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Bioecology of Common Cutworm (*S. Litura*) of Mulberry

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***Abstract*-** Bioecology of common cutworms (S. litura) was diligently documented at the crop protection section of the Don Mariano Marcos Memorial State University-Sericulture Research and Development Institute, primarily aimed to generate substantial data for the formulation of control measures. Specifically, focused on the developmental stages, behavior and factors associated to their resurgence and geographical distribution.

Common cutworm is a complete metamorphic insect and considered as a serious pest of mulberry threatening sericulture farmers in their quest for quality leaves for silkworm rearing. Round-shiny white eggs are pile-up in 3-4 layers and usually laid in 2-7 batches. Incubation took place in 2-3 days.

On the other hand, newly hatched transparent green larvae have pin-sized black spots around their bodies. Color changes every after casting-off their old skin until reaching full maturity. Larvae development lasted for 19.36 days. Matured worms secured the ground for pupation making earthen cells as encasement. It was completed in 8-9 days and immediately after emergence of the moth, copulation follows that lasted for two days and four days egg laying period.

Outbreak and population build-up were influenced by biotic and abiotic factors (predators, parasites, disease causing organisms, host plants and weather conditions). High population of cutworms and predators were noted throughout the year heavy downpour affected egg production.

Index Terms- Bioecology, cutworms, threshold, defoliation, feeding behavior, resurgence, distribution, fecundity, pupation, copulation, predators, parasites, outbreak, build-up, host plants.

I. Introduction

Insect-pests cause great hazard to the world's vegetation and significant reduction of crop's output. Many multiply hundredfold in a short period feeding on leaves, stem and fruits to complete their development stages.

Common cutworm (S. litura) popularly known as tobacco caterpillar enjoys wide distribution. It was spotted somewhere in Northern Luzon but also reported in other Asian nations, Australia and Pacific Islands where host plants were cultivated. They fed on plants belonging to 44 families preferably tobacco, cotton, ground nuts, cabbage, cauliflower among others. It was also found feeding on weeds such as Amaranthus spinosus, portulaca, Zinnia elegans, and Chenopodium amaranticolor (Prasad, 1997).

On mulberry, cutworm is a threat to the production of quality leaves (Telan and Gonzales, 2000). A cluster of worms numbering about 500-600 is capable of defoliating a multi-branched mulberry in 7-10 days. It is very devastating especially when conditions warrant their outbreak and population build-up. It is imperative therefore, to generate sufficient informations on its biological activities and factors associated on their resurgence and distribution for effective pest control.

II. Objectives

General: Document the biology and behavior of common cutworms (S. litura) on mulberry, its alternate hosts and factors affecting resurgence and distribution.

Specific:

a. Characterize the test organism according to external and biological parameters;
b. Establish the life cycle of the test organism on mulberry;
c. Determine the egg production performance;
d. Identify natural enemies and other habitations and;
e. Document factors relative to their resurgence and distribution.

III. Review of Literature

Geographical distribution

Cutworm (S. litura) has been reported in the Philippines by Torreno (1985) infesting rice, tobacco, and other food crops. Record also shows that its distribution has been noted in EPPO Region, Africa, Asia, Europian Union, North America and Oceana (http://www.eppo. int'in, IIE 1993, no. 61, Table 1).

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Table 1. Geographical Distribution of S. litura (Fabricus) isolated by Local and Foreign Scientist.

REGION/COUNTRY	SOURCE AND YEAR OF DOCUMENTATION
Philippines	Capco, 1957
India	Hampson, 1919; Cotes and Swinhoe, 1888; Anon, 1965; Lal and Nayak, 1963; San Gupta and Behura, 1957
Burma	Hanson, 1963
Bonin Islands	Shiraki, 1952
Bangladesh	Alom, 1962
Cambodia	Hanson, 1963
China	Hampson 1909
Christmas Islands	Cab, 1967
Cocos-Keeling	Hampsom, 1909
Indonesia	Wallace, 1966
Japan	Shiraki, 1952
Korea	Eguchi, 1926
Laos	Hauson, 1963
Malaysia	Corbett and Miller, 1933
Maldivces	Cab, 1967
Nepal	Cab, 1967
Pakistan	Anon, 1965
Rukyu Island	Shiraki, 1952
Singapore	Hampson, 1919
Taiwan	Misaka, et. al, 1940
Thailand	Anon, 1965
Vietnam	Hanson, 1963
Australia	Forte and Shedby, 1965; Cab, 1967
Caroline Islands	Bryan Jr., 1949
Gilbert Islands	Hampson, 1909
Marshall Islands	Cab, 1909
Midway Islands	Cab, 1967
New Caledonia	Cohic, 1967
Norfolk Islands	Cab, 1967
Papua New Guinea	Dun, 1965; Anon, 1962
Phoenix Islands	Cab, 1967
Society Islands	Hampson, 1909
Solomon Islands	Cab, 1967
Tonga	Cab, 1967
Tubai Islands	Cab, 1967
Wallis Islands	Cab, 1967
West Irian	Cohic, 1959
West Samoa	Dumbleton, 1954

Food Source

Spodoptera litura is a highly polyphagous insect found feeding on vegetables, food crops, weeds and other economic crops (Brown and Dewhurst, 1995; Holloway, 1989). Host plants is presented in Table 2.

Table 2. Host/Food Source, Area or Region and Scientist/Documentor.

Hosts/Food Source	Area/Region	Researcher/Documentor
Taro	Solomon Islands	MC Forlane, 1987
Rice	Philippines	Im, et. al, 1989
Tobacco	Philippines	Torreno, 1985
	India	Dhandapani, 1985
Coffee and C. odorata	India	Singh and Sacban, 1993
Sugarbeet	India	Singh and Sacban, 1993
Groundnut	India	Singh and Sacban, 1993
Soybeans	India	Singh and Sacban, 1993
Cauliflower	India	Singh and Sacban, 1993
Jatropa curgas	India	Singh and Sacban, 1993
Lucerne	India	Meshran and Josh, 1994
Tobacco and Castor	India	Meshran and Josh, 1994
Banana and Corn	India	Rao, 1956
Groundnut, Sunflower, Cotton, Jute, Tomato	India	Rao, 1956
Cabbage, Cauliflower, Chow Chow, Blackgram	India	Agyar, 1963
Sweet potato, Agathi, chilli, Onion	India	David and Kumarswami, 1975
Tomato, Tobacco,Potato	India	Pruthi, 1969
Castor, Gram linseed, Groundnut, Jute, Corn, Lucerne, Banana, Rose, Poppy, Sugarbeet, Brinjal cabbage, and Sweet potato	India	Pruthi, 1969
Okra, Clove and Surghum	India	Thomas, et. al, 1969
Onion poppy	India	Singh and Byas, 1975
Sunflower	India	Singh and Dabral, 1977
Fennel, Fenugreek	India	Ayyanna, et. al, 1982
Blackcumin, Soybean, Gree gram, Jute and Black pepper	India	Nagalingham, et. al, 1979
Soybean	India	Singh, 1980
Amaranthus	India	Srivastava, et. al, 1971
Cowpea	India	Puttaswamy and Reddy, 1981
Marsilea Quadriflora	India	Yadau and Yadar, 1983
Onion	Korea	Sain, et. al, 1983
Cabbage	China	Choo, 1988
Soybean and Alfalfa	Japan	Zhoo and Aeto, 1994
White clove	Japan	Okado, 1993
Long bean and Cotton	Malaysia	
Jute	India	Singh and Hol, 1972
Gladiolus	China	Patel, 1943
Gladiolus	India	Wang, 1982
Cynara sculymus	India	Krishnaiaw, et. al, 1967
Sun hemp	India	Ramamurthy, et. al, 1967
Potato	India	Ansai, et. al, 1992

Morphological Description and Feeding Behavior

Eggs were laid in clusters (2,685 eggs/cluster) according to Torreno (1985) and Troung (1989). Earlier, Miyahara et. al, 1971, noted that between 2-5 days after moth emergence, females lay 1000-2000 eggs/mass on lower leaf surface of any host plant. Egg masses are covered with hair-like scales from the end of the insect's abdomen. Fecundity is adversely affected by high temperature and low relative humidity (about 960 eggs laid at 30 ^{0}C and 90% RH and 145 eggs at 35 ^{0}C and 30% RH).

The larvae pass through six instar in 15-23 days at 25-26 ^{0}C. Young age larvae in groups, leaving the epidermis of the leaf intact. Later, the late age/grown-up larvae disperse and hide underground during the day and feed at night and early in the morning.

Pupal period is usually spent in earthen cell (encasement) and lasts 11-13 days at 25^0C. Life span of adult is about 4-10 days depending on temperature and low relative humidity. Thus, life cycle for one generation can be completed in five weeks. In Japan (Nakasuji, 1976) four generations develop between May to October while in the tropics, there may be eight annual generations.

Host range of common cutworm, S. litura covers over 40 families containing at least 87 species (Salama, et. al, 1970). Among the main crop species attacked by S. litura in the tropics are: C.esculenta, cotton, flax, groundnuts, jute, lucerne, maize, rice, soyabeans, tea, tobacco, ambergines, brassica, capsicum, cucurbits, phaseolus, potatoes and vigna. Other hosts include ornamentals, wild plants, weeds and shade trees (Salama, et. al, 1970).

Crop loss and economic impact.

Common cutworm, S. litura is an extremely serious insect pest capable of defoliating many economically important crops. In India, yield of soybeans was reduced by 42% (Srivastava, et. al, 1972). On the other hand, yield loss of tobacco was reached at 23-24, 44.2 and 50.4 when plants were infested with two, four and eight larvae respectively (Patel, et. al, 1971). Likewise, 4-8 larvae per Colocasia esculenta reduced yield by 10% similar to 2-3 and 1-2 larvae per plant of ambergines and capsicum (Nakasuji and Matsuzaki, 1977).

IV. MATERIALS AND METHODS

Series of experiments were carried-out in the field and in the screen house generating substantial informations for the realization of the objectives of the project.

Collection of Specimen and Mass Production

Test insects were collected from mulberry plantations of the Central Experimental Station of DMMMSU-SRDI. They were cultured/mass produced in the screen house using rearing pans, jars and gerber bottles. Specimens were provided with mulberry leaves of desired age to sustain their growth and development.

Characterization of the Different Developmental Stages

Documentation started upon hatching where the larvae were characterized according to external and biological activities. Observation and data gathering continued until the completion of one generation. Another set of experiment was laid out for the determination of the longevity of the developmental stages.

Oviposition and Fecundity

Newly emerged male and female moths were introduced in caged plants inside the screen house for close monitoring. Paired moth, male and female was also confined in a large mosquito net in the open field for performance comparison. Egg laying performances were recorded.

Identification of Matured Enemies

Series of pest survey were conducted to closely observe the association of different insects with cutworm within the mulberry plantations. They were classified according to predators or pest like cutworms and pyralid. Newly hatched and grown larvae of cutworms were collected and cultured in the screen house with predetermined beneficial insect.

Infected and dead cutworms were thoroughly diagnosed according to the cause of illness or death.

Host Determination

A survey was conducted within mulberry plantation observing the positive reaction of cutworms to weed species. Similar activity was conducted on nearby farms identifying crops vulnerable to cutworms.

Abiotic Factors Affecting Pest Activity

Monthly insect counts (larvae and egg clusters) were conducted determining the population levels across months and establishing the seasonal pattern.

V. RESULTS AND DISCUSSIONS

Metamorphosis

Common cutworms of mulberry undergo complete metamorphosis (egg, larvae, pupa and adult). Stages of growth and development were influenced by nutrition and rearing conditions. Shiny round shelled eggs were produced in large numbers and deposited underneath the middle leaves. Upon hatching, young age larvae sought soft tissue and slowly migrated to older leaves as they advance to the later stages. Five moultings were noted with the fully matured larvae forming soil case for protection. After several days, adult broke-out of the pupal shell, copulate and produced eggs.

Physical Characteristics

Eggs. Shinny-round shelled eggs were laid in 7-10 batches in a duration of four days that weighed ± 0.124 mg/egg and a diameter of ± 0.0098 millimeter. Incubation took place in ± 2.36 days within the range of 2-3 days as recorded by Truong in 1989 using tobacco as substrate.

Larvae. After hatching, larvae undergone six stadium with the first instar noted as the longest at ± 4.08 days and shorter duration at later larval stages (2.44-3.64 days only). Weight gradually increases as they advance to the next stage with a single matured worm weighing 689.0 mg and a body diameter of ± 1.73 mm and ± 3.56 cm long (Table 3 and Fig.1). Total larval development was computed at 19.36 days, longer than those fed with castor 15.4 days but shorter than those fed with maize, 20.6 days (Singh and Hai, 1972). Highly variable larval development was noted by Truong in 1989 at 15-27 days depending on the rearing condition.

Pupa. Fully matured larvae secured the ground (1-2 cm below the surface) for pupation. It was completed in 8.29 days a little longer than the 7-8 days pupation using tobacco a food source as documented by Truong, 1989 (Table 3 and Fig.1). A pupa weighed ± 281 mg with a diameter of ± 5.23 mm and a length of ± 1.73 cm.

Adult/moth. Female moth emerged a day or two earlier than males. A pair copulated for two days and laid their eggs in patches for four days. Generally, moth weighed ± 138 mg with a body size of ± 5.04 mm and ± 1.79 mm from the head to the tip of the abdomen. It took about ± 7.8 days period from emergence to the completion of egg laying.

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Total Development Period for One Generation

Nutrition influenced the overall development of the insect-pest. When fed with mulberry, total life time for one generation was only ± 37.81 days that was much shorter the 52-56 day duration with tobacco leaves as food (Prasad, 1977).

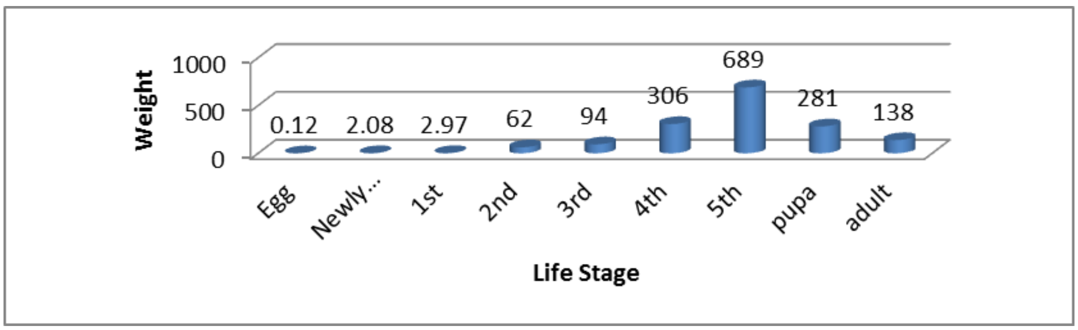
Fecundity

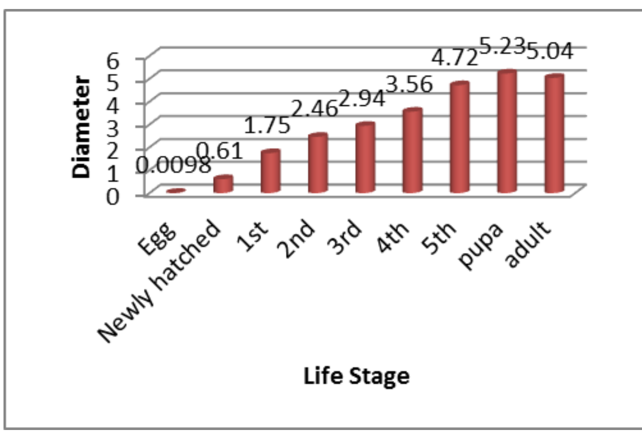
Egg production performance was influenced by rearing condition as shown in (Table 3 and Fig.1). Better egg production was noted when reared in the open field than in a limited space and unfavorable condition as in cage or screen house (635.67 eggs vs 557.86 egg/pair). Likewise, caged insects scattered their eggs into 6.5 clusters unlike in the normal condition with only 2.5 clustered egg/pair.

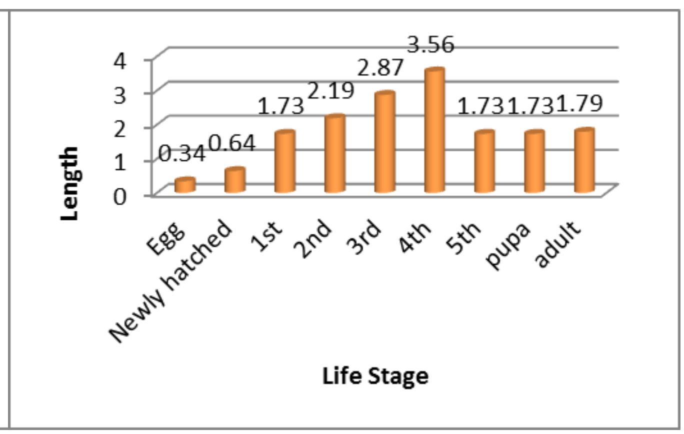
Table 3. Characteristics and life cycle of common cutworm.

Stages of Development	**Weight (mg)**	**Size (mm)**	**Length (cm)**	**One Generation (days)**
Egg	± 0.124	± 0.0098		± 2.36
Larvae				
1st	± 2.08	± 0.610	± 0.34	± 4.08
2nd	± 2.99	± 1.75	± 0.64	± 3.24
3rd	± 94.00	± 2.46	± 1.73	± 3.48
4th	± 306.00	± 3.56	± 2.87	± 2.44
5th	± 689.00	± 4.72	± 3.56	± 3.64
Pupa	± 281.00	± 5.23	± 1.73	± 8.29
Adult	± 138.00	± 5.04	± 1.79	± 7.80
Total				**± 35.33**

Figure 1. Morphological characteristics of common cutworm S. litura.







Natural Enemies Affecting Resurgence and Distribution

A. Biotic Factors. Biological agents like predators, parasites and disease causing organisms showed down the multiplication of cutworm. Species of spider, beetles and bugs were found preying on newly hatched/juvenile worms. Likewise, crickets, cotton stainer, praying mantis and katydid were found occasionally feeding on newly hatched cutworms (Table 4).

Parasites were observed emerging from dead larvae and isolated as tachinid fly and wasps. Death of larvae was noted to be due to viruses, fungi and bacteria (Table 4). Similar parasites and disease causing organisms were also isolated by Pojas, 1987 as cited by Torreno.1985.

Population build up was favored by the abundance of vulnerable host plants. Legumes, solanaceous plants, cucurbits, pechay and cabbage were found harboring cutworms of different ages. Likewise, weed species like spinach marakamote, jute, gatas-gatas, pigweed and other weeds associated with mulberry were also prune to cutworms (Table 5).

Table 4. Biological agents affecting the multiplication of common cutworm.

Predators	Parasites	Disease-Causing Organisms
Lynx and jumping spiders	Trachivid fly	fungi
Ladybird and coccinalid beetles	Wasps	bacteria
Reduvid and tobacco bugs		virus
Tree cricket		
Katydid		
Cotton stainer		
Praying mantis		

Table 5. Potential food sources of cutworm within mulberry plantation and neighboring farms.

Common Crops		Weed Species	
Common Name	Scientific Name	Common Name	Scientific Name
Tomato	L. esculentum	Spinach	A. pemaras
Eggplant	S. melongena	Marakamore	I. acotangula
Pepper	C. annum	Jute	C. capsularia
Cowpea	V. sinensis	Gatas-gats	E. hirta
Corn	Z. mays	Maratabako	M. arvensis
Cabbage	B. oleraceae	Andadasi	C. alata
Squash	C. maxima	Pigweed	P. oleraceae
Mungbean	P. vulgaris	Wild jute	
Okra		Tantandok	
Pechay			
Cucumber			
Pigeon pea	C. cajan		

B. Abiotic Factors. Temperature, relative humidity, frequency of rain including floods critically affected the development of the insect pest. High temperature and relative humidity during summer and scarcity of food supply greatly reduced egg production. Likewise, heavy down pour in July (about 44.2 man/day) and stormy weather with gusty winds in August prevented the resurgence and redistribution of cutworms. However, larvae started to regroup and converge to roboustly growing mulberries, rice fields and vegetable plantations. High population extends until June with second population peak on October. (Fig.2 and Fig.3).

Fig. 2. Seasonal abundance of cutworm eggs, larvae and predators.

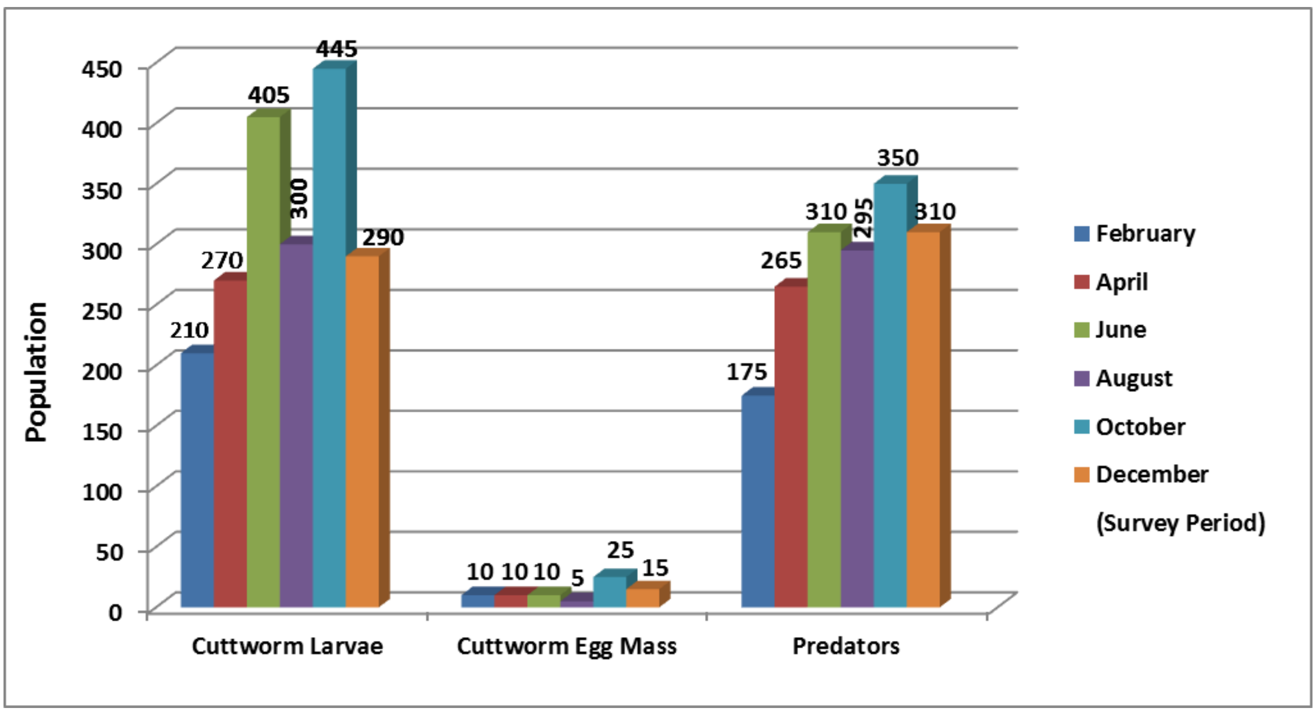
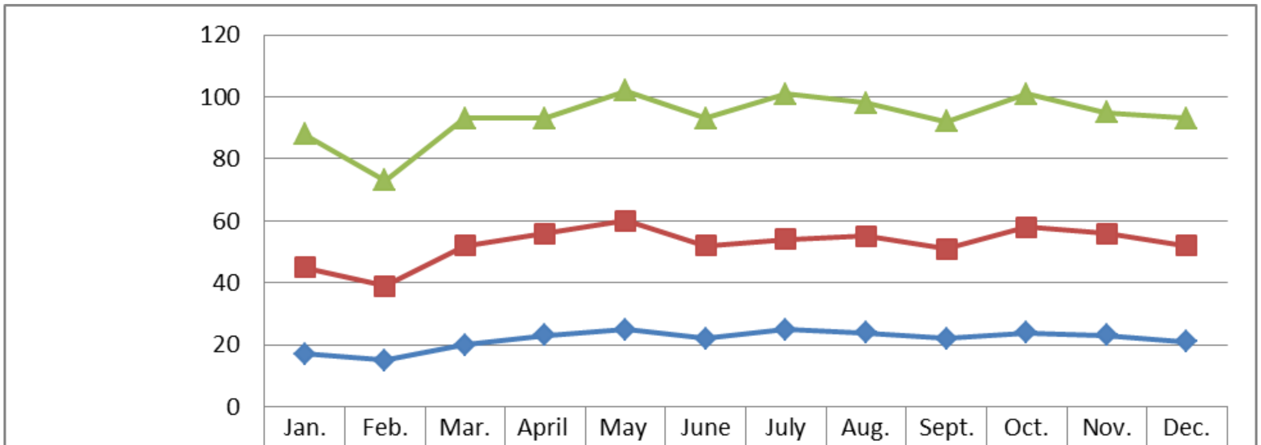
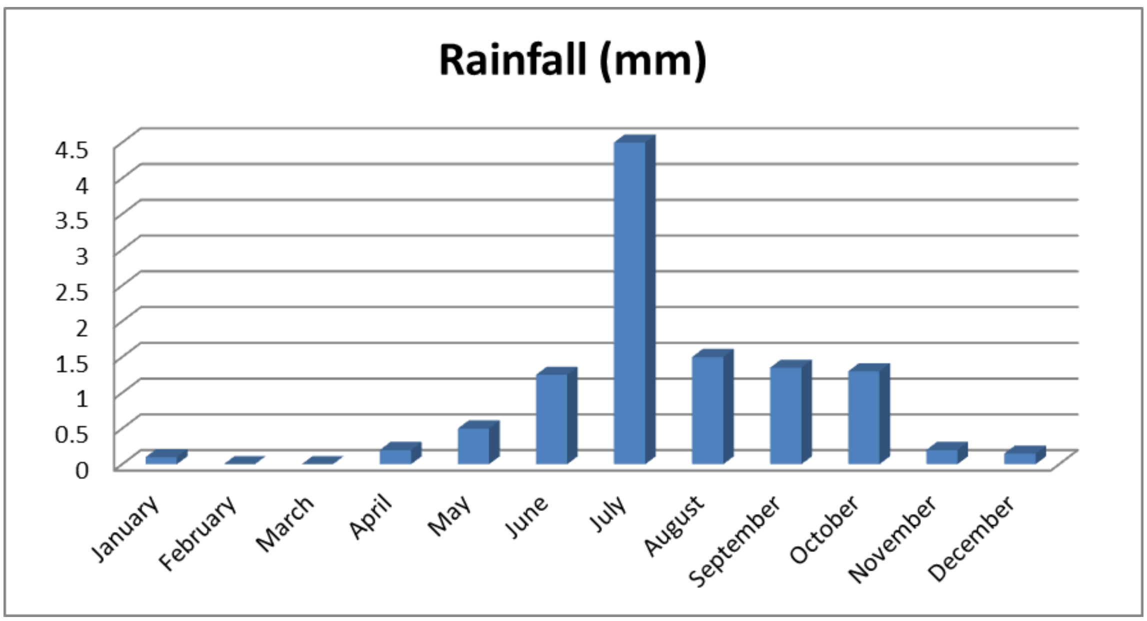


Fig. 3a. Agrometeorological data affecting pest population (temperature and relative humidity).



	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
RH (8AM)	43	34	41	37	42	41	47	43	41	43	39	41
Temp. (2PM)	28	24	32	33	35	30	29	31	29	34	33	31
Temp. (8AM)	17	15	20	23	25	22	25	24	22	24	23	21

Fig. 3b. Agrometeorological data affecting pest population (rainfall).



VI. SUMMARY

Cutworm develops in four stages of metamorphosis known to be influenced by food sources, biotic and abiotic factors. Shinny round shelled eggs were produced in large numbers (between 557.86-635.67 eggs/pair) and deposited underneath the middle leaves.

Incubation took place in 2-3 days where newly hatched transparent greenish larvae called ants fed on tender leaves and gradually increases in size and gained weight as they advance into the next phases of growth. Color changes as they cast off their old skin until attaining their maximum size and weight. First stadium was noted to be the longest at 4.08 days with other instars completed between 2.44 – 2.64 days. Larval development lasted for 19.36 days.

Fully matured worms secure the ground for pupation and took 8-9 days before the moth emerged. Male and female moth copulated for two days with four days egg laying period. Total lifetime for one generation was 37.81 days.

Egg production performance was higher in the normal open field than confined in cage. Pest outbreak and redistribution was influenced by biological agents and abiotic factors. Population build-up was favored by the abundance of food sources serving as their breeding host as well.

Population rose-up starting February to June with another population peak in October but slide down in December.

VII. RECOMMENDATIONS

Sets of information gathered served as spring board in designing efficient pest control and ecologically sound management based on the following: a) features and behavior of the pest; b) longevity as guide as to the best time to deal with the pest; c) egg laying performance of a paired moth to know their capacity to reproduce; and anticipated yield loss and, d) documentation of biotic and abiotic factors leading to proper time of crop establishment, choice of cropping system and strategic area to focus pest control operation without disturbing beneficial insects..

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