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Construction of life table parameters of cigarette beetle, *Lasioderma serricorne* on different varieties of dry turmeric

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Abstract
An age specific, life and fertility tables of *Lasioderma serricorne* on different varieties of turmeric (Duggirala, Tekurpet, Mydukur local and Kasturi) were constructed and various life parameters were calculated at the dept. of Entomology, S.V. Agricultural college, Tirupati, at prevailing room temperature of 30 ± 2° C and 65 ± 5 % RH. Among turmeric varieties, the insect when reared on Tekurpet showed a high survival rate, life expectancy, net reproductive rate (51.37), fecundity (58), intrinsic rate of natural increase (0.0705), low mortality rate, mean generation time (56.06) and doubling time (9.84) and was ranked as susceptible variety. Similarly, the insect when reared on Kasturi showed low survival rate, life expectancy, net reproductive rate (21.67), fecundity (42.14), intrinsic rate of natural increase (0.0432) high mortality rate, mean generation time (71.08) and doubling time (16.12) and was ranked as tolerant variety.

Keywords: age specific life table, Life and fertility table, Intrinsic rate of natural increase, life expectancy

Introduction
Cigarette beetle, *Lasioderma serricorne* (Fabricius) (Coleoptera: Anobiidae) is a serious pest of high valued stored products such as spices, condiments, tobacco *etc.* This insect pest occurs throughout the tropical and subtropical regions of the world and is known to infest and consume all stages of the product, resulting in spoilage of at least one per cent (US$ 300 million) of stored tobacco stocks annum^{-1} USDA, 1972 [21]. Although low temperature and humidity restrict its growth, yet it occurs commonly in warm buildings throughout the temperate regions Arbogast *et al*., 2003 [3]. Cigarette beetle breeds on a wide variety of commodities, including both plant and animal materials Lecato, 1978 [14] and Ashworth, 1993 [1] and is one of the several beetle pests that commonly infest warehouses and retail stores Arbogast *et al*., 2002 [2].
Turmeric, *Curcuma longa* (F: Zingiberaceae) is one of the oldest spices and had been used in India since ages. Though essential oil of turmeric is credited with interesting pesticidal properties against certain pests, it still acts as a major host for *L. serricorne*. Hegde and Awaknavar, 1994 [21] reported 7.15 per cent quantitative loss of turmeric caused by cigarette beetle after three months of storage and it increased to 22.75 per cent at six months after storage.
Life table is a representation of the survivorship of a defined population. It is also called as mortality table. Natural mortality is an important determinant of the population dynamics of a species and an understanding of mortality forces should aid development of better management strategies for insect pests. The lowest r_m value which is a part of the life table studies value indicates that the particular cultivar is relatively insusceptible compared with the other cultivars tested and this information could be used in IPM of *L. serricorne.*

Materials and Methods
The studies on the varietal influence of turmeric on life tables of Cigarette beetle, *Lasioderma serricorne* (Fabricius) were carried out at the Department of Entomology, S.V. Agricultural College, Tirupati during 2014-2015. The turmeric varieties used in the experiment were Duggirala, Tekurpet, Mydukur local and Kasturi.

Freshly emerged adults of *L. serricorne* were collected from the nucleus culture and were released into the plastic jar secured with a lid provided with grounded powder of fennel. After two days the eggs were removed from the powdered fennel with the help of camel brush and used for the estimation of the life table parameters. The experiment was conducted at room temperature 30 ± 2° C and 65 ± 5 % RH. Two types of life tables, Age-specific survival or mortality life table, life and fertility table of female were constructed for *L. serricorne* in this study by the methods suggested by Deevey 1947 [11], Morris and Miller 1954 [16].

Different varieties of dry turmeric (Duggirala, Tekurpet, Mydukur local and Kasturi) were powdered and used for studying life tables. The study was initiated with a cohort of 75 eggs which were laid in a single day. The total of 75 eggs was placed on each variety of dry turmeric in Petri plates. The newly hatched grubs were allowed to develop till pupation and adult emergence. Mortality from the hatching of eggs to emergence of adults were recorded daily. Fecundity of the female was noted daily from adult emergence to death.

Considering the ratio of females to males and the fecundity, the number of female births was calculated. Survived and dead counts for both immature and adult stages were taken on every fifth day. Based on survived and dead counts recorded, the death and survival rates (x and lx) were calculated. The adult beetles that emerged from each variety of turmeric were paired and observed regularly to record the daily egg laying and survival. Based on which per cent distribution was obtained.

The techniques for computing various life parameters and observations, for constructing the life tables were followed as specified by Birch, 1948 [5], Chaudhary and Bhattacharya, 1986 [9]. An accurate estimate of r (r_m) was calculated by Lotka-Euler equation, S (e^{-rx} lxmx) = 1. The procedure to calculate r_m from the above equation became more practical by multiplying either side of the equation with e^7 which was equal to 1096.6. Then the equation became S (e^{7-rx} lxmx) = 1096.6. Taking two trial values on either side of r_c differing in the second decimal place, the two trial e^{7-rx} lxmx were plotted on the horizontal axis against their respective r values on the vertical axis with a line drawn from the value of e^{7-rx} lxmx =1096.6. The point of intersection gave the precise value of r_m which was expressed as female progeny / female / day.

Life parameters of *Lasioderma serricorne*

Net reproductive rate (R_0) =$\sum$ lxmx

Mean Generation Time (T_c) in days = $\frac{\sum lxmx\, X}{\sum lxmx}$

Intrinsic rate of increase-appx.(r_c) (Females/female/day):$r_c = \frac{\log_e R_0}{T_c}$

Intrinsic rate of increase(r_m) (Females/female/day):
$\sum e^{7-r_m} x$ lxmx =1096.6

Corrected Generation Time (T) in days: $T = \frac{\log_e R_0}{r_m}$

Finite rate of increase (λ) (Females/female/day): λ = anti $\log_e r_m$

Doubling time (DT): $DT = \frac{\log 2}{\log \lambda}$

Weekly multiplication of population = λ^7

Annual rate of increase ARI = $(\lambda)^{365}$

Hypothetical F_2 females = R_0^2

Results and Discussion

Life table studies on *L. serricorne* on different varieties of turmeric

Results of the present study indicated that the age specific survival and duration of different stages of *L. serricorne* were different on different varieties of turmeric. The egg stages lasted for 6, 5, 6 and 7 days on Duggirala, Tekurpet, Mydukur local and Kasturi respectively. Larval stages varied significantly on different hosts. The larval stages were completed on 45th and 48th day after egg laying when reared on Tekurpet and Duggirala while they were extended up to 52nd and 68th day on Mydukur local and Kasturi respectively. Similarly, the pupal stage lasted up to the 52nd and the 57th day after egg laying on Tekurpet and Duggirala, whereas, they were completed on 61st and the 75th day on Mydukur local and Kasturi respectively. On the whole, *L. serricorne* required 52 and 57 days to emerge as adults when reared on Tekurpet and Duggirala, whereas on Mydukur local and Kasturi, they took 61 and 68 days. Per cent survival of the egg, larvae and pupa were 88, 40 and 33.33 on Duggirala, 86.66, 48 and 40 on Tekurpet, 86.66, 40 and 32 on Mydukur local and 93.33, 30.66 and 16 on Kasturi, respectively.

The life expectancy of newly deposited eggs were similar on all the varieties of turmeric that was 24.2, 23.9, 23.6 and 24.7 days on Duggirala, Tekurpet, Mydukur local and Kasturi, respectively. The computation of life table expectancy data (Table 1) clearly indicated that the life expectancy of *L. serricorne* on all the four different varieties declined gradually with the advancement of age. The morality rate of *L. serricorne* was higher at larval stages when reared on all the four varieties of turmeric and then it declined at pupal and adult stages but the mortality rate (dx, Table 1) was higher at all the stages of *L. serricorne* when reared on Kasturi when compared to the other varieties of turmeric.

From the life and fertility table of female *L. serricorne* (Table 2) given the information about fecundity (mx), net reproductive rate (R_o) and gross reproductive rate. The fecundity of *L. serricorne* reared on Tekurpet (58.0) was higher than the Duggirala (52.57) and Mydukur local (50.85). The lowest fecundity was observed when reared on Kasturi (42.14). Correspondingly, the net reproductive rate (R_o)was higher (51.37) when reared on Tekurpet as compared to Mydukur local (39.36) and Duggirala (36.09) and R_o was least when reared on Kasturi (21.67) indicating that the insect can assume status of potential pest on Tekurpet (Table 2).

The mean length of generation (T_c),was low on Tekurpet (56.06 days) as compared to Mydukur local (64.47 days) and Duggirala (60.03 days) and was the longest when reared on Kasturi (71.08) (Table 7). Innate capacity for increase (r_c), Intrinsic rate of increase (r_m) and finite rate of increase (λ) were 0.0593, 0.0595 and 1.061 females/ female/day on Duggirala, 0.070, 0.0705 and 1.073 females/female/day on Tekurpet 0.057, 0.05725 and 1.059 females/ female/day when reared on Mydukur local and 0.043, 0.0432 and 1.044 females/ female/day on Kasturi, respectively (Table 7).

The intrinsic rate of increase is the true measure of the reproductive potential of an organism Chaudhari and Nikam, 2001 [22]. The highly preferred host not only accelerates larval development but also enhances fecundity Sedlacek *et al.*, 1986 [22]. The shorter generation time (55.87) and higher intrinsic rate of increase (0.0705) shortened the population

doubling time of *L. serricone* to 9.84 days when reared on Tekurpet as compared to 11.43 days on Mydukur local and 11.71 days on Duggirala. The longer mean generation time (71.08 days) and lower intrinsic rate of increase (0.0432 females/female/day) with the longest population doubling time of *L. serricorne* to 16.12 days was observed when reared on Kasturi (Table 7). Based on the $r_m$values and doubling time (DT), the host suitability of the *L. serricorne* was assessed and recorded as Tekurpet (most suitable) followed by Mydukur local, Duggirala and Kasturi (least suitable). Accurate measure of the intrinsic rate of natural increase (r_m) was higher in all the varieties of turmeric when compared to approximate estimate of the intrinsic rate of natural increase (r_c) indicating the tendency of population to have overlapping generations Southwood, 1966 [22]. The annual rate of increase was the highest in Tekurpet followed by Duggirala, Mydukur local and Kasturi (Table 7). Thus the present study confirmed the preference of *L. serricorne* for Tekurpet as evidenced by higher R_o and r_m values and least preference of *L. serricorne* for Kasturi as evidenced by lower R_o and r_m values.

Mendes Luiz and Tella Romeu de, 1955 [17] explained that competition during the larval stage was found to be the chief factor responsible for the shortening of the mean adult life for both sexes of *L. serricorne* (F). From the above life table studies, it was evident that Kasturi was the most tolerable variety among turmeric varieties tested. But according to Lakshmi and Sudhakar, 2003 [22] chemical constituents like total ash, silica, potassium, protein and curcumin were found responsible for attributing resistance or susceptibility of turmeric cultivars of *L. serricorne.* According to them, the most tolerant variety was Kasturi for rearing of *L. serricorne* which was intune with the above findings.

Prasad and Nandagopal, 2008 [18] constructed the life table of *Caryedon serratus* (Coleoptera: Anobiidae) reared on seeds of three different hosts *viz.*, groundnut, tamarind, and Bengalgram. They reported that based on the r_m values and doubling time, the most suitable host for multiplication of *Caryedon serratus* was assessed and reported that tamarind was the most suitable host followed by groundnut and Bengalgram. The computation of life table expectancy data clearly indicated that the life expectancy of *Caryedon serratus* declined gradually with the age which was in tune with the results of present study.

In the current study, among turmeric varieties net reproductive rate was maximum on Tekurpet (51.37) followed by Mydukur local (39.36), Duggirala (36.09) and Kasturi (21.67) (Table 7). The net reproductive rate of *L. serricorne* in the present study deviates with the results of Bharathi *et al.*, 2001 [6] which was the maximum (6.5017) on FCV followed by burley (5.3963) and cigar wrapper (3.6791). This shows that *L. serricorne* prefers turmeric than FCV, burley and cigar wrapper types. At the temperature of 28 ± 1°C, the net reproduction rate (R_0) was 47.46, 42.125, 31.75, 32.625 and 6.00 female/female/day when reared on chicken stock powder (maggi), Baker's yeast, grains millo, dried ficus, and dried tobacco leaves respectively Alaa saleh, 2012 [4] which were nearly in tune with the present results. Net reproductive rate was higher (4.8595) in natu tobacco compared to chewing tobacco (3.1658) Bharathi *et al.*, 2002 [7]. The lower net reproductive on tobacco might be due to its higher Nicotine content.

In the present study intrinsic rate of increase (r_m) was 0.0595, 0.0705, 0.05725 and 0.0432 female/ female/day when reared on Duggirala, Tekurpet, Mydukur local and Kasturi respectively (Table 7). According to Alaa saleh, 2012 [4] intrinsic rate of increase (r_m) was 0.096, 0.11, 0.088, 0.087 and 0.027 female/ female/day when reared on chicken stock powder (maggi), Baker's yeast, grains millo, dried ficus, and dried tobacco leaves respectively. This Age-specific fecundity schedules reflect *L. serricorne* ability for doubling its population faster on Baker's yeast than on (powdered chicken stock (Maggi), grains milo, dried ficus and dried tobacco leaves at same temperature 28± 1 °C.

In the present study, among turmeric varieties, the doubling time of population was 11.71, 9.84, 11.43 and 16.12 days (Table 7). According to Alaa saleh, 2012 [4] the doubling time of the population (DT) was 7.22, 6.30, 7.88, 7.97 and 25.67 days when reared on chicken stock powder (maggi), Baker's yeast, grains millo, dried ficus, and dried tobacco leaves respectively. The population took 22.93 and 33.07 days to double itself in Natu and chewing tobacco respectively Bharathi *et al.*, 2002 [8]. The population took 15.63, 22.82 and 24.41 days to double itself on FCV, burley and cigar wrapper respectively Bharathi *et al.*, 2001 [6].

The ultimate aim to develop the life-table of an insect under laboratory conditions was to decide the expected life span of particular insect with its reproductive potential in a specific set of weather conditions with an abundance of space and food supply. The present study showed that the chemical composition of different varieties could have significantly influenced the development and reproduction of *L. serricorne* and the growth parameters described in the present study could be used to predict population density on different varieties of turmeric to workout a suitable management strategy.

Conclusion

Life table studies give the complete information about an insect *viz.*, survival rate, mortality rate, life expectancy, net reproductive rate, fecundity, mean generation time, doubling time and intrinsic rate of natural increase. The intrinsic rate of increase is the true measure of the reproductive potential of an organism. By using all the above life parameters, host suitability can be assessed. The insect with a high survival rate, life expectancy, net reproductive rate, the fecundity, intrinsic rate of natural increase and with a low mortality rate, mean generation time and doubling time when reared on a particular variety can assessed as tolerant variety. Similarly, the insect with a low survival rate, life expectancy, net reproductive rate, fecundity, intrinsic rate of natural increase and with high a mortality rate, mean generation time and doubling time when reared on a particular variety can assessed as a susceptible variety. From the above findings, among turmeric varieties it can be assessed that Kasturi was most tolerant variety.

Table 1: Age specific survival of *L. serricorne* on different varieties of turmeric

Treatments	Age interval	Deaths	Surviving	Lx	Nx	dx	qx	Tx	ex	ex in days
Duggirala	0-6 (E)	9	75	1.00	1000	120.00	0.12	4026.67	4.03	24.2
	6-17 (L)	18	66	0.88	880.00	240.00	0.27	3026.67	3.44	37.8
	17-27(L)	11	48	0.64	640.00	146.67	0.23	2146.67	3.35	33.5
	28-48(L)	7	37	0.49	493.33	93.33	0.19	1506.67	3.05	61.1
	49-57(P)	5	30	0.40	400.00	66.67	0.17	1013.33	2.53	20.3

	58-72(A)	4	25	0.33	333.33	53.33	0.16	613.334	1.84	25.8
	72-80(A)	0	21	0.28	280.00	280.00	1.00	280.00	1.00	8.0
Tekurpet	0-5 (E)	10	75	1.00	1000	133.33	0.13	4773.33	4.77	23.9
	6-15 (L)	8	65	0.87	866.67	106.67	0.12	3773.33	4.35	39.2
	16-27(L)	12	57	0.76	760.00	160.00	0.21	2906.67	3.82	42.1
	28-45(L)	9	45	0.60	600.00	120.00	0.20	2146.67	3.58	60.8
	46-52(P)	6	36	0.48	480.00	80.00	0.17	1546.67	3.22	19.3
	53-62(A)	5	30	0.40	400.00	66.67	0.17	1066.67	2.67	24.0
	62-70(A)	0	25	0.33	333.33	0.00	0.00	666.67	2.00	16.0
	70-80(A)	0	25	0.33	333.33	333.33	1.00	333.33	1.00	10.0
Mydukur local	0-6 (E)	10	75	1.00	1000.0	133.33	0.13	3933.33	3.93	23.6
	7-18 (L)	20	65	0.87	866.67	266.67	0.31	2933.33	3.38	37.2
	19-30(L)	8	45	0.60	600.00	106.67	0.18	2066.67	3.44	37.9
	31-52(L)	7	37	0.49	493.33	93.33	0.19	1466.67	2.97	62.4
	53-61(P)	6	30	0.40	400.00	80.00	0.20	973.33	2.43	19.5
	62-75(A)	5	24	0.32	320.00	66.67	0.21	573.33	1.79	23.3
	76-80(A)	0	19	0.25	253.33	253.33	1.00	253.33	1.00	4.0
Kasturi	0-7 (E)	5	75	1.00	1000.0	66.67	0.07	3533.33	3.53	24.7
	8-22 (L)	20	70	0.93	933.33	266.67	0.29	2533.33	2.71	38.0
	23-42(L)	15	50	0.67	666.67	200.00	0.30	1600.00	2.40	45.6
	43-68(L)	12	35	0.47	466.67	160.00	0.34	933.33	2.00	50.0
	69-75(P)	11	23	0.31	306.67	146.67	0.48	466.67	1.52	9.1
	76-90(A)	12	12	0.16	160.00	160.00	1.00	160.00	1.00	14.0

Lx= proportion alive at the beginning of age interval; nx=Number alive at the beginning of age interval; dx=Number dying during age interval; qx= Mortality rate during age interval (qx=dx/nx); ex= Expectation of further life of an individual of age x; E=egg stage; L=larval stages; P=pupal stages and A=adult stages

Table 2: Life and fertility table of female *L. serricorne* on different varieties of turmeric

Treatments	Age in days	No of individuals in age class	Survival rate (lx)	Fecundity (mx)	Net reproductive rate (lxmx)	Lxmx.X	Percent contribution
Duggirala	58.5	14	0.19	50	9.33	546.00	25.86
	59.5	12	0.16	52	8.32	495.04	23.05
	60.5	10	0.13	53	7.07	427.53	19.58
	61.5	7	0.09	52	4.85	298.48	13.45
	62.5	5	0.07	55	3.67	229.17	10.16
	63.5	3	0.04	54	2.16	137.16	5.99
	64.5	1	0.01	52	0.69	44.72	1.92
	Total			Mean=52.57	Total=36.09	Total=2178.1	
Tekurpet	53.5	16	0.21	60.00	12.80	684.80	24.92
	54.5	14	0.19	58.00	10.83	590.05	21.07
	56.5	11	0.15	59.00	8.65	488.91	16.84
	57.5	10	0.13	58.00	7.73	444.67	15.05
	58.5	8	0.11	57.00	6.08	355.68	11.83
	59.5	5	0.07	56.00	3.73	222.13	7.27
	60.5	2	0.03	58.00	1.55	93.57	3.01
				Mean=58	Total=51.37	Total=2879.82	
Mydukur local	62.5	14	0.19	50.00	9.33	583.33	23.71
	63.5	13	0.17	52.00	9.01	572.35	22.90
	64.5	11	0.15	49.00	7.19	463.54	18.26
	65.5	9	0.12	53.00	6.36	416.58	16.16
	66.5	5	0.07	52.00	3.47	230.53	8.81
	67.5	4	0.05	50.00	2.67	180.00	6.78
	68.5	2	0.03	50.00	1.33	91.33	3.39
				Mean=50.85	Total=39.36	Total=2537.67	
Kasturi	69.5	11	0.15	42.00	6.16	428.12	28.43
	70.5	9	0.12	45.00	5.40	380.70	24.92
	71.5	8	0.11	43.00	4.59	327.95	21.17
	72.5	5	0.07	40.00	2.67	193.33	12.31
	73.5	4	0.05	43.00	2.29	168.56	10.58
	74.5	1	0.01	42.00	0.56	41.72	2.58
	75.5	0	0.00	40.00	0.00	0.00	0.00
				Mean=42.14	Total=21.67	Total=1540.38	

Table 3: Determination of intrinsic rate of natural increase (r_m) of *L.serricorne* reared on Duggirala

X	lxmx	rx(r=0.059)	7-rx	e7-rx	e^{7-rx} lxmx	rx(r=0.062)	7-rx	e7-rx	e^{7-rx} lxmx
58.5	9.33	3.45	3.55	34.76114	324.44	3.627	3.373	29.16589	272.215
59.5	8.32	3.51	3.49	32.76956	272.64	3.689	3.311	27.41252	228.0722
60.5	7.07	3.57	3.43	30.89208	218.30	3.751	3.249	25.76456	182.0696
61.5	4.85	3.63	3.37	29.12218	141.34	3.813	3.187	24.21567	117.5267
62.5	3.67	3.69	3.31	27.45367	100.66	3.875	3.125	22.7599	83.45295
63.5	2.16	3.75	3.25	25.88076	55.90	3.937	3.063	21.39164	46.20593

64.5	0.69	3.81	3.19	24.39797	16.92	3.999	3.001	20.10563	13.93991
					1130.21				943.4823

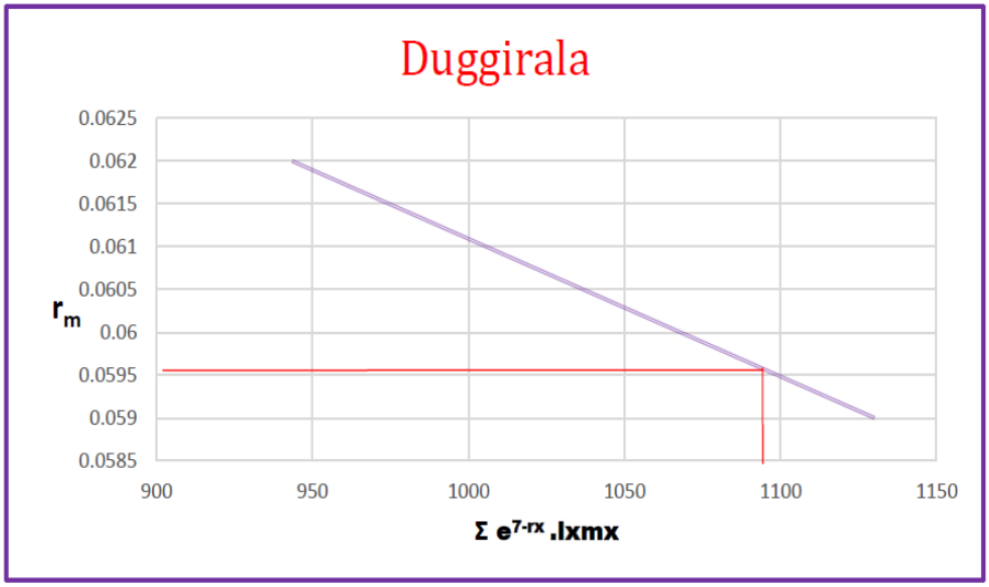

Fig 1

Table 4: Determination of intrinsic rate of natural increase (r_m) of *L.serricorne* reared on Tekurpet

x	Lxmx	rx(r=0.070)	7-rx	e7-rx	e^{7-rx} lxmx	rx(r=0.073)	7-rx	e7-rx	e^{7-rx} lxmx
53.5	12.80	3.75	3.26	25.91961	331.77	3.9055	3.0945	22.0762	282.5753
54.5	10.83	3.82	3.19	24.16729	261.65	3.9785	3.0215	20.52205	222.1854
56.5	8.65	3.96	3.05	21.01003	181.81	4.1245	2.8755	17.73429	153.4607
57.5	7.73	4.03	2.98	19.58962	151.49	4.1975	2.8025	16.48581	127.4903
58.5	6.08	4.10	2.91	18.26524	111.05	4.2705	2.7295	15.32522	93.17735
59.5	3.73	4.17	2.84	17.0304	63.58	4.3435	2.6565	14.24634	53.18633
60.5	1.55	4.24	2.77	15.87904	24.56	4.4165	2.5835	13.24341	20.48314
					1125.91				952.5585

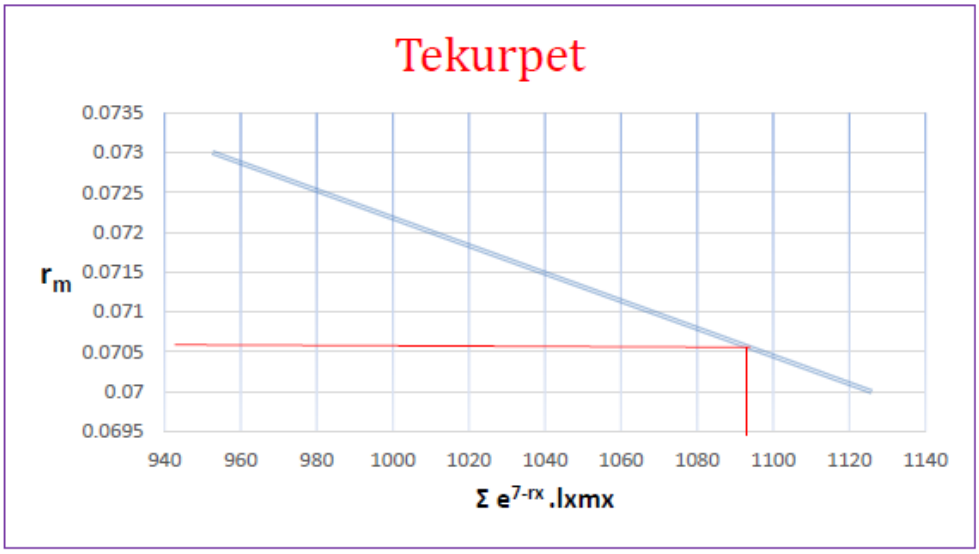

Fig 2

Table 5: Determination of intrinsic rate of natural increase (r_m) of *L.serricorne* reared on Mydukur local

X	lxmx	rx(r=0.057)	7-rx	e7-rx	e^{7-rx} lxmx	rx(r=0.060)	7-rx	e7-rx	e^{7-rx} lxmx
62.5	9.33	3.5625	3.43	31.10909	290.3515	3.75	3.25	25.79	240.7098
63.5	9.01	3.6195	3.38	29.38546	264.8609	3.81	3.19	24.28	218.9197
64.5	7.19	3.6765	3.32	27.75733	199.4827	3.87	3.13	22.87	164.3877
65.5	6.36	3.7335	3.26	26.21941	166.7555	3.93	3.07	21.54	137.0065
66.5	3.46	3.7905	3.20	24.7667	85.85789	3.99	3.01	20.28	70.32965
67.5	2.66	3.8475	3.15	23.39448	62.38527	4.05	2.95	19.10	50.94921
68.5	1.33	3.9045	3.09	22.09828	29.46438	4.11	2.89	17.99	23.99108
					1099.158				906.2936

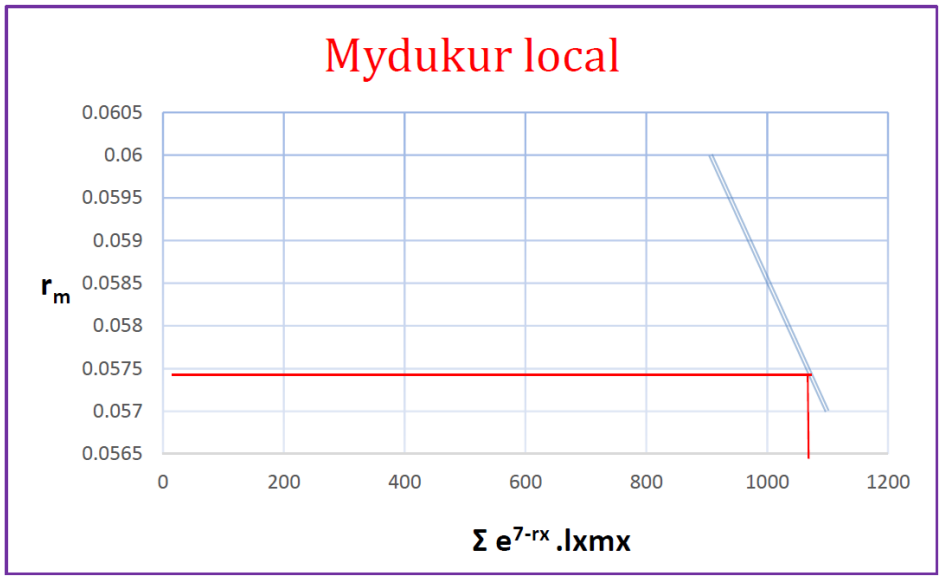

Fig 3

Table 6: Determination of intrinsic rate of natural increase (r_m) of *L.serricorne* reared on Kasturi

X	lxmx	rx(r=0.043)	7-rx	e7-rx	e^{7-rx} lxmx	rx(r=0.045)	7-rx	e7-rx	e^{7-rx} lxmx
69.5	6.16	2.9885	4.0115	55.22965	340.2147	3.1275	3.8725	48.06239	296.0643
70.5	5.40	3.0315	3.9685	52.90511	285.6876	3.1725	3.8275	45.94753	248.1166
71.5	4.58	3.0745	3.9255	50.67841	232.445	3.2175	3.7825	43.92572	201.4726
72.5	2.66	3.1175	3.8825	48.54543	129.4545	3.2625	3.7375	41.99288	111.981
73.5	2.29	3.1605	3.8395	46.50222	106.6451	3.3075	3.6925	40.14508	92.06606
74.5	0.56	3.2035	3.7965	44.545	24.9452	3.3525	3.6475	38.3786	21.49202
75.5	0.00	3.2465	3.7535	42.67017	0	3.3975	3.6025	36.68984	0
					1119.392				971.1927

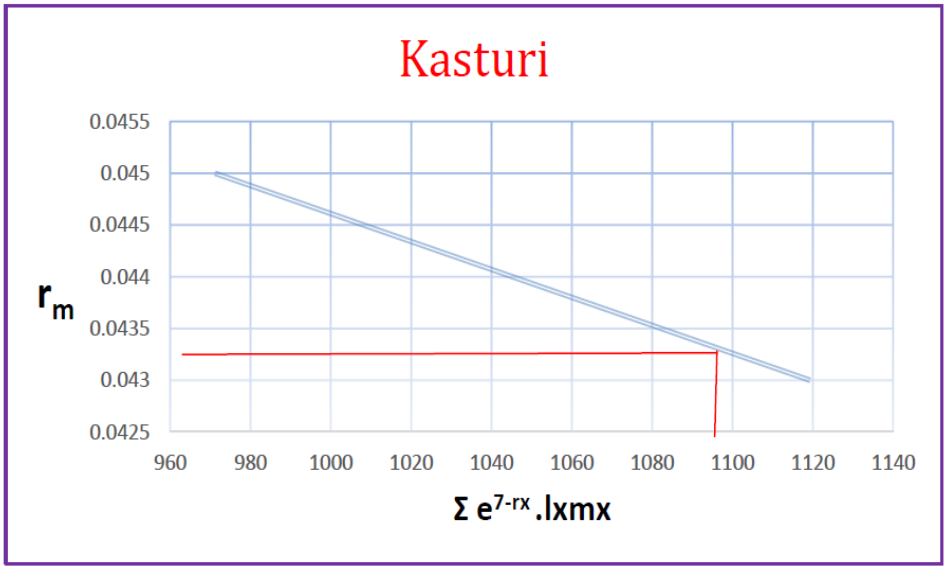

Fig 4

Taking two trial values on either side of r_c differing in the second decimal place, the two trial e^{7-rx} lxmx were plotted on the horizontal axis against their respective rvalues on the vertical axis with a line drawn from the value of e^{7-rx} lxmx =1096.6. The point of intersection gave the precise value of r_m which was expressed as female progeny / female / day.

Table 7: Life parameters of *L. serricorne* when reared on different varieties of turmeric

Life parameters	Duggirala	Tekurpet	Mydukur local	Kasturi
Net reproductive rate (R_o)	36.09	51.37	39.36	21.67
Mean generation time ($T_c = \sum lxmx.X/ R_o$)	60.35	56.06	64.47	71.08
$\log_e R_o$	3.586	3.939	3.6727	3.0759
Intrinsic rate of increase. approx (r_c)	0.059	0.070	0.057	0.043
Intrinsic rate of increase (r_m)	0.0595	0.0705	0.05725	0.0432
Corrected Generation Time($T= \log_e R_o/ r_m$)	60.27	55.87	64.15	71.20
Finite rate of increase(λ = Anti $\log_e r_m$)	1.061	1.073	1.059	1.044

$\log_e 2$	0.693	0.693	0.693	0.693
$\log_e \lambda$	0.0592	0.0704	0.06062	0.043
Doubling Time($DT = \log_e 2 / \log_e \lambda$)	11.71	9.84	11.43	16.12
Weekly multiplication of population (λ^7)	1.52	1.64	1.49	1.35
Annual Rate of Increase($ARI = \lambda^{365}$)	269.73×10^7	149.55×10^9	118.05×10^7	0.67×10^7
Hypothetical F_2 females (R_0^2)	1302.49	2638.88	1549.21	469.59

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