FUNCTIONAL RESPONSES OF *C. sIphurea, C. lunata* and *C. propingua* (COLLEPTERA: COCCINELLIDAE fed on *APHIS GOSSYPII* (HOMOPTERA: APHIDIDAE) in EASTERN Tanzania

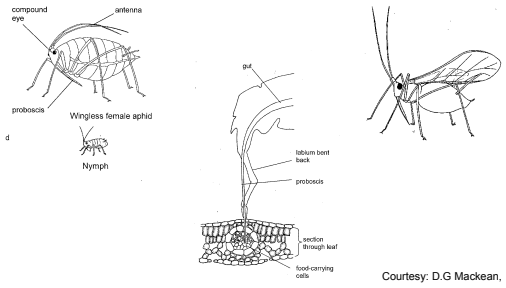
Mrosso F.P, Mwatawala W.M. and G. Rwegasira

SEACF 17TH – 18TH 2014 MEETING, MAPUTO MOZAMBIQUE

Introduction

- **Despite its importance, cotton is threatened by a wide range of insect pests.**
- **Most devastating pest in the Eastern Cotton Growing Area (ECGA) is American bollworm, *Helicoverpa armigera* (Hubner) followed by Cotton aphids, *Aphis gossypii* (Glover).**
- **Aphids suck the plant juices causing the young leaves to curl downwards at the edges.**
- **The honey dew produced by aphids affects photosynthetic efficiency of the plant.**
- **Honey dew contamination causes significant problems in spinning process . Aphids also transmit viruses causing more than 50 plant diseases.**

Aphid



Courtesy: D.G Mackean,

- **Insecticide recommended: Organophosphates, carbamates and acetamiprid, recently Imidacloprid.**
- **These chemicals have a translaminal property that provides effect in sucking insects pests as opposed to pyrethroids**
- **Despite the inefficiency of pyrethroids on aphids, farmers still use it as it is cheap**
- **The continuous application of insecticides has led to reduced response of aphids to the used insecticides.**
- **To-date, cotton aphid resistance to several classes of insecticidal compounds has been well documented and has been found to contribute to the difficulty of achieving the effective control of aphids**
- **Biological control could offer an alternative option for the control of aphids.**

- Natural enemies for the aphid in the ECGA include Coccinellids (ladybirds), lacewings, hoverflies, parasitic wasps, predatory bugs and spiders. They are common natural enemies for cotton aphids .
- Several species of ladybird beetles have been documented else where to be effective in the control of aphids, because both the adult and larvae feeds effectively on aphids.
- Studies by Rondon (2005) recommends the use of coccinellids in the management of cotton aphids on straw berries.
- Studies by Khan and Suhail (2000) revealed that Ladybirds are the potential agents for controlling aphids in farmlands of cotton.

- **Very little information is available on their use on biological management of major cotton pests in the ECGA.**

- **The current study explored the functional Response of three aphidophagus coccinellids of the genus Cheilomenes; *Cheilomenes lunata*, *Cheilomenes sulphurea* and *Cheilomenes propingua* found frequenting cotton crop in eastern Tanzania**

MATERIALS AND METHODS

- Ten day old Coccinellid adults were introduced individually in petridishes and left to starve for 24h (Ahmad and Omkar, 2005) to standardize their appetite.

- Group of seven petridishes were introduced with different densities of mature apterae aphids (Timms, 2008) *viz*. , 25,50, 100, 200, 300, 400, 500, replicated 10 times (Ahmad and Omkar, 2005).

- Data on number of prey eaten against the number of initial prey density offered were recorded in using the following Table format:

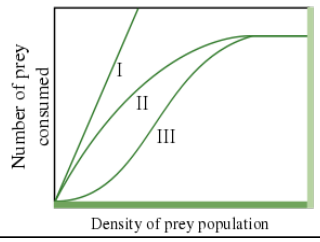
Template for data entry(one specie/sex).

Density of prey X (H)	Petri-dishes (Replications), Prey consumed per dish (Ha)										Total	Mean Y (Ha)
	1	2	3	4	5	6	7	8	9	10		
25												
50												
100												
200												
300												
400												
500												

Data analysis

- The data Y (Ha) were plotted against X (H) and shapes of curves were estimated using 2007 Microsoft Excel Programme. After plotting this graph, Type of Functional response was determined.

- Make graph – Microsoft Excel programme
- Confirm shapes – maximum likelihood analysis



- Since it is difficult to distinguish critically between type II and type III shapes of functional responses, a logistic regression model was used (equation 1) before fitting the data to a particular Hollings equation.
- The logistic regression model is frequently used by Ecologists to confirm the shape and type of functional response of a predator against a prey by taking the proportion of prey consumed (H_a / H) as function of initial prey density supplied (Juliano, 2001; Raza and Shila, 2009; Ahmad and Omkar, 2005).

$$\frac{Ha}{H} = \frac{\exp(qo + q_1H + q_2H^2 + q_3H^3)}{1 + \exp(qo + qH + q_2H^2 + q_3H^3)} \qquad (equation.1)$$

- Where q_0, q_1, q_2, q_3 are the intercepts, linear, quadratic and cubic coefficients, respectively and these were estimated using maximum likelihood with SAS Software

- Juliano (2001) indicated that if $q_1 < 0$, the proportion of prey consumed declines monotonically with the initial number of prey density supplied, this describes type II functional response and if $q_1 > 0$ and $q_2 < 0$, the prey eaten is positively density dependent thus describing type III functional response.

Search rates and Handling time

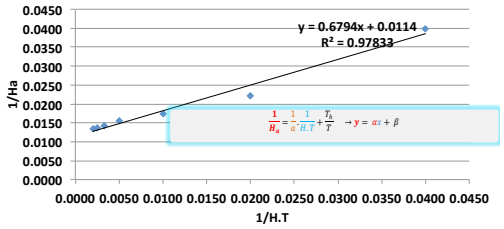
- After obtaining type of functional response and shape of the curve, the handling time (h_a) and search rate (a) were determined using Hollings disc equation (2) modified by reciprocal linear transformation (Livdahl and Steven, 1983) (equation 3) which is inform of equation 4 as follows:

$$H_a = \frac{a.H.T}{1 + a.H.T_h} \rightarrow \frac{1}{H_a} = \frac{1}{a}.\frac{1}{H.T} + \frac{T_h}{T} \rightarrow y = \alpha x + \beta$$

equation 2 *equation 3* *equation 4*

- Where **Ha** is the number of prey consumed by the predator, **H** is the initial prey density, **'a'** is the search rate, **T** is the time of a predator and prey exposed together for the case of this study is one day, **Th** is handling time with each prey eaten. In order to estimate these parameters, the experimental data were organized in the following Table format.
- These parameters were obtained by plotting **1/Ha** against 1/**HT**.

Plotting I/Ha against 1/H.T (T= 1 day) – Male *C. propingua*



Results and Discussion

- **The Functional response curves show that *C. lunata* is the most vigorous predatory specie in consuming aphid followed by *C. sulphurea* and *propingua* (Fig 1) for males and Fig 2 for females, however at lower densities their response were almost the same.**
- **Every tested specie revealed decline in consumption rate at higher densities which is a phenomenon to type II functional responses (Ahmad and Omkar, 2005).**

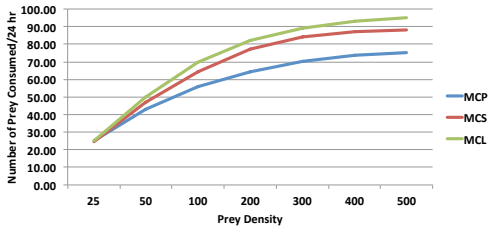


Figure 1. Functional response Type II of males *Cheilomenes propingua (MCP), C. lunata* (MCL) and *C. sulphurea (MCS)* at different densities of *A. gossypii* (derived from Microsoft Excel 2007 Programme)

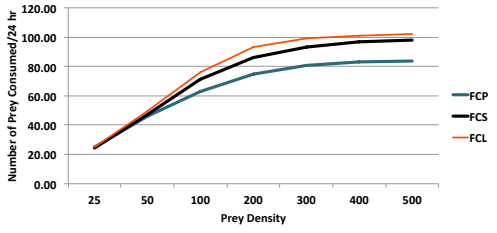


Figure 2. Functional response Type II of females *Cheilomenes propingua (FCP), C. lunata (FCL)* and *C. sulphurea (FCS)* at different densities of *A. gossypii* (derived from MS Excel 2007 Programme).

Table 1. Parameter estimates for logistic regressions of the proportion of prey eaten (H_a) against the number of prey supplied (H) for *Cheilomenes propingua,C. lunata* and *C. sulphurea* in 24 hours.

Parameter	Female			Male		
	C. propingua	*C. lunata*	*C. sulphurea*	*C. propingua*	*C. lunata*	*C. sulphurea*
Intercept (P_0)	-1.9742	-2.0348	-2.0261	-0.19679	-1.9577	-2.0174
Linear (P_1)	-0.00764	-0.00473	-0.00623	-0.0100	-0.00733	-0.00727
Quadratic (P_2)	8.001EE-6	-2.23E-6	5.242E-6	1.869E-6	8.74E-6	7.997E-6
Cubic (P_3)	-2.06E-9	8.898E-9	-5.72E-12	6.306E-9	-2.81E-9	-2.78E-9
r^2	0.95	0.82	0.97	0.92	0.97	0.97

Results and Disc. cont.

- The logistic regression revealed negative linear parameter (q_1<1) (Table 1) in all three spcies tested, *Cheilomenes propingua, C. lunata and C. sulphurea*.
- Search rates did not differ significantly between species except for *C. propingua* female and male which were the highest (P < 0.01).
- The predatory coccinellid *C. lunata* and *C. sulphurea* males (Table 2a) and females Table 2b) were found to have similar search rates.

Results and Disc. cont.

- Handling times Th for the three female coccinellids were generally lower than that of males (Table 2).
- There was a significant difference (P < 0.01) between *Cheilomenes propingua* males handling time (0.279h) and that of *C. sulphurea* (0.220h) and *C. lunata* (0.2170h).
- Likewise the females handling time of *C. propingua* (0.240h) was significantly higher (P=0.0002) than that of females of *C. sulphurea* (0.196h) and that of *C. lunata* (0.171h).

Results and Discussion cont.

- The handling times of *C. sulphurea* and *C. lunata* in both sexes did not differ significantly (P>0.05) between species.

	REP 1		REP 2		REP 3		REP 4		REP 5	
	a	*Th*	*a*	*Th*	*a*	*Th*	*a*	*Th*	*a*	*Th*
MCP	1.710	0.360	1.371	0.250	1.390	0.247	1.381	0.266	1.509	0.293
MCS	1.412	0.238	1.377	0.214	1.371	0.230	1.326	0.216	1.304	0.206
MCL	1.362	0.214	1.367	0.214	1.666	0.324	1.289	0.271	1.306	0.192
FCP	1.353	0.206	1.297	0.185	1.666	0.324	1.289	0.271	1.335	0.197
FCS	1.192	0.182	1.284	0.189	1.222	0.160	1.276	0.173	1.304	0.197
FCL	1.289	0.180	1.300	0.180	1.270	0.166	1.311	0.182	1.257	0.175

Specie/ sex	REP 6		REP 7		REP 8		REP 9		REP 10	
	a	*Th*	*a*	*Th*	*a*	*Th*	*a*	*Th*	*a*	*Th*
MCP	1.563	0.293	1.509	0.276	1.392	0.247	1.500	0.269	1.560	0.283
MCS	1.291	0.185	1.325	0.247	1.246	0.209	1.086	0.170	1.265	0.216
MCL	1.291	0.185	1.325	0.197	1.348	0.206	1.342	0.206	1.307	0.187
FCP	1.432	0.245	1.333	0.223	1.454	0.266	1.427	0.240	1.461	0.247
FCS	1.323	0.206	1.424	0.226	1.184	0.187	1.129	0.185	1.246	0.156
FCL	1.303	0.194	1.245	0.156	1.277	0.170	1.248	0.156	1.278	0.168

Table 2b. Estimated parameters (search rates ('a') and Handling time ('T_h')) for male *Cheilomenes* sp

Specie	Search rate ('a")	Handling time ('T_h')
C. propingua	1.489*a*	0.279*a*
C. sulphurea	1.360*b*	0.220*b*
C. lunata	1.312*b*	0.217*b*
CV	**7.724**	**14.614**
LSD	**0.100**	**0.027**
P	**0.004**	**0.001**

Means followed by the same letter within the column are not significantly different (p<0.05).

Table 2b. Estimated parameters (search rates ('a') and Handling time ('T_h')) for female *Cheilomenes* spp

Specie	Search rate ('a")	Handling time ('T_h')
C. propingua	1.404*a*	0.240*a*
C. sulphurea	1.277*b*	0.196*b*
C. lunata	1.258*b*	0.171*b*
CV	**6.815**	**15.208**
LSD	**0.084**	**0.029**
P	**0.0036**	**0.0002**

Means followed by the same letter within the column are not significantly different (P<0.05).

Conclusion

- In view of above, *C. lunata, C. sulphurea* and *C. propingua* have type II functional response and hence they have potential of being used as one of components of aphid management programmes but *C. lunata* and *C. sulphurea* seem to have more potential than the *C. propingua*.

Acknowledgement

- Ministry of Agriculture and Cooperatives in Tanzania for financial support
- Cotton Development Trust Fund Organizers for financial support
- Technicians for collecting data

End

Thank you for your attention