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AGE ASSOCIATED CHANGES IN THE REPRODUCTIVE PERFORMANCE OF FEMALE *SPODOPTERA LITURA* (NOCTUIDAE: LEPIDOPTERA)

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Abstract

*Reproductive senescence in **Spodoptera litura** is likely to be correlated with changes in the reproductive cycle of both males and females as they enter sexual maturity.*

*In the present study, the effect of aging on the reproductive performance of both sexes was studied in Spodoptera litura. Aging in both sexes significantly reduced reproductive fitness. Female aging had a significantly stronger effect than male aging on fecundity and fertility. However, the increased age of the male and female moths had a negative effect on the percentage of mating, the total number of eggs, and the hatchability. The female reproductive performance in **Spodoptera** litura decreased considerably with the increase in moths' age. The reduction in fecundity within the females who mated late in relation to the females which mated early was much greater than the number of eggs laid by virgin females before mating. The key cause of the decline in fecundity was found due to aging.*

Key Words: *spodopetra litura, agerig, fecundity*

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Introduction

The relationship between age and reproduction is an important parameter required for studying and understanding the effective mechanism that- involves mating disruption. This can be achieved by preventing or delaying the mating .The optimal delay of mating within the target insects for achieving maximum control efficacy is the main concern of this study. This relationship between age and reproductive performance of the insects can be also important in the implementation of the **SIT** (Sterile insect technique).

The role of age in a mating system, though theoretically and empirically assessed in other insects for the better understanding of its evolutionary significance, has been meagerly studied in *Spodoptera litura*. Information on how the age influences mating behavior and reproduction in predaceous ladybirds may supplement our knowledge for their options in rearing , biological control and is thus of pragmatic relevance (Hodek and Ceryngier, 2000).

The quest arises if the paternal age contributes to the fecundity and progeny production? Whether the delayed mating affect quantitative progeny production? Are the older males better mates? To seek the answers to these questions and to evaluate age as a variant factor, experiments were designed to determine its influence on reproductive performance of *Spodoptera litura.*

The tobacco cutworm, *Spodoptera litura* (Lepidoptera: Noctuidae) is a serious polyphagous pest worldwide and is a potential candidate for SIT. The female sex pheromone in *S. litura* has been identified and proposed for control applications (**S.Yang ,** 2009). *S. litura* larvae and adults are widely being studied in behaviour, physiology and molecular biology studies due to their large size and ease of breeding,

Materials And Methods

Spodoptera litura (Fabricius) commonly known as tobacco caterpillar belongs to family Noctuidae (Lepidoptera). Being a serious polyphagus pest its outbursts are sporadic, (Srivastava, 1962). The present studies involve the effect of ageing on the reproductive capacities of the *Spodoptera litura* .The stock culture of *Spodoptera litura* was obtained from Entomological laboratory of IARI Pusa, New Delhi.

The culture of *Spodoptera litura* was maintained on Castor leaves *Ricinus communis* under controlled temperature (26.2±2°C), humidity (65±5% RH) and 14 h light: 10 h dark cycle conditions in (7.5cmdia× 25cm) glass jars. Eggs of the insect were

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seeded on the soft castor leaves and put in the plastic boxes (10cm dia× 12cm height), covered on top with white muslin cloth. Pupae collected from spools were sexed. Male and female pupae were placed in separate jars that were checked twice daily. The moths of pre –determined age were drawn from this colony to perform the desired experiments.

Experimental set-up and observations :

Effect of Ageing on the fecundity was recorded by installing the experimental set up of mating newly emerged males (up to 24 hours) with three and five day old virgin females respectively in a mating cage. In the reciprocal cross newly emerged females were allowed to mate with three and five day old unmated males. The experimental cages were laid with sugar solution soaked cotton swabs as food. Each treatment was replicated 10 times .The glass cages were checked daily for number of eggs laid by females after collection of the eggs from underside of leaves with the help of soft haired brush.

The observation of fecundity, fertility and development period of one day old female mated with one day old male was taken as control.

Percentage reproductive success (RS) ,mortality percent and growth index (GI) were also calculated:

RS=No. of adults emerged÷ No.of eggs laid×100

GI=%RS÷development period

The age specific fecundity in Virgin females with respect to mated ones were observed. The eggs were counted for checking any variation in their number.

The variation in the development period, egg laying capacity and hatching was also studied in control and aged male and female insects.

The longevity of adults was recorded until all the adults were dead. Longevity in relation to the sexual activity among both male and female insect moths was studied also.

The effect of ageing on the fecundity and longevity of newly emerged adults of *Spodoptera litura* was studied by keeping virgin females singly in the cages with the food . The eggs laid by the virgin females were counted and kept for further studies.

Results

These results clearly indicate that age does have a significant effect on the reproductive attributes of both male and female *Spodoptera litura.*

Female reproductive activity of normal and aged females was assessed by their egg laying capacity for seven days. The number of larvae which hatched out of eggs was also recorded in the experimental set up to assess the fertility. On an average reproductive period of female moth occupied 25% of their total life span.

Table2 also indicated the age associated changes on the number of eggs laid per female in one week life span .

Gunn and Gatehouse, (1985) demonstrated that the reproductive potential of *Spodoptera exempta* is dependant on the availability of water in adult stages. The reserve material derived from larval and adult feeding make up to the reproduction and oviposition. (Parson and Marshall,1939). In young stages these reserves are in bulk ,therefore females after mating lay more viable eggs .But as the age prolongs the reserve materials are used in physical activity like flight,search for mates and other physiological activities. So the expenditure of this reserve material lead to non-viable egg production.

Egg laying activity was expressed in terms of average number of eggs laid by the female in its total life span. The data in Table 1 and 2 signify the decrease in the number of eggs with the increase in the age of female moth. The average number of eggs per female in its seven days life span is 1594.8±32.5 but this average number decreases with the increase in female age i.e. 748.8±23.14 . However the coefficient of variance was small and constant for the first and second day of fecundity. It showed an increase in egg production for 3rd and 4th day . But later it decreased gradually . Very few eggs were laid on 7th day and the female died on 8th day without oviposition.

The Average mortality of eggs in case of control (1dayoldmale×1dayfemale)was compared with the mortality of eggs in other experimental setups (1dayoldfemale ×5 dayoldmale and 5dayfemale× 1day old male).

It showed that vigor and viability of eggs in order to hatch declined with the increase in the age of females. The percentage mortality was high i.e. 28.7 to 34.7 in the experimental setup of 5dayfemale crossed with 1day old male from first to 7th day . However the percentage mortality declined when the age of female was 1day old and male 5 day old i.e. 25.3%to 26.6%.

The viability of eggs were also affected where male was older but not to the extent of female moth.

The Developmental period of the offsprings of older females was significantly more than the offsprings of young females but the reproductive success was greater where female age was less. It was 87.4% in control ,but went down in the cross between 1day old female and 5 day old male (74.8%).

There was further decrease in reproductive success when female was 5day old and male one day old (66.3%).

Growth index in case of control (3.03) was greater than that of experimental set ups (2.28 in one day male crossed with 5 day female and2.55 when one day female crossed with 5 day male). Raina ,(1970) observed that in *Callosobruchus chinesis* the eggs laid during last days of oviposition were nonviable. Also there was prologation of lifecycle in eggs after the twelfth day of oviposition.

Longevity in relation to sexual activity was also studied . It was found that isolated virgin females and males had a longer life span (males-6.1days and females -9days) than mated ones (males 4.6days and females 7days). This revealed that there was a significant variation in longevity of insects in relation to sexual activity.

Experimental setups involving the **virgin females** showed that virgin females were able to oviposit a small number of eggs during its life span of 7 days. The female is not able to lay the eggs on Ist and 2nd day. The process of oviposition increased with the increase in the age of the female and then abruptly stops. In case of mated females the egg laying starts soon after mating on the Ist day . There is an increase in the egg production from Ist to 4th day .After the 4th day the number of eggs laid per female also decreased as the age of the female increased.

Discussion

Virginity of a female has a profound effece on ageing, fecundity and longevity of an insect. In absence of mating the virgin females live longer than mated ones .

The longevity of the female decreased with the increase in sexual activity. Based on the relationship between reproductive potential and life span in ***Drosophila*** Bilewics (1952) showed that life span of virgin females and isolated males was longer than that of mated ones. Avidov et-al ,(1965) reported that the virgin females of *Callosobruchus chinesis* did not oviposit in absence of copulation

Analysis of relationship between reproductive activity and the life span of individual flies revealed that shorter lived males exhibited higher copulatory activity than longer lived males (Aigaki and Ohba,1983). Patridge and Farquhar,(1981) also observed in *Drosophila* that sexual activity reduces the lifespan in male fruitflies and lead to cumulative reversible effects of sexual activity.

Williams (1957) has suggested that ageing may be caused by deleterious **pleiotrophic effects of genes in later stage of life.In order to pursue females** the male houseflies spend their metabolic potential while increasing their flying activity. The expenditure of their metabolic reserves lead to their early death.(Ragaland and Sohal,1973,1975) Clarke and Rockstein,(1964) demonstrated that the reduced metabolic activity caused by under feeding may prolong life in insects.

Females of *C. jactatana* could be more susceptible to aging than males since six days old females are less preferred for mating in comparison with three days old females, while females do not demonstrate a preference for males of different ages (Jiménez-Pérez and Wang 2004b).

Table 1 : Effect of Ageing on Fecundity of *Spodoptera litura*

Male	Female	Total no. of eggs /Female	No.of adults /Female	Developme nt period	Reproducti ve success	Mortality %	Growt h index
1day	1day	1594.8±0.74	1405±40.05	28.8±0.74	87.4±0.17	12.2±0.41	3.02
1day	5day	748.8±23.14	497.2±33.8	29.5±0.43	66.3±0.29	34.77±0.17	2.28
1day	3day	1000.35±0.77	764±2.28	28.8±0.33	76.4±0.43	23.61±0.33	3.23
3day	1day	1248.22±1.12	1075±0.06	28.8±0.55	86.1±0.11	17.3±0.15	2.98
5day	1day	1390.4±45.79	1040.24±37.4	29.0±1.75	74.8±0.34	25.05±0.16	2.55

Table 2 : Effect of parental age on the fecundity of *Spodoptera litura*

Age of the Insect	No. of the days for egg laying							
	1day old	2day old	3day old	4day old	5day old	6day old	7day old	8day old
virgin female	0	0	5.0±2.0	10.05±2.54	11.2±2.4	16.2±2.5	dead	0
1dφ×1dø	103.6±8.35	163.8±36.05	307.05±60.92	356.6±52.2	311.6±48.4	222.1±28.2	130.2±9.9	dead
1dø×5dφ	172.2±14.2	173.8±6.3	147.2±13.3	115.2±20.6	94.6±32.7	32.6±18.2	12.6±4.2	dead
1dø×3dφ	135±11.2	172±12.3	255±11.5	235±14.9	130±23.6	65±6.6 .	29±4.4	dead
3dø×1dφ	150±5.22	202±26.3	365±55.28	285±52.13	130±.44.31	78±28.2	28±6.6	dead
1dφ×5dø	7.2±6.7	71.2±44.6	207.4±80.9	396.7±81.6	260.4±88.7	83.2±37.91	14.4±1.37	dead

Φ—female

Ø-- Male

Table3 : Longevity in relation to sexual activity in *Spodoptera litura*

Experiment Insect	Longevity in days	Mean ± S.E
Virgin Female	9	9.0±0.1
Unmated Male	6.2	6.2±0.04
Mated Female	7	7.02±0.24
Mated Male	4.6	4.6±0.46

Thus, females mating at an older age are suffering reduced fecundity without gaining the advantage of the expected extended lifespan.

Reproductive senescence in *S.litura* is likely to be correlated with changes in the reproductive cycle of females as they enter sexual maturity. Newly emerged females are not eagerly receptive to mating. During the first day the neurosecretory materials accumulate and activate a receptivity center in the brain, leading to the development of mating behavior (Mack et-al ,2000). During this time the corpus allatum is inhibited by nervous signals from the br ain, leading to low levels of oocyte maturation and yolk deposition. The result of the coordinated activities of the receptivity center and the corpus allatum is that females typically mate when oocytes are small, about 1-mm long, and some yolk has been deposited. The insertion of the spermatophore after mating acts to reduce receptivity and increase activity of the corpus allatum, stimulating the further growth and development of the

Table 4: Variation in the Fecundity of the virgin female with respect to the number of eggs laid in the mated females

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Age of female in days	Mean of no. of eggs in Virgin female	Cumulative number	Mean of no. of eggs in mated female	Cumulative number
1	0	0	103±8.35	103.6
2	0	0	163±36.05	266.2
3	5.0±2.10	5	307±62.4	577.4
4	15.0±2.54	15	356±52.4	930.4
5	11.0±2.4	11	311.6±48.2	1242.2
6	16.0±2.5	16	222.02±28.4	1464.3
7	0		130.2±9.9	1594.2

oocytes. Thus, about 7 days after mating, mature oocytes pass through the bursa past the spermatheca and are fertilized

The reproductive capacity of moths could vary with age, due to a low quality or quantity of sperm, to the low male sensitivity to the pheromone released by the female, or to the low receptivity and attraction to individuals from the opposite sex (Brits 1979; Anton and Gadenne 1999; Delisle and Simard 2003).

In *Spodoptera exigua* (Hubner, 1808) , Rogers and Marti (1996) observed that individuals that copulated one or two days after emergence presented higher fecundity and fertility, but had a shorter longevity when compared to individuals that mated later.

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