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Field life table of white grub/Scarabaeidaes on groundnut (*Arachis hypogaea* L.)

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Abstract
The field life table of white grub/scarabaeidaes on groundnut was constructed to understand the factors responsible for mortality of different developmental stages of white grub/scarabaeidae in groundnut at Anandpar village of Vanthali Taluka in Junagadh district during *kharif*, 2018. The sampling was done from previously selected white grub infested groundnut field from the fifteen quadrates and 15 cm deep from the soil in each selected field thrice, at 30 days interval. The results revealed that mortality in younger group, older group and pupal stage were mainly due to fungal infection *i.e. Beauveria bassiana* Bals (3.76, 4.99 and 3.82%), *Metarhizium anisopliae* Metschn (2.54, 5.11 and 3.09%) and parasitic mite *i.e. Rhizoglyphus sp.* (8.23, 9.04 and 4.85%), respectively. Among the different life stages of the white grub/scarabaeidaes, the maximum population declined in older grub group as the "k" value for this group was to the tune of 0.1386. It was seen that, in all the groups parasitoids caused more mortality than fungal diseases.

Keywords: *B. bassiana*, Field life table, "k" value, *M. anisopliae*, *Rhizoglyphus sp.*, white grub/scarabaeidaes

Introduction
White grubs/scarabaeidaes are the soil dwelling and root-feeding grub of scarab beetles (Coleoptera: Scarabaeidae), which are popularly known as cockchafers, leaf chafers, chafer beetles, May beetles or June beetles. The family "Scarabaeidae" is the second largest omnipresent family, which includes over 30,000 species [11] among them 2500 species of both the phytophagous and coprophagous species found in Indian sub-region [2]. Majority of these phytophagous belongs to the sub family Melonthiane, Ruteline, Dynastinae and Cetoninae [11]. The fauna of the Indian sub-region is very rich and diverse but, it is yet to be fully explored [9]. There are fourteen species of white grub that are important species in Saurashtra region of Gujarat state *viz.*, *Phyllognathus sp.*, *Apogonia rauca* Fabricius, *Holotrichia consanguinea* Blanch, *Holotrichia fissa* Brenske, *Holotrichia serrata* Hope, *Maladera sp.*, *Schizonycha ruficollis* Fabricius, *Adoretus bicolor* Brenske, *Adoretus deccanus* Ohaus, *Adoretus versutus* Harold, *Adoretus sp.*, *Anomala bengalensis* Blanchard, *Anomala dorsalis* Fabricius and *Anomala varicolor* Gyllenhal [7].

The scarab species have been observed to cause serious damage throughout the country right from Himalayas to Kerala and Gujarat to North Eastern region [3, 10]. Looking at the severity of the damage, this pest has been recognized as pest of national importance since 1975 [15]. The presence of one grub/m2 may cause 80 to 100 per cent plant mortality [18]. Several predators and parasitoids have been identified on white grubs such as *Metarhizium anisopliae* Metsch and *Beauveria bassiana* Balsm, which are considered to have great potential. Several isolates of *M. anisopliae* have been identified to be highly virulent against the insects living in soil and cryptic habitats and have been subsequently used in research against a range of insect pests. *Metarhizium* potentiality against few insect species belonging to Orthroptera, Isoptera, Homoptera and Coleoptera has been experimentally proved and is being exploited in isolated parts of the world. To generate more information regarding bioagent of scarab beetle "Field life table of white grub/scarabaeidaes on groundnut (*Arachis hypogaea* L.)" was studied.

Materials and Methods
Sampling procedure
The sampling was done from previously selected white grub infested groundnut field at Anandpar village of Vanthali Taluka in Junagadh district during *kharif*, 2018.

The grubs of I, II and III instar were collected from the fifteen quadrates (approximate 1 m x 1 m) and 15 cm deep from the soil in each selected field thrice, at 30 days interval. Rest of the research work was carried out at Department of Entomology, College of Agriculture, JAU, Junagadh.

Stage sample
The egg was laid singly deep in the soil, so it could not be collected from the field. Thus, the younger grub (I and II instar) and older or grown grub (III instar) were collected.

Mode of observations
The collected grubs were reared in the laboratory on groundnut pod till the adult emergence. The extent of grub and pupal parasitism and the mortality due to biotic factors was noted in different instars.

Construction of life table
The column heading, used for the construction of the life tables in the present study, were those proposed by Morris and Miller (1954) [13] and Harcourt (1969) [6] are as under:

Heading		Denotion
X	=	The age interval, egg, grub and pupa or adult
Lx	=	The number surviving at the beginning of stage noted in the ‘x’ column
dx	=	The number dying within age interval stated in the ‘x’ column
Dxf	=	The mortality factor responsible for ‘dx’
100qx	=	Per cent mortality
Sx	=	Survival rate within the age mentioned in the ‘x’ column

Criteria for filling the columns of life table
The method and criteria suggested by Harcourt (1963) [5] and Atwal and Bains (1974) [1] for computing and filling the data in life table for different age intervals (stages) were followed in the present study. The 20 per cent mortality was contributed during eggs stage. Mortality of grubs were recorded by grouping the grub into two group, younger grub group (I & II instar) and older grub group (III instar). Procedure for computing the various columns are described below:

Younger grub
The younger grub group was formed by I and II instar grub. The ‘lx’ for these groups was worked out.

Older grub
The ‘lx’ for grown up grub of III instar was worked out by subtracting the mortality due to parasitism, fungal diseases and unknown factors from younger grub.

Pupae
The ‘lx’ was derived after deducting the mortality due to parasitism, fungal diseases and unknown causes from the population of older grub.

Adult/beetle
The ‘lx’ was worked out on the basis of number of adults emerged from the pupae. Mortality in the pupal stage due to parasitism and unknown causes was deducted from ‘lx’ of pupae.
Females x 2 were the percentage of females applied to ‘lx’ for adult. The data were doubled to maintain the balance in the life table.

Trend index (I)
The value of ‘I’ was computed by taking the ‘lx’ for young grub in the new season expressed as the ratio of old.

Generation survival (SG)
This is the index of population trend without effect of fecundity. The index was worked out as a ratio of number of females x 2 (N3) to younger gurb (N1) *i.e.* N3/N1.

Analysis of causes of fluctuations of population and identification of key mortality factors
As the mortality factors cause population fluctuation, separate budget was worked out to determine the key mortality factor (K) that influenced the population trend on the crop. The method suggested by Varley and Gradwell (1963) [17] was followed to find out the density relationship of mortality factors. Similarly, the value of killing power (K) of each mortality factor or the group of mortality factors in different age groups was also worked out by taking the difference between the logarithms of population density before and after its action. The total killing power (K) was computed by taking the sum of killing power of K’s.
$K = k0 + k1 + k2 \ldots kn$

Where, k0, k1, k2,…kn were the “k” values at first instar, second instar, third instar grub and pupal stages.

Results and Discussions
The result summarize (Table- 1) that mortality in younger group, older group and pupal stage were mainly due to fungal infection *i.e. B. bassiana*, *M. anisopliae* and parasitic mite *i.e. Rhizoglyphus sp.* The result further revealed that, per cent mortality in younger grub group, older grub group and pupal stage was 14.54, 19.14 and 11.76 per cent, respectively. The population of younger group, older group and pupal stage declined by different diseases and parasitic mite *viz.*, *B. bassiana* (3.76, 4.99 and 3.82), *M. anisopliae* (2.54, 5.11 and 3.09) and *Rhizoglyphus sp.* (8.23, 9.04 and 4.85), respectively. In earlier reports, entomopathogenic nematodes *H. zealandica* (X1 strain) and *H. bacteriophora* (GPS11 strain) provided effective and acceptable control of the late second and early third instar *P. japonica* and third instar *C. borealis* in the field conditions [4]. Entomopathogens *viz.*, *B. bassiana*, *B. brongniartii* and *M. anisopliae* were proved pathogenic to *Holotrichia* sp. [12]. Highest mortality of *D. virgifera virgifera* in first instar larvae (94% marginal death rate) due to unknown factors [16]. *M. anisopliae* at 4 x 108 conidia/g recorded higher per cent mortality of *L. lepidophora* grubs (33.33) [14]. Natural enemies like entomopathogenic nematode and fungus were potential in controlling white grubs [8].
The Generation Survival (SG) (Table- 1) was found to be 0.59 and the positive value of the trend index (I) was 0.083, which indicated that the mortality factors operating during this period were not effective in suppressing the white grub/scarabaeid population in succeeding generations. The data (Table- 2) revealed that, mortality (K’s) of grubs in younger grub group was due to parasitoids (0.0682) and fungal disease (0.0283). Similarly, in older grub group, maximum mortality was caused due to parasitoids (0.0923) followed by fungal diseases (0.0463). In the pupal stage parasitoids (0.0544) caused more mortality than fungal diseases (0.0311). Thus, the data from Table 2 revealed that among the different life stages of the white grub/scarabaeid,

the maximum population declined in older grub group as the "k" value for this group was to the tune of 0.1386. From the results it was seen that, in all the groups parasitoids caused more mortality than fungal diseases.

Table 1: Key mortality factors of white grub/scarabaeid on groundnut during *kharif*, 2018

Age interval (X)		No. alive/ha(lx)	Factors responsible for dx (Dxf)	No. dying during x (dx)	Mortality per cent (100qx)	Survival within s (Sx)
Younger grub group (N1)	1st and 2nd instar	984	**Fungal diseases**			0.9
			B. bassiana	37	3.76	
			M. anisopliae	25	2.54	
			Parasitic mite			
			Rhizoglyphus sp.	81	8.23	
			Total	143	14.54	
Older grub group	3rd instar	841	**Fungal diseases**			0.81
			B. bassiana	42	4.99	
			M. anisopliae	43	5.11	
			Parasitic mite			
			Rhizoglyphus sp.	76	9.04	
			Total	161	19.14	
Pupa		680	**Fungal diseases**			0.88
			B. bassiana	26	3.82	
			M. anisopliae	21	3.09	
			Parasitic mite			
			Rhizoglyphus sp.	33	4.85	
			Total	80	11.76	
Beetle		600	Deformed adults	19	3.17	0.97
			Total	19	3.17	
Female x 2		581	(Reproducing females- 330.5)			
Normal female x 2 (N3)		581	-			0.1
Generation total		403	-		48.61	-
Expected eggs [(N3/2) x Fecundity]				27101		
No. of dead/ sterile eggs				5420.2		
Viable eggs				21680.8		
Expected number of younger larvae				21680.8		
Actual number of younger larvae (N2)				82		
Trend index (N2/ N1)				0.083		
Generation survival (SG= N3/ N1)				0.59		

Table 2: Budget for white grub/scarabaeid on groundnut

Age interval	No./ ha	Log No. / ha	K's
Younger grub group	984	2.9930	-
After mortality due to			
Fungal Disease	922	2.9647	0.0283
Parasitoids	841	2.9248	0.0682
Total			0.0965
Older grub group	841	2.9248	
After mortality due to			
Fungal Diseases	756	2.8785	0.0463
Parasitoids	680	2.8325	0.0923
Total			0.1386
Pupae	680	2.8325	
After mortality due to			
Fungal Diseases	633	2.8014	0.0311
Parasitoids	600	2.7782	0.0544
Total			0.0855
Beetle (Adult)	600	2.7782	
Deformed adults	581	2.7642	0.0140
Total			0.0140
Reproducing females	330.5	2.5192	0.2450
Total			0.2450
K's =			0.5795

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