



BIOLOGY OF POTATO TUBER MOTH *PHTHORIMAEA OPERCULELLA* (ZELLER) UNDER STORAGE AT DIFFERENT SEASONS IN HASSAN DISTRICT, KARNATAKA, INDIA

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Abstract

Studies were undertaken to learn biology of the Potato Tuber Moth *Phthorimaea operculella* (Zeller) on potato under storage conditions during winter, summer season and rainy season. Results obtained showed that with an average range temperature of 28°C and relative humidity 66% in winter season, average range temperature of 33°C and relative humidity 47% in summer season and average temperature of 30°C and average of relative humidity of 79% in rainy season, the development durations of immature stages were as follows, The incubation period was 3.6 days in winter season, 3 days in summer 3.5 days in rainy season The larval stage duration average was 11.8 days in winter, 8.2 days in summer season, 10.3 days in rainy season, The pupal stage duration average was 6.1 days in winter season, 6 days in summer and 7.1 days in rainy season, the total life cycle average was 21.5 days in winter, 17.2 days in summer and 20.9 days in rainy season, the average number of eggs laid by female was 118.6 eggs/female in winter season for 60.4 eggs/female in summer season, 90.5 in rainy season The female survived for an average of 16.9 days in the winter, 11.1 days in summer, 13.3 days in rainy, the male survived for 14.9 days in winter season, 8.2 days in summer season and 11 days in rainy season.

Key words: Potato, Storage, Seasons and Life cycle

Introduction

Potato (*Solanum tuberosum* L.) popularly known as 'The king of vegetables', has emerged as fourth most important food crop in India after rice, wheat and maize. Indian vegetable basket is incomplete without Potato. Because, the dry matter, edible energy and edible protein content of potato makes it nutritionally superior vegetable as well as staple food not only in our country but also throughout the world. According to 2018 data Area of potato in Karnataka is 41,000 ha, Production 36,10,000 tonne and Productivity is 13.30 tonne/ha, in Hassan district Area of potato is 11071 ha, Production 1,42,971 tonne and Productivity 12.91 tonne/ha (Department of Horticulture, Hassan 2018).

Insect pests are one of the major constraints in the commercial production of potato crop. According to Simpson (1977) this species has apparently originated

from Western South America along with its host (Graf, 1917). It was first introduced to India in 1906 through seed potatoes brought to Bombay from Italy (Lefroy, 1907).

The potato tuber moth *Phthorimaea operculella* (Zeller) is a serious insect pest of potato it causes great damage in store condition. In some cases the damage reached 100 per cent for the stored potato Potato tuber moth (PTM) is found in tropical, subtropical, and Mediterranean areas (Golizadeh and Esmaeili, 2012) is the most serious pest both in field and storage, causing great damage to foliage and tubers and it is one of the pests that causes the most extensive damages in the field and storage of potatoes, especially in warm dry climates (Larrain *et al.*, 2007).

The larvae mine leaves and tubers, causing damage to potatoes in storage and in field condition. Although, the larvae do some feeding on potato foliage and stems,

the economic importance of this pest is in the damage it causes in tubers (Hanafi, 1999). Infested potatoes put aside at harvest when stored together with uninfested potatoes serve as the primary source of infestation in stores (Chandel *et al.*, 2005). The information about various aspects of the insect, i.e. study of biology during different season is help to know the characteristic of insect. However, the present study is aiming to contribute to the knowledge about the biology of this insect in winter, summer season and rainy season

Materials and Methods

Materials used for the study of biology were rearing cages, test tubes, brush, hand lens, honey or sugar syrup (food for adult moth of PTM), and potato for rearing of adult PTM.

Location and Conditions

The study were undertaken during 2018-19 at Hassan district of Arsikere Taluk situated at 76° 15' E longitude and 13° 15' N latitude with an altitude of 808 m MSL, under conditions of an average temperature of 28°C and average of relative humidity of 66% in winter season, average temperature of 33°C and average of relative humidity of 47% in summer season and average temperature of 30°C and average of relative humidity of 79% in rainy season the relative humidity and temperature were daily measured by using the thermo-hygrometer. Observations were recorded during winter season from 1st November 2018 to 23rd November 2018, summer season from 21st January 2019 to 8th Feb 2019 and rainy season from 18th June 2019 to 9th July 2019, to compare the results of the different seasons. Data were statistically Analysed using single factor Anova, ten treatments and three replications.

Collection of specimen

Field survey was carried out for collection of specimen, potato tubers infested by Potato Tuber Moth were collected from different farmer's field of in seven taluks of Hassan district Hassan, Arkalgud, Holenarsipura, Channarayapatna, Arsikere, Alur and Belur. The infestation of Potato Tuber Moth is usually by the larvae, the infested potato can be easily recognized by the presence of holes and mounds of excreta present at the surface of tunnel entrances.

To Study life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) during winter, summer and rainy season, rearing of the Potato Tuber Moth was a prerequisite for the bioassays and storage experiments. Potato tuber infested with the Potato Tuber Moth were collected from the farmer's field and placed in wooden

rearing cages.

Adults were paired in glass test tube for mating covered with paper under side for matting to facilitate egg laying, honey or sugar solution was supplied to feed the moth, colour papers were checked every day, the number eggs were counted eggs were examined daily for hatching and the change in their colour was noticed and recorded. The egg was minute, oval in shape, pearly white colour changed to yellow colour on maturity and black just before hatching, after egg hatching first instar larva was immediately transferred on fresh potato, larva was pored with the help of a brush in to the potato tubers, duration of larval were noticed and recorded. The larva passed through four instars, it was yellow creamy grey in colour when young and becomes greenish white or pink when older, with dark brown head, Pupation occurs on the soil or on the stored potato tuber, each pupa was covered with sandy soil to facilitate the pupation, pupa was spindle shape, uniform brown colour, Pupa was isolated individually in a bottle to determination of the emergence time pupation period was calculated.

Results and discussion

The Potato Tuber Moth is worldwide pest of potato



Fig. 1: Potato Tuber Moth infected potato tubers



Fig. 2: Egg stage of Potato Tuber Moth



Fig. 3: Larva of Potato Tuber Moth



Fig. 4: Pupa stage of Potato Tuber Moth



Fig. 5: Potato Tuber Moth in test tube

in tropics and subtropic region. The present work included detailed studies on the biology winter, summer and rainy season in Hassan district of Karnataka state, The biological studies showed that, the temperature and relative humidity affected the duration of the different developmental of the stages during the winter, summer and rainy season.

Eggs stage

Eggs were deposited singly or in groups on the paper, incubation period varies from 3-4 days (table 1) The average incubation period was 3.6 days (table 2) in winter season, duration of incubation period is from 3 days in summer season (table 1) average incubation period was 3 days (table 2) and in rainy season incubation period varies from 3-4 days (table 1) the average incubation period was 3.5 days (table 2) statistical analysis showed significant differences between three season, This is similar to the findings obtained by Mairy, *et al.* (1999) who stated that the incubation period was 3.45 days,

Larval stage

The duration of larval development from egg hatching to pupation lasted from 11-13 days (table 1) with average 11.80 days in winter season (table 2), duration of larva is from 7-9 days (table 1) with an average of 8.2 days in summer season (table 2) and in rainy season duration of larva is from 10-11 days (table 1) with average of 10.3 days (table 2) statistical analysis showed significant differences between three season.

First larval instar is very small, worm like with yellowish colour, head and prothoracic shield dark brown. In winter season the duration of first instar larva ranged between 3-4 days (table 3) with an average of 3.9 days (table 4) in winter season, during summer season of first instar larva is 3 days (table 3) with an average of 3 days

Table 1: Study of life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) in different seasons

Name of the different season	Specimen number	Incubation period (days)	Larval period (days)	Pupal period (days)	Total life cycle (days)
Winter season	1	4	11	5	20
	2	3	11	5	19
	3	4	11	6	21
	4	3	12	7	22
	5	4	12	6	22
	6	4	11	6	21
	7	4	12	6	22
	8	3	13	6	22
	9	4	12	7	23
	10	3	13	7	23
Summer season	1	3	9	6	18
	2	3	9	7	19
	3	3	8	6	17
	4	3	7	5	15
	5	3	8	6	17
	6	3	7	6	16
	7	3	9	7	19
	8	3	8	6	17
	9	3	9	6	18
	10	3	8	5	16
Rainy season	1	4	10	8	22
	2	3	10	7	20
	3	4	10	8	22
	4	3	10	8	21
	5	3	11	6	20
	6	4	10	7	21
	7	4	10	7	21
	8	3	11	7	21
	9	4	10	7	21
	10	3	11	6	20

(table 4) and in rainy season duration of first instar larva ranged from 3-4 days (table 3) with an average of 3.1 days (table 4) there are significant difference between three season.

The body colour of second instar larva is white, with dark spots and number of bristles on each segment, head

Table 2: Mean of life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) in different seasons.

S.N.	Parameters (days)	Winter season	Summer season	Rainy season	'p' value
1	Incubation period	3.60	3.0	3.5	0.008**
2	Larval period	11.80	8.2	10.3	0.000**
3	Pupal period	6.10	6.0	7.1	0.003**
4	Total life cycle	21.50	17.2	20.9	0.000**

** : significant at 1%

clear dark, thoracic prolegs dark brown. The abdominal pseudo legs are white in colour duration of second larval instar ranged between 2 days (table 3) with an average of 2 days, (table 4) in winter season while in summer duration of second larval instar was range 1-2 days (table 3) with an average of 1.4 days (table 4) and in rainy season duration of second larval instar 2 days (table 3) with an average of 2 days (table 4) statistical analysis showed significant difference between three season.

The body colour of third instar is creamy to green with more visible spots along the body, head and prothoracic shield are dark brown in colour, The third instar larva ranged 3-4 days (table 3) with an average of 3.70 days (table 4) in winter season, while in summer duration of

Table 3: Study of life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) in different seasons

Name of the different seasons	Specimen number	Duration of first instars (days)	Duration of second instars (days)	Duration of third instars (days)	Duration of fourth instars (days)	Total
Winter season	1	4	2	3	2	11
	2	3	2	4	2	11
	3	4	2	3	2	11
	4	4	2	4	2	12
	5	4	2	4	2	12
	6	4	2	3	2	11
	7	4	2	4	2	12
	8	4	2	4	3	13
	9	4	2	4	2	12
	10	4	2	4	3	13
Summer season	1	3	2	2	2	9
	2	3	2	2	2	9
	3	3	1	2	2	8
	4	3	1	2	1	7
	5	3	1	2	2	8
	6	3	1	2	1	7
	7	3	2	2	2	9
	8	3	1	2	2	8
	9	3	2	2	2	9
	10	3	1	2	2	8
Rainy season	1	3	2	3	2	10
	2	3	2	3	2	10
	3	3	2	3	2	10
	4	3	2	3	2	10
	5	4	2	3	2	11
	6	3	2	3	2	10
	7	3	2	3	2	10
	8	3	2	4	2	11
	9	3	2	3	2	10
	10	3	2	4	2	11

third instar larval is 2 days (table 3) average duration was 2 days (table 4) and in rainy season duration of larva ranged from 3-4 days (table 3) with an average of 3.2 days (table 4) statistical analysis shows significant differences between three season.

Table 4: Mean duration Study of life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) in different seasons

S.N.	Parameters (days)	Winter season	Summer season	Rainy season	'p' value
1	First instars	3.90	3	3.1	0.000**
2	Second instars	2.0	1.4	2.0	0.000**
3	Third instars	3.70	2	3.2	0.000**
4	Fourth instars	2.20	1.8	2	0.049*

** : Significant at 1%

* : Significant at 5%

Fourth instar has green to pinkish colour with dark brown head and prothoracic leg, the thoracic legs are dark while the pseudo legs are green The fourth larval instar ranged between 2–3 days (table 3) with an average of 2.2 days (table 4), in summer season duration ranged from 1-2 days (table 3) with an average duration 1.8 days (table 4) and in rainy season duration is 2 days (table 3) with an average of 2 days (table 4) statistical analysis shows significant difference between three season, The increase in temperature and the decrease in relative humidity reduced the larval duration, The findings agreed with result obtained by Fu Rong, *et al.* (2004) who stated that the period ranged from 11 to 15 days and the summer findings agreed with Gamboa and Notz (1990) who mentioned 9 to 10

Table 5: Study of life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) in different seasons

Name of the different seasons	S.N.	Number of egg laid no/female	Longevity of Female (days)	Longevity of Male (days)
Winter season	1	123	16	15
	2	121	16	15
	3	112	17	14
	4	120	18	13
	5	109	17	15
	6	120	16	15
	7	122	16	17
	8	121	18	15
	9	120	17	15
	10	118	18	15
Summer season	1	70	9	8
	2	55	11	9
	3	62	13	8
	4	73	14	10
	5	50	11	8
	6	65	12	8
	7	46	9	8
	8	58	10	7
	9	45	11	9
	10	80	11	7
Rainy season	1	95	12	13
	2	90	15	12
	3	90	13	11
	4	90	13	10
	5	90	12	10
	6	85	14	12
	7	90	12	10
	8	85	13	11
	9	95	15	11
	10	95	14	10

days for the larval period. The summer findings also agreed with Mohammed (2000) who stated 8 to 10 days with an average of 8.5 ± 0.3 days. similar to the findings obtained by Mairy, *et al.* (1999) who stated that the larval duration averages were 11.8 days, 8.2 days and 10.3 days in winter, summer and rainy season respectively.

Pupa stage

Before pupation the fully grown fourth instar larva stopped feeding and left the inside of tuber searching for favorable place to pupate. Pupation occurs on the soil or on the stored potato tuber, The duration of pupal period ranged between 5-7 days (table 1) with an average of 6.1 days (table 2) in winter season, duration of pupa is from 5-7 (table 1) with an average of 6 days in summer season (table 2) and in rainy season pupal period ranged between 6-8 days (table 1) with an average of 7.1 days (table 2) statistical analysis showed significant differences between three season, This is similar to the findings by Fu-Rong, *et al.* (2004) who stated 5 to 6 days for pupal

duration, and different from the findings of Gamboa and Notz (1990) who stated 6-7 days. This may be due to the climatic conditions.

Life cycle

The whole life cycle of the Potato Tuber Moth from egg to adult emergence under laboratory conditions ranged from 19-23 days (table 1) with an average of 21.5 days in winter (Table 2), from 15-19 days (table 1) with an average of 17.2 days (table 2) in summer season and during rainy average ranged from 20-22 days (table 1) with an average of 20.9 days (table 2) statistical analysis showed significant differences between 3 season, agreed with the results obtained by Keller (2002) who stated 25.5 days at 25.6°C and 110 days at 11.2°C . Variable durations of the adult life span or longevity were recorded.

Number of Eggs/female

The number of egg laid in the winter was 109 to 123 egg/female (table 5) with an average of 118.6 egg/female (Table 6), number of egg laid during summer varies from 46-80 egg/female (table 5) with an average of 60.4 egg/female (Table 6) and during rainy season number of egg laid varies from 85-95 (table 5) with an average of 90.5 (Table 6) statistical analysis shows significant difference between three season, similar findings by Saeed Hassan Mohammed Zein Mostamhil (1999) The fecundity in the winter was 105 to 151 egg/female with an average of 127.8 ± 15.6 egg/ female, while in the summer from 16-85 eggs/female with an average of 54.5 ± 20.9 eggs/female, and there was a significant difference. The increase in the temperature reduced the eggs laying.

Longevity of Female and Male

The female life span during winter ranged from 16-18 days (table 5) with an average of 16.9 days (Table 6) during summer female life span ranged from 9-14 days (table 5) with an average of 11.1 days (Table 6) and during rainy

Table 6: Mean of Study of life cycle of Potato Tuber Moth *Phthorimaea operculella* (Zeller) in different seasons

S.N.	Parameters	Winter season	Summer season	Rainy season	'p' value
1	Number of egg laid (no/Female moth)	118.6	60.4	90.5	0.000**
2	Longevity female (days)	16.9	11.1	13.3	0.000**
3	Longevity male (days)	14.9	8.2	11	0.000**

** : significant at 1%

season female life span ranged from 12-15 days (table 5) with an average of 13.3 days (Table 6) here was significant differences between three season. Female of Potato Tuber Moth survived for 16.9 days in winter, 11.1 days in summer and 11 days in rainy season, The male life span ranged from 13-17 days (table 5) with an average of 14.9 days (Table 6) in the winter, during summer male life span ranged from 7-10 days (table 5) with an average of 8.2 days (Table 6) and during rainy season male life span ranged from 10-13 days (table 5) with an average of 11 days (Table 6) the data analysis showed that there was significant differences between three season, The longevity data indicated that the female lived longer than the male in both the season. Results agreed with those obtained by Mohammed (2000) who stated that the female life span took 7 to 13.75 days, while in the male took 5.1 ± 1.5 days.

Conclusions

The biology of the Potato Tuber Moth was studied. However, the following could be concluded

The duration of different developmental stages of Potato Tuber Moth *Phthorimaea operculella* (Zeller) incubation period in winter season was 3.6 days in summer 3 days, 3.5 days in rainy season, 11.80 days for larvae in winter 8.2 days in summer and 10.3 days in rainy and pupation period in winter 6.1 days, in summer 6 days, in rainy 7.1 days Average total life cycle duration from egg to adult emergence was 21.5 days in winter season in summer 17.2 days, in rainy 20.9 days number of egg laid/female in winter season was 118.6 in summer 60.4 and in rainy 90.5, female longevity was 16.9 days in winter, in summer it was 11.1 days, in rainy 13.3 days, male longevity was 14.9 days in winter, 8.2 days in summer season 11 days in winter.

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