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Studies on the biological attributes of *Spodoptera litura* & *Pieris brassicae* on different host plant in mid altitude of Meghalaya

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Abstract
Vegetable cultivation is important in the agriculture economy of India particularly in the north eastern states. Among the vegetables, cole crops are one of the most abundantly consumed vegetables all over the world. It provides much needed dietary fibres, essential minerals and vitamins. The chief constraint in the production of cole crops is insect pest complex, which damage the crops right from germination till harvesting time. Among all, lepidopteran pests are dominant and causing huge losses in cole crops. Hence, an investigation was carried out to study the effects of different host plants on biological attributes of the *Spodoptera litura* and *Pieris brassicae*, Overall results revealed that, different host plants were found to have variable effects on certain biological parameters. Cabbage was found to be a most preferred host for oviposition by both the insects. Larval period of *S. litura* (Frabicius) during different instars were not affected when fed on different hosts except 3rd instar, where it was found to be significantly highest on cabbage (5.75±0.25 days) and lowest on knol- khol (4.75±0.25 days) and also pupal period of *S. litura* was found to be significantly higher on knol- khol (7.25±0.25 days). It was observed that, the total larval period was found to be significantly lower on cabbage (22±0.40 days) and highest on cauliflower (28.20±0.57 days) and the larval weight of 3rd instar was found to be significantly higher on knol- khol (2.75±0.14g). This study can be concluded that, cabbage is the most preferred host for oviposition for both the test insects.

Keywords: *Spodoptera litura*, *Pieris brassicae*, biological attributes

Introduction
Cole crops the most abundantly consumed vegetables in the world include various cultivars of cabbage (*Brassica oleracea* var. c*apitata)*, cauliflower (*B. oleracea* var. *botrytis*), and knol-khol (*B. oleracea* var. *gongylodes)* and are extensively grown across the world. Globally, cabbage is grown on 3.1 million ha area and cauliflower and broccoli together grown on 9,83,000 ha (FAOSTAT, 2007) [1]. Even though, the crop has got huge domestic requirement, a number of limiting factors have been attributed for low productivity. Among them, the chief constraint in the production is damage caused by pest complex right from germination till harvesting time.

Several insect pests have been reported on cole crops worldwide, but very few are a real offender and frequently cause serious losses in yield. Most of the serious pests of cole crops mainly belong to order Lepidoptera. The most important Lepidopteran pests of cole crops are tobacco caterpillar *Spodoptera litura* (Frabicius), large cabbage white butterfly *Pieris brassicae* (Linnaeus), Indian cabbage white butterfly *Pieris canidia* (Linnaeus), and Diamond back moth *Plutella xyllostella* (Linnaeus).

A general of fifty-one insect pests species unfavourable cruciferous vegetation were mentioned from all through the world (Maison, 1965) [2]. In India a total of 37 insect pest species have been reported to feed on cruciferous crops. The vertical distribution of important pests of cole crops in Meghalaya was also influenced by the environmental factors as the climatic conditions of North east India are highly conducive for development and reproduction of insect species (Sachan and Gangwar, 1980). Moreover, North east India stocks global borders with 5 exceptional countries, consequently trans-boundary insect migration is likewise inevitable. Understanding the biology and behaviour of arthropods, detailed monitoring of life history and population dynamics of pests and natural enemies is important. Keeping in view the importance of Brassicas crops in the country including the NE region and at the mean time keeping the importance of major lepidopteran pests as the major constraints for the cultivation of Brassicas crops, the present study was conducted to accomplish the following objectives –

To study the biological attributes of *Spodoptera litura* & *Pieris brassicae* on different host plants in mid -a altitude of Meghalaya.

Materials and Methods

Location & Site

The study was carried out during 2014-15 in the IPM laboratories of Entomology section of Crop Protection Division, ICAR Research Complex for North Eastern Hill (NEH) Region, Umiam, Meghalaya. The institute is situated at Umiam (Barapani), 25º41'-21" North latitude and 91º55'-25" East longitude having an elevation of 1010 m above the msl. The climatic condition in this area is of mid tropical zone, with an average annual rainfall of 2810 mm with maximum temperature range of 20.90C to 27.40C and minimum temperature from 6.70C to 18.10C.

Collection of insect strain

Fresh eggs and larvae of different the insect pests *viz.*, tobacco caterpillar *S. litura* (Fabricius) and large cabbage white butterfly *P. brassicae* (Linnaeus) were collected from the unsprayed cabbage field of Division of Crop Protection (Entomology), ICAR Research Complex for NEH Region, Umiam, Meghalaya during the year 2014- 2015 and further reared in laboratory for different experiments.

Mass rearing of the test insect strains

Two lepidopteran pests *viz.*, *Spodoptera litura & P. brassicae*, were reared in biological control laboratory under temperature of 25±2 ˚C, relative humidity of 70-80% and 14:10 as Light and Dark period. The eggs were kept in sterilised petriplates (7.5 cm diameter). The moistened filter papers were kept inside the petriplates to prevent the desiccation. The field collected larvae were reared on fresh, healthy and tender leaves of cabbage and other available leaves of cauliflower and knol- khol throughout the experiment. After hatching from the eggs, the larvae were kept in the petri plates. After attaining 2nd instar, the larvae were transferred into the plastic jars having a size of 15 x 10 cm (Plate 1). Additional fresh and tender leaves of cabbage were provided as and when necessary and the jars were covered with muslin cloths using a rubber band. Pupae were separately kept in other jar after one day of their formation. After emergence, adult insects were released for mating in the wooden cages having a size of 50x50x50cm (Plate no.2) containing fresh cabbage seedlings for oviposition. Cotton swab with 10% sucrose solution was provided as a source of food for the adults. The eggs were collected and were placed in clean plastic containers until their hatching. Upon hatching, the larvae were provided with fresh leaves for the second generation. This methodology was followed for *P. brassicae*

In case of *S. litura*, the mature larvae were transferred to another container containing sterilised plastic jars for pupation. After emergence, the adult moths were kept inside a plastic container (11 cm diameter x 10 cm high) for mating and provided with sheet of papers for oviposition. Cotton swab with 10% sucrose solution was provided as a source of food for the adults. Eggs on papers were collected daily and placed in clean containers (12 cm diameter x 6.5 cm high). Eggs were incubated under laboratory conditions at a temperature of 25±2 °C and relative humidity of 70 to 80%. The larva inside each container was examined daily for ecdysis and upon moulting.

Studies on the biology of the major lepidopteran pests of cole crops on different host crops

Biology of two major lepidopteran pests *viz.*, *Spodoptera litura* (Fabricius) and *Pieris brassicae* (Linnaeus), were studied on three host plants (cabbage, cauliflower and knol-khol). Both the test insects were reared in the laboratory as explained and utilised for further experiments.

Before experiment, the two test insects were allowed to complete one generation on respective host plants. The experiment was started from the egg stage of the test insects. Newly hatched first instar larvae of both the insects were released separately on three different host plants and allowed to feed until their pupation. Fresh leaves of respective host plants were provided separately and regularly. Rearing containers were cleaned daily and replace as and when necessary. Pupae were separated after one day of their formation. After emergence, mated adults were allowed to lay eggs on respective host plants, where they fed. Cotton swab with 10% sucrose solution was provided as a source of food for the adults. Observations on incubation period, larval period of all the instars, pupal period, oviposition period, adult longevity and fecundity were recorded regularly. Larval instars were also recorded after each moulting after examining a head capsules.

Plate 1: Plastic jars for feeding newly emerged larvae

Plate 2: Wooden cage used for rearing of adult and pupa

Results & Discussion

1. Biological attributes of tobacco caterpillar, *Spodoptera litura* on different host plants

Different life stages of *S. litura* are shown in Plate (a-b) Table 1 indicated developmental time and various life stages of *S. litura* (F.) reared on different host plants. Incubation period of *S. litura* was found to be 2.37±.12 days, 2.12±.12 days and 2.12±.12 days on cabbage, cauliflower and knol- khol, respectively. It was observed that *S. litura* undergone five (5) instars to complete their larval development. Larval period of different instars were not affected when fed on variable hosts

except 3rd instar, where it was found to be significantly higher on cabbage (5.75±0.25 days) followed by cauliflower (5.25±0.25 days) and it was lowest on knol- khol (4.75±0.25 days) (Table 1). Total larval period of *S. litura* was not affected when fed on different host plants and it was found to be 23.75±0.25 days, 24.25±0.62 days and 24.25±0.62 days on cabbage, cauliflower and knol- khol, respectively (Table 1).

Significant variation was found in pupal period, when larvae fed on different host plants. Pupal period was found to be significantly higher on knol- khol (7.25±0.25 days) followed by cabbage (6.75±0.25 days) and lowest in cauliflower (5.75±0.25 days). Adult longevity and oviposition period of *S. litura* was not affected, when their larvae fed on different host plants.

Plate 3a. Eggs of *S. litura* **Plate 3b.** Larvae of *S. litura* **Plate 3c.** Pupae of *S. litura* **Plate 3d.** Adult of *S. litura*

Plate 3: (a-d) Developmental stages of *S. litura*

Table 1: Developmental period of *Spodoptera litura* on different host plants under laboratory conditions

Host plant	Developmental period (days) (Mean ±SEM)									
	Incubation Period	Larval period					Total larval period	Pupal period	Adult longevity	Oviposition period
		1st instar	2nd instar	3rd instar	4th instar	5th instar				
Cabbage	2.37±0.12a	3.50±0.28a	4.25±0.25a	5.75±0.25a	5.25±0.47ab	5.00±0.40a	23.75±0.25a	6.75±0.25b	7.62±0.23a	3.87±0.12a
Cauliflower	2.12±0.12a	4.25±0.25a	5.00±0.40a	5. 25±0.25a	4.75±0.25a	5.00±0.81a	24.25±0.62a	5.75±0.25a	7.12±0.12a	3.87±0.31a
Knol khol	2.12±0.12a	4.25±0.25a	4.25±0.25a	4. 75±0.25a	4.50±0.28b	4.25±0.12a	24.25±0.62a	7.25±0.25b	7±0.4a	3.75±0.25a
F value	1.333	2.700	1.929	4.000	1.167	1.588	.293	9.333	1.370	0.088
df	11	11	11	11	11	11	11	11	11	11
P value	0.311	0.121	0.201	0.057*	0.354	0.257	0.753	0.006*	0.303	0.916

(One way ANOVA, Tukeys HSD Test, p≤0.05)
Note: Different small letters after the mean values indicate significant differences among treatments.

Table 2: Weight of various life stages and fecundity of *Spodoptera litura* on different host plants under laboratory conditions

Host plant	Biological parameter (Mean ±SEM)					Pupal weight (in grams)	Fecundity (No. Of eggs/ female)
	Larval weight (in grams)						
	1st instar	2nd instar	3rd instar	4th instar	5th instar		
Cabbage	0.05±0.00a	0.21±0.00a	2.98±0.50a	5.66±0.14a	6.73±0.43a	2.74±0.1a	1550.0±51.38b
Cauliflower	0.07±0.00a	0.22±0.02a	2.81±0.46a	5.23±0.17a	6.68±0.29a	2.69±0.38a	1400.0±91.28a
Knol khol	0.07±0.00a	0.24±0.01a	2.45±0.29a	5.37±0.18a	7.10±0.13a	2.57±0.27a	1450.00±93.38a
F value	1.935	1.070	0.402	1.143	0.555	1.23	14.25
df value	11	11	11	11	11	11	11
P value	0.200	0.383	0.681	0.361	0.593	0.740	0.035*

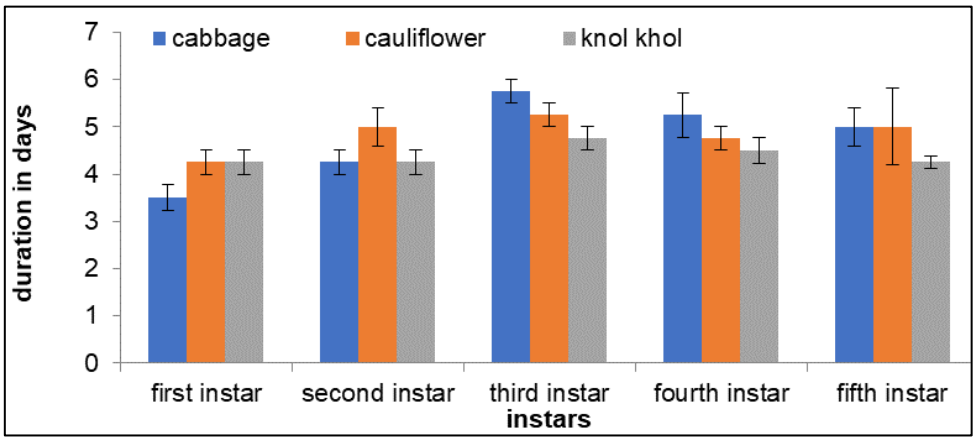

Fig 1: Developmental period of different larval instars of *Spodoptera litura* on different host plants

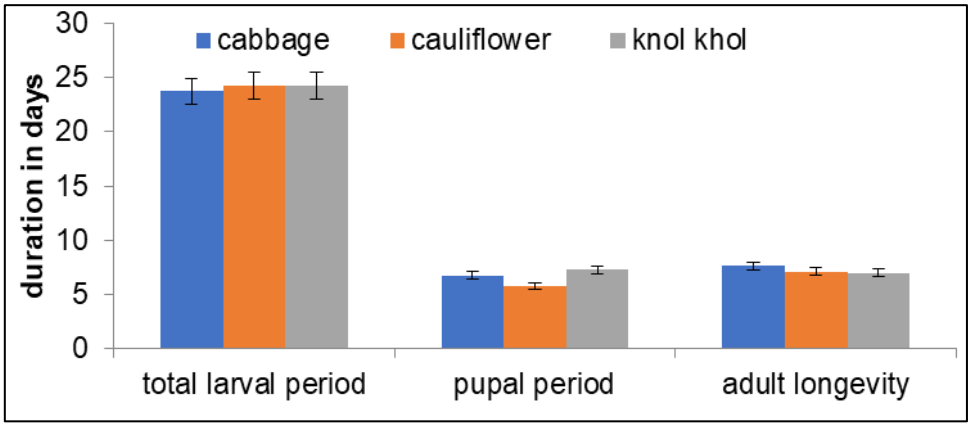

Fig 2: Total larval period, pupal period and adult longevity of *S. litura* on different host plants

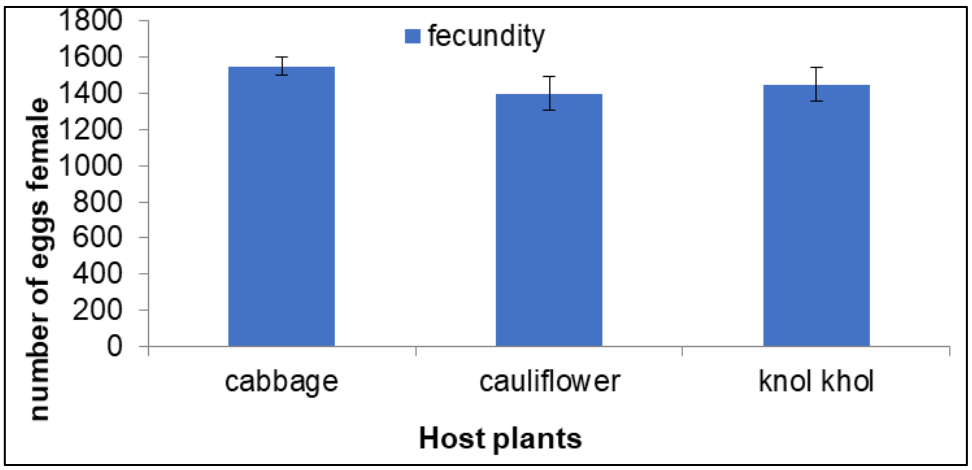

Fig 3: Mean life time fecundity of *S. litura* on different host plants

Weight of various life stages of *S. litura* and fecundity of adult female are shown in Table 2. Larval weight, pupal weight and fecundity of *S. litura* were not affected when fed on different host plants. Larval weight of 1st, 2nd, 3rd, 4th and 5th instars was observed to be 0.05±0.00g, 0.21±0.00g, 2.98±0.50g, 5.66±0.14g and 6.73±0.43g, respectively on cabbage. Similarly, it was found to be 0.07±0.00g, 0.22±0.02g, 2.81±0.46g, 5.23±0.17g and 6.68±0.29g on cauliflower and 0.07±0.00g, 0.24±0.01g, 2.45±0.29g, 5.37±0.18g and 7.10±0.13g on knol-khol. Mean lifetime fecundity of *S. litura* female was found to be significantly higher on cabbage (1550.0±51.38 eggs) followed by knol-khol (1450.00±93.38 eggs) and cauliflower (1400.0±91.28 eggs) (Fig. 3)

2. Biological attributes of cabbage butterfly, *Pieris brassicae* on different host plants

Different life stages of *P. brassicae* are shown in Plate 4 (a-d). The developmental period of different stages of *P. brassicae* are indicated in Table 3. Significant difference was not observed in the incubation period, when larvae fed on variable hosts. The incubation period of *P. brassicae* was observed to be 2.37±0.12 days, 2.12±0.12 days and 2.12±0.12 days on cabbage, cauliflower and knoI- khol, respectively. It was observed that *P. brassicae* undergone five (5) larval instars. Significant differences in larval period were found from 2nd instar till 5th instar (Fig.3). The total larval period was found to be significantly lower on cabbage (22±0.40 days) followed by knol- khol (26.50±0.28 days) and highest on cauliflower (28.20±0.57 days) (Fig.4.5). Significant variation was also found on the pupal period of *P. brassicae* and it was observed to be highest on knol- khol (7.25±0.25 days) followed by cabbage (6.75±0.25 days) and cauliflower (5.75±0.25 days). The adult longevity and oviposition period of *P. brassicae* was not influenced by the different host plants. The adult longevity of *P. brassicae* was found to be 7.62±0.23 days, 7.12±0.12 days and 7±0.40 days on cabbage, cauliflower and knol- khol, respectively. The oviposition period was observed to be 3.87±0.12 days 3.87±0.37 days and 3.75±0.25 days on cabbage, cauliflower and knol- khol, respectively.

Larval weight of *P. brassicae* was not affected when their larvae reared on different host plants (Table 4). Interestingly, the larval weight of 3rd instar was found to be significantly higher on knol- khol (2.75±0.14g) followed by cabbage (2.50±0.28g) and lowest on cauliflower (1.87±0.28g). Similar trend was observed in pupal weight and it was found to be highest on knol- khol (1.21±0.05g) followed by cabbage (1.01±0.14) and cauliflower (0.95±0.03g). Significant variation was also observed in their fecundity (Fig. 6), where it was found to be significantly highest on cabbage (97.50±5.26 eggs) followed by knol- khol (93.25±4.99) and cauliflower (73.75±4.17 eggs).

Plate 4a. Eggs of *P. brassicae* **Plate 4b.** Larvae of *P. brassicae* **Plate 4c.** Pupae of *P. brassicae* **Plate 4d.** Adult of *P. brassicae*

Plate 4 (a-d): Developmental stages of *Pieris brassicae*

Table 3: Developmental period of *Pieris brassicae* on different host plants under laboratory conditions

Host plant	Developmental period (days) (Mean±SEM)									
	Incubation Period	Larval period					Total larval period	Pupal period	Adult longevity	Oviposition period
		1st instar	2nd instar	3rd instar	4th instar	5th instar				
Cabbage	2.37±0.12^{a}	3.25±0.25^{a}	4.75±0.25^{ab}	4.50±0.28^{a}	6.25±0.25^{b}	4.25±0.25^{ab}	22±0.40^{a}	6.75±0.2^{b}	7.62±0.23^{a}	3.87±0.12^{a}
Cauliflower	2.12±0.12^{a}	3.50±0.28^{a}	4.25±0.55^{a}	4.75±0.25^{ab}	5.75±0.25^{b}	4.75±0.25^{a}	28.20±0.57^{c}	5.75±0.25^{a}	7.12±0.12^{a}	3.87±0.37^{a}
Knol khol	2.12±0.12^{a}	3.75±0.47^{a}	5.25±0.25^{a}	5.50±0.28^{a}	4.50±0.28^{a}	3.50±0.28^{a}	26.50±0.28^{b}	7.25±0.25^{b}	7±0.40^{a}	3.75±0.25^{a}
F value	1.333	0.500	4.0	3.545	11.70	5.700	12.56	9.333	1.370	0.088
df	11	11	11	11	11	11	11	11	11	11
P value	0.311	0.622	0.057*	0.03*	0.003*	0.025*	0.002*	0.006*	0.303	0.916

(One way ANOVA, Tukeys HSD Test, p≤0.05)
Note: Different small letters after the mean values indicate significant differences among treatments.

Table 4: Weight of various life stages and fecundity of *Pieris brassicae* on different host plants under laboratory conditions

Host plant	Developmental period (Mean±SEM)					Pupal weight (in grams)	Fecundity (No. of eggs/ female)
	Larval weight (in grams)						
	1st instar	2nd instar	3rd instar	4th instar	5th instar		
Cabbage	0.001±0.00^{a}	0.92±0.47^{a}	2.50±0.28^{ab}	2.50±0.28^{a}	4.25±0.25^{a}	1.01±0.14^{a}	97.50±5.26^{b}
Cauliflower	0.02±0.00^{a}	0.80±0.04^{a}	1.87±0.28^{a}	2.75±0.25^{a}	3.75±0.25^{a}	0.95±0.03^{a}	73.75±4.17^{a}
Knol khol	0.025±0.00^{a}	0.90±0.05^{a}	2.75±0.14^{b}	2.83±0.86^{a}	4.50±0.28^{a}	1.21±0.05^{b}	93.25±4.99^{b}
F value	0.000	1.800	5.087	0.517	2.100	1.67	14.733
df value	11	11	11	11	11	11	11
P value	1.000	0.220	0.033*	0.613	0.178	0.015*	0.001*

(One way ANOVA, Tukeys HSD Test, p≤0.05)
Note: Different small letters after the mean values indicate significant differences among treatment

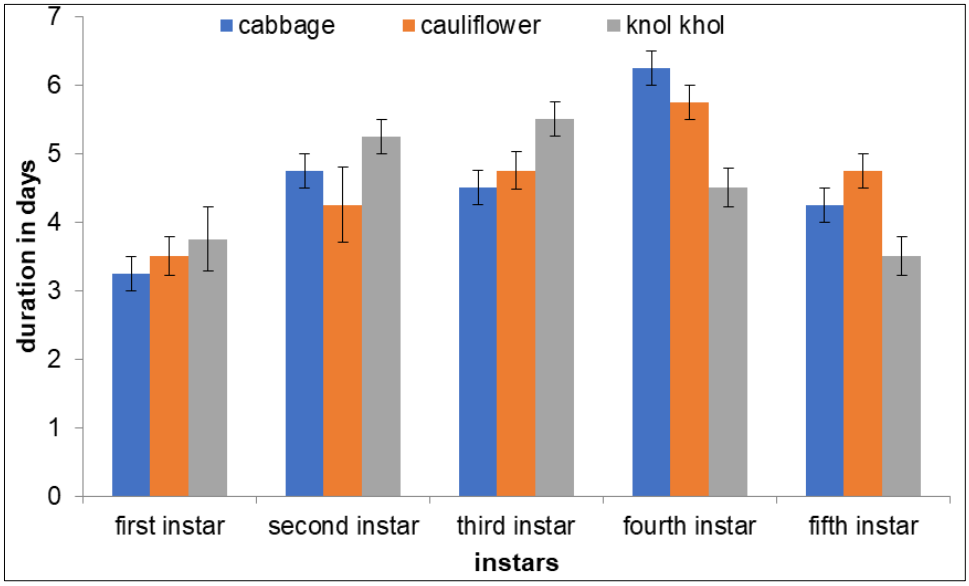

Fig 4: Developmental period of different larval instars of *Pieries brassicae* on different host plants

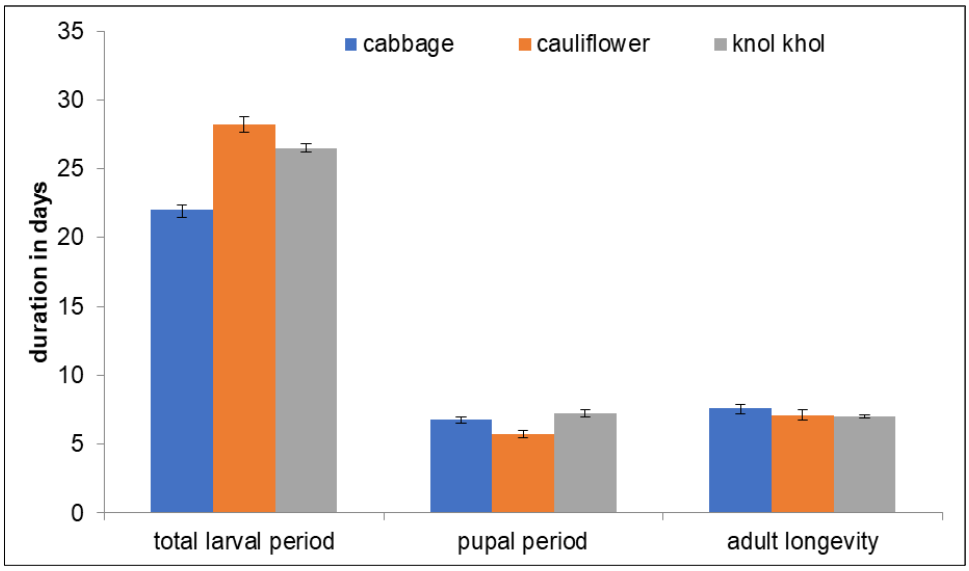

Fig 5: Total larval period, pupal period and adult longevity of *P. brassicae* on different host plants

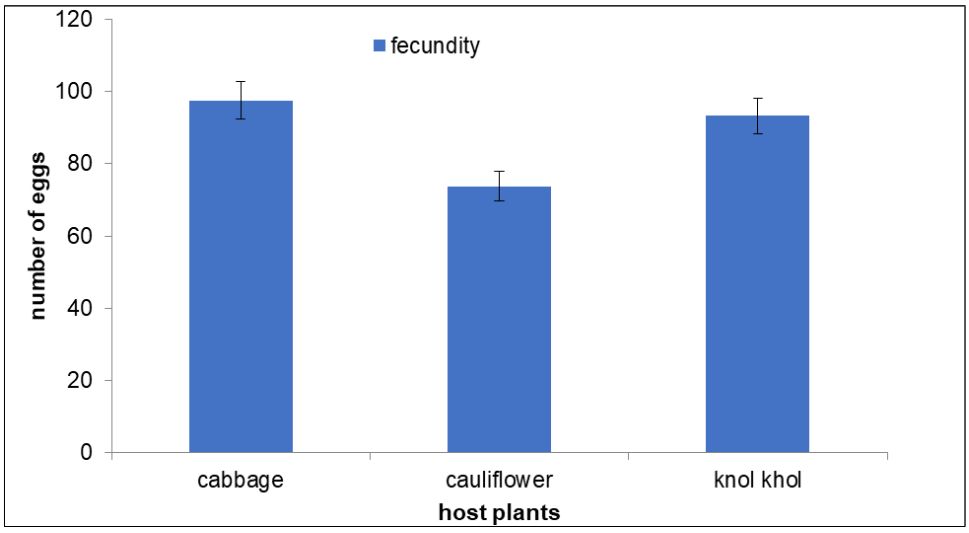

Fig 6: Mean lifetime fecundity of *P. brassicae* on different host plant

Summary and conclusion

The findings of the experiments of 'Studies on the biological attributes of major lepidopteran pests on different host plants' are summarized and concluded as below:

1. Larval period of *Spodoptera litura* (Frabicius) during different instars were not affected when fed on different hosts except 3rd instar, where it was found to be significantly highest on cabbage (5.75±0.25 days) and lowest on on knol- khol (4.75±0.25 days). Pupal period of *S. litura* was found to be significantly higher on knol-khol (7.25±0.25 days) and lowest in cauliflower (5.75±0.25 days). Larval weight, pupal weight and fecundity of *S. litura* was not affected when fed on different host plants and mean lifetime fecundity of *S. litura* was found to be significantly higher on cabbage (1550.0±51.38 eggs).
2. Significant difference was not observed in the incubation period of *Pieris brassicae* (Linnaeus) on variable hosts. The total larval period was found to be significantly lower on cabbage (22±0.40 days) and highest on cauliflower (28.20±0.57 days). Significant variation was also found on the pupal period of *P. brassicae* and it was observed to be highest on knol- khol (7.25±0.25 days). The larval weight of 3rd instar was found to be significantly higher on knol- khol (2.75±0.14g) and lowest on cauliflower (1.87±0.28g). Similar trend was observed in pupal weight of *P. brassicae*. Mean lifetime fecundity was found to be significantly highest on cabbage (97.50±5.26 eggs) and lowest on cauliflower (73.75±4.17 eggs).

Conclusion

This study can be concluded that, cabbage is the most preferred host for oviposition for major lepidopteran pest.

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