in table 2 and Fig. 1. The value for intrinsic rate of natural increase was 0.2122 female/female/day. The corrected innate capacity for increase in numbers (rm) was calculated by using the formula, $\Sigma\ e^{7\text{-}rmx}$. lxmx = 1096.63. The two trial values of 1493.38 and 1019.24 were plotted on horizontal axis against their respective arbitrary rm values 0.22 and 0.25 on vertical axis and the corrected rm was calculated as 0.2443 female/female/day by interpolation method (Fig.1.). It is evident that the corrected innate capacity for increase in numbers (rm) was 0.2443 female per female per day and with

TABLE 2

Mean length of generation, innate capacity for increase in number of *Tetranychus macfarlanei* on okra leaves.

Population growth statistics	
Mean length of generation $T_c = \frac{\Sigma l x mx.X}{Ro}$	16.14 days
Innate capacity for increase in number $r_c = \frac{\log_e Ro}{Tc}$	0.2122 female/female/day
Arbitrary rm 0.22 and 0.25 corrected rm Σe^{7-rmx}. lxmx=1096.63	0.2443 female/female/day
Corrected generation time $T = \frac{\log_e Ro}{rm}$	14.02 days
Finite rate of increase in number $\lambda = \text{antilog}_e rm$	1.2767 female/female/days
Weekly multiplication of population	5.62
Doubling time	2.84 days
Hypothatical F_2 female	944.76

a daily finite rate of increase (λ) 1.2767 female per female per day, the population would multiply 5.62 times every week under the given set of conditions on okra. The mean time required to complete one generation was 14.02 days. The hypothetical femals population in F_2 generation was 944.76. The doubling time and weekly multiplication was 2.84 days and 5.62, respectively. It could be seen from the table 3 that on reaching stable age-distribution, the population of *T. macfarlanei* in its various stages viz; egg, larva, protonymph, deutonymph and adult contributed to the tune of 75.84, 10.53, 5.64, 1.79 and 6.20 per cent. Thus, more than 93% contribution was made by immature stages. In literature, no information is avaliable on these aspects in case of *T. macfarlanei*. There are a few reports available on life-table studies for other Tetranychus species like *T. urticae* (Laing, 1969; Shih *et. al.*, 1976; Ho & Lo, 1979) and *T. cinnabarinus* (Shih & Shieh, 1978) and *T. neocaledonichus* (Gutierrez & Chazeau, 1972); Ho & Lo,

TABLE 3

Stable age-distribution of *Tetranychus macfarlanei* on okra leaves (rm = 0.2443).

Pivotal age in days (X)	*lx*	e^{-rm} *(x +1)*	*L x* e^{-rm} *(x + 1)*	*% distribution*	*% contribution*
0	1	0.7832	0.7832	23.443	
1	1	0.6134	0.6134	18.361	
2	1	0.4805	0.4805	14.383	
3	0.9761	0.3763	0.3763	11.264	
4	0.9512	0.2947	0.2804	8.393	75.84 eggs
5	0.8837	0.2308	0.2040	6.106	
6	0.8175	0.1808	0.1478	4.424	10.53 larva
7	0.7750	0.1416	0.1097	3.284	
8	0.7100	0.1109	0.0787	2.356	5.64 protonymph
9	0.6875	0.0868	0.0597	1.787	1.787 Deutonymph
10	0.6875	0.0680	0.0467	1.398	
11	0.6875	0.0533	0.0366	1.096	
12	0.6875	0.0417	0.0287	0.859	
13	0.6875	0.0327	0.0224	0.670	
14	0.6875	0.0256	0.0176	0.527	
15	0.6875	0.0200	0.0137	0.410	
16	0.6875	0.0157	0.0108	0.323	
17	0.6875	0.0123	0.0084	0.253	6.20 aduts
18	0.6875	0.0096	0.0062	0.188	
19	0.6250	0.0075	0.0047	0.141	
20	0.5625	0.0059	0.0033	0.099	
21	0.5625	0.0046	0.0026	0.078	
22	0.5000	0.0036	0.0018	0.054	
23	0.4375	0.0028	0.0012	0.037	
24	0.3750	0.0022	0.0008	0.025	
25	0.2812	0.0017	0.0004	0.015	
26	0.2187	0.0013	0.0003	0.009	
27	0.1875	0.0010	0.0002	0.006	
28	0.1875	0.0008	0.0001	0.004	
29	0.1875	0.0006	0.0001	0.003	
30	0.1875	0.0005	0.0009	0.002	
31	0.0937	0.0004	0.0004	0.001	

(1979) Laing (1969) found almost similar value of Ro as 30.93 for *T. Urticae* at 15-28°C, but he found lower rm value (0.143) and higher mean genaration time (24.0 days) than that recorded in present study (rm 0.2443 and T = 14.02 days). In this context, as per Birch (1948), the comparison of two or more population by means of their net reproductive rates may be quite misleading unless the mean length of generation are the same. Two or more populations may have the same reproductive rate but their intrinsic rate of increase may be quite different because of different lengths in generation time.

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