CHAPTER IX
GENERAL DISCUSSION

The phytophagous insects use plant nutrients for their growth and development. The quality and quantity of host plants have a great role in the growth and reproduction of an insect. Each host plant contains various nutritional and anti-nutritional substances for which regulation of their uptake by an insect shows integration of a highly complex set of interacting processes (Simpson and Raubenheimer, 1999). Any change in the nutritional quality of the host plant may result in adverse physiological adaptation. The environmental factors have a direct influence on the host plants in different seasons (Hering and Taguchi, 1951).

The diet of phytophagous insects has got a significant influence on the biochemical constituents of the insect tissues. Continuous feeding generally depends on continuous phagostimulation and an insufficient concentration of phagostimulants causes early cessation of feeding (Bdmays et al., 1975). The present study revealed the effect of selected host plants on biochemical components of the insect tissues. The quality of host plants describes the tissue components of the insects (e.g., the levels of protein, carbohydrate, trace elements and defensive compounds) that can affect the feeding and digestion positively or negatively in herbivorous insects.

The protein content in different tissues (midgut, fat body and haemolymph) of last instar castor fed larvae of S. litura was found to be comparatively very high than in the tissues of the larvae fed with other host plants. Among the selected host plants castor showed the highest protein concentration than the other host plants in the summer, monsoon and post monsoon seasons. This variation in plant proteins may be due to the
environmental factors such as the amount of light it receives, the chemical composition of the soil and inputs of water (Felton, 1996; Walter et al., 2012). So the feeding of castor leaves may have caused an increase in the concentration of protein in the midgut, fat body and haemolymph of *S. litura* larvae during all the seasons. During the larval feeding stage the rate of synthesis of protein is generally higher in the fat body and in the mature larvae the protein content is higher in both the haemolymph and fat body (Thompson, 1975).

In all the selected host plants protein content was highest during summer than in monsoon and post monsoon seasons. Similar work was reported by Sheth (2011) who suggested the presence of highest protein content in all the parts of *Calotropis procera* during the summer season and lowest in the winter season. However, Chaluvachari and Bongale (1995) have reported lower value of nitrogen, protein and sugar content in leaf during summer. But Obata and Fernie (2012) reported higher concentration of protein in leaves under stress conditions. The temperature and humidity variations prevailing during summer must have caused the variation in protein level in the food plants. This seasonal variation in the protein content of the host plants also influenced the protein content in the midgut, fat body and haemolymph of the *S. litura* when they were fed with these host plants. So the midgut, fat body and haemolymph of *S. litura* showed higher concentration of protein during summer than in the monsoon and post monsoon seasons when fed with all the selected host plants.

Similarly the low intake of food or the intake of low quality food by *S. litura* during post monsoon season may reduce the protein content in its tissues. The fluctuation in the protein content in the whole body tissue may be attributed to a variety factors such as diet, temperature, photoperiod, developmental stages and soil condition of host plants. The influence of all
these factors will implicit seasonal changes in the protein and free amino acid pool (Graney and Giesy, 1986). Therefore it may be assumed that the variable nutritional value caused by seasonal variation may be responsible for difference in protein level in different tissues of *S. litura* during different seasons. Variations in protein content of insect tissues due to the effect of feeding and physiological activities are reported by various researchers (Banno *et al*., 1993; Aruga, 1994).

The present work recorded the highest amino acid content in the leaves of selected host plants during the summer season comparing to the monsoon and post monsoon seasons. This results corroborate with the findings of Kramer (1983) who reported that during summer the water stress disrupted the nitrogen metabolism leading to solubility of protein and accumulation of amino acids. But Ferrario *et al.* (1998) reported that under drought stress amino acids concentration in tobacco plants decrease due to the low activity of nitrate reductase enzymes which is responsible for transforming NO$_3^-$ to NO$_2^-$. This seasonal variation in the aminoacid content of the selected host plants has also influenced the amino acid content in the tissues of *S. litura* when they were fed with these host plants.

The highest concentration of amino acids was recorded in the midgut tissue, fat body and haemolymph of larvae of *S. litura* during the summer season. This may be due to the highest concentration of amino acid in the host plant leaves during the summer season. Among the selected host plants the castor leaves showed highest amino acid content and the banana leaves showed least amino acid content than the other selected plant leaves. This variation in the aminoacid content of the host plants also influenced the concentration of amino acid in the midgut tissue, fat body and haemolymph of the larvae of *S. litura* fed with these host plants. Due to the presence of higher concentration of aminoacid in the castor leaves all the tissues of the larvae fed
with castor leaves exhibited a higher concentration of amino acid than the tissues of larvae fed with other host plants. In the present work, it was noticed that a high concentration of amino acid was present in the haemolymph of the larvae than in the midgut tissue and fat body. Various researchers made detailed investigation on haemolymph free amino acid level in different insects (Wyatt, 1961; Sutcliff, 1963; Florkin and Jeuniaux, 1974).

Cook et al. (1972) reported that the decline in free amino acid content in insects during winter season is associated with the carbohydrate metabolism. In banana fed larvae, the low level of free aminoacid during the post monsoon season may be due to their utilization for generating energy via gluconeogenesis. Influence of dietary components in the concentration of amino acids in insect larvae was reported by Burnet and Sang (1968) and Strong (1964).

Other growth related functions, like metamorphosis (Ducbautreau and Florkin, 1959), detoxification (Cauda, 1955) organ formation (Goldberg and Demeillon, 1948), energy production, histogenesis (Jolly et al., 1972) and during different metabolic, metamorphic and stressful situations like osmoregulation (Bishop et al., 1925) and protein synthesis (Buck, 1953) also affect the variations in amino acid content of the insect tissues.

Carbohydrates are probably the most widely distributed and widely occurring compounds in plants in which their quantity and quality vary exceedingly. In the present study, among the selected host plants the amount of total carbohydrate content was recorded highest in castor in comparison to other selected host plants. This variation may be due to the following factors as described by various researchers that is in plants fluctuation in carbohydrates exists at different levels, including between the species (Yeoh et al., 1992), within the species (Sattelmacher et al., 1994) and within an individual plant (Mattson, 1980) depending on the type of tissue (i.e., leaves,
flowers, seeds and stems) and its age (i.e., young versus old leaves). The feeding of these host plants by the larvae of *S. litura* may lead to the corresponding variations in carbohydrate content of their midgut tissue, fat body and haemolymph. The castor fed larval tissue showed highest carbohydrate concentration. This indicated the influence of dietary components on the biochemical constituents of the insect tissues. This finding was supported by Friedman *et al.* (1991) who reported that the quality of a herbivore insect diet changes both within and between its host plants, and these fluctuations can be predictable, such as seasonal changes in plant quality or unpredictable, such as the changes caused by environmental stress.

Plant’s protein and carbohydrate content can differ in response to environmental factors, such as the amount of light it receives, the chemical composition of the soil and inputs of water (Felton, 1996; Walter *et al.*, 2012). In the present work, concentration of carbohydrate in leaves during post monsoon was lower than that of summer for all the selected host plants. This finding is supported by Pandey (1995) who reported that the carbohydrate concentration in plants fluctuate according to season. Miller (2003) reported that the ecological factors may bring about a change in local climate that, in turn may influence the soil and soil nutrient based inter-plant competition resulting in the individual plant variations. These variations are felt right from the biochemical constituents, through the structure (anatomy) and functions (physiology) to the genetic makeup. This alterations in the carbohydrate content of the host plants caused corresponding variation of these compounds in the larval tissues when the larvae feed on them. This may be the reason for the low carbohydrate content in the midgut, fat body and haemolymph of *S. litura* larvae during the post monsoon season when fed with these host plants.

It has been generally accepted that numerous over wintering insects accumulate sugar alcohols such as sorbitol as well as glycerol through the
breakdown of glycogen storage (Grubor et al., 1992). The variations of carbohydrate in different organs, supported the speculation about the conversion of fat into carbohydrate during developmental stages. (Nestel, 2004; Nestel and Nemny-Lavy, 2008). In insects the variation of carbohydrate also occurred during the larval pupal transformation (Wyatt, 1962) and ecdysis (Lohr and Gade, 1983).

Lipids have an important role in serving as an energy reservoir in insects (Hadley, 1985). Allocation patterns of lipids are influenced by many environmental factors including water and food availability, photoperiod, humidity as well as temperature (Chown and Nicolson, 2004).

Scoggin and Tauber (1968) reported that numerous factors influenced the lipid content of the insects such as nutrition, developmental stage, sex, starvation, environmental temperature, diapause, cold hardiness etc. Food consumption and utilization is also affected by the existing atmospheric temperature and humidity at the rearing time (Benchaumin and Jolly, 1986).

The tissues (midgut, fat body and haemolymph) of castor fed larvae showed the maximum lipid content than the larvae fed with other host plants. It may be due to the presence of higher lipid content in the insect diet when fed with castor leaves. This finding was supported by Mullins (1985) who reported that several factors such as diet, temperature and disease influence the insect haemolymph composition of a species. Beenakkers and Scheres (1971) reported the dietary lipid and its effect on the insect tissues.

In this study the concentration of lipid content in midgut, fat body and haemolymph was reported higher during the early summer than that of monsoon and post monsoon seasons. reported that lipid metabolism relies up on oxygen utilization which frequently increases with temperature increase upto a critical point. Various studies done on numerous insect species
revealed that temperature rise leads to increased metabolic rate (Mankin et al., 1999; Taveras et al., 2004).

Many researchers worked in the quantitation of haemolymph lipid in various insects such as *Formia regina* (Hopf, 1940), *Papilia japonica* (Ludwig and Wugmeister, 1954), *Bombyx mori* (Sreedhara and Bhat, 1965) and they suggested that the lipid content and composition of haemolymph was highly dependent on the age, sex, dietary and hormonal status. In the present work, when comparing the tissues, the fat body showed higher amount of lipid than midgut and haemolymph. Chippendale (1973) suggested similar results in *Sitotroga cerealella* larvae in which fat body contained 0.7mg/gm lipid and lipid content in the haemolymph was 0.07mg/ml.

Total proteins, triacylglyceride, and glycogen are the three main storage macromolecules in insects. Because of the difference in concentration of these molecules in host plants, utilization of different host plants by the insect might lead to a gain in various amount of these storage macromolecules in the insects.

Plants are rich in secondary metabolites. The preliminary phytochemical screening of methanolic extract of five selected plant leaves revealed the differential occurrence of phytochemicals including, alkaloids, flavonoids, glycosides, steroids, terpenoids, saponins, tannins, proteins, amino acids, phenolic compounds and reducing sugars. The variations in the presence of phytochemical compounds in the different plant leaves extract were reported by many researchers in castor (Obumselu, 2011; Cherish and Ibraheem, 2014) in papaya (Willson et al., 2007; Ikeyi et al., 2013), in banana (Pothavorn et al., 2010; Repon Kumer et al., 2013), in colocasia (Vaibhavi and Chanda, 2016), and in sweet potato (Márcia Thais, 2011; Ahmed Awol, 2014). This variations may be due to the environmental stress related factors in the plants. Plants might overcome the stresses through
avoidance or tolerance which includes metabolic adjustment through alteration of compatible solutes or secondary metabolites (Ramakrishna and Ravishankar, 2011; Krasensky and Jonak, 2012).

The quantitation of chlorophyll content in different host plant leaves revealed the variation in the chlorophyll content between the host plants and it was in the order castor > papaya > colocasia > banana > sweet potato. Highest chlorophyll content was noticed in the castor leaves. Sannappa and Jayaramaiah (2002) and Chandrappa et al. (2005) also reported higher chlorophyll content in castor. This variation in the chlorophyll content may be due to the factors such as leaf age, nutritional status and a range of environmental and phenological conditions, which influence the relationship between photosynthetic rate and chlorophyll content (Nagaraj et al., 2002; Barry et al., 2009). The leaf senescence pattern may also affect the chlorophyll content (Gratani and Moriconi, 1989; Gratani and Bombelli, 2001). Demarez et al. (1999) reported that chlorophyll concentration in leaves strongly increases at the beginning of the growing season.

Polyphenols are the most commonly found secondary metabolites in plants. All plants differ in their phenolic contents. In this work, significant difference in total phenolic content was recorded among methanolic extract of different host plant leaves. Highest phenolic content was recorded in castor leaf whereas lowest was found in banana. This difference may be due to the environmental factors such as climatic conditions, soil type, biotic and abiotic stress and nutrition which were found to influence the presence as well as the amount of important phytochemicals in plants.

Food quality is very important for the growth, development and reproductive potential which depends mainly on nutritional composition including both the absolute and relative amount of water, proteins, amino acids, carbohydrate, lipids, minerals etc. (Slanky and Scriber, 1985). Possible
differences in secondary components or nutrient quality of host plants may have impact on the survival, growth, fecundity and developmental time of insects (Berynes and Chapman, 1994). The quantity, rate and quality of food utilized by a larva influences its performances such as growth rate, developmental time, final body weight, dispersal ability and probability of survival (Kerkut and Gilbert, 1985).

All plants differ in their phenolic contents and even different parts of the same plant may differ in their phenolic content. So based on the difference in the amount of total phenolic content and on the difference in the individual phenolic compound of the host plant leaves, variations were observed in the developmental activities of the larvae.

The present work indicated that all nutritional indices varied when S. litura fed on the five selected host plants. Efficiency of conversion of food on different host plants was found to differ considerably in S. litura larvae (Balasubramanian et al., 1985) and in general by insects (Slansky and Scriber, 1985; Scriber and Slansky, 1991). The present result showed that S. litura had similar relative growth rates on castor, colocasia, papaya and sweet potato, but had the lowest relative consumption rate when feeding on banana compared with those for the other four host plants. S. litura larvae showed least preference for feeding on banana leaves and had lower relative growth rate, relative consumption rate, and approximate digestibility, but it had an extremely higher efficiency of conversion of ingested food and considerably higher rate of efficiency of conversion of digested food, indicating that the larvae are capable of compensating by more efficiently utilizing their limited banana leaf tissues than other host plants. This finding was supported by Zhu et al. (2005). One of the reason for such variation may include the homeostatic adjustment of consumption rates and efficiency parameters such that an insect can approach its "ideal" growth rate even with foods of varying
quality. The digestion rate in insects is affected by the enzyme activities on various feeding materials, including trehalase, invertase, and others. In practice however, it can be quite difficult to ascertain "cause" and "effect" responses with efficiency parameters. Efficiency parameters are very closely related to the physiological characters of the insects. Understanding of these basic principles of nutritional ecology can enhance the information of insect’s adaptation to new food resources.

Depending up on the diet, the size of the head capsules, especially at the end of developmental stage, can differ greatly (Mattana and Foerster, 1988; Santos et al., 2003). The highest width of the head capsule was recorded for last instar of colocasia fed larvae of *S. litura*. This may be due to the increased moisture content or nutrient contents in the colocasia leaf. The influence of food suitability on the number of instars is reported by Parra (2009). *S. litura* passes through six instar stages on different host plants and there are several examples showing the effects of the quality of food on the number of instars in polyphagous insects (Santos et al., 1980).

Variations in the length and weight of the *S. litura* larvae was noticed when fed with selected host plants. The length and weight of the larvae influenced by the diet quality and the environmental factors (Davidowitz et al., 2003). Colocasia and castor fed larvae showed highest length and weight during the last instar stage. This difference may be due to high moisture content or the highest nutrient contents in the leaves of colocasia and castor compared to other host plants. With the increasing percentage of moisture content in leaf the absolute consumption and growth rate of larvae also increased (Paul et al., 1992). Parpiev (1968) also reported similar work in silkworm. The banana fed larvae showed lesser weight and length compared to the other host plants. This may be due to the lowest feeding rate, less water content and nutritional content of the banana leaves which may affect energy
expenditure, nutritional efficiency and growth of herbivorous insects. This finding was supported by Martin and Van’t Hof (1988). The increase of larval weight with consumption of food indicated higher level of protein content in the later stages of development.

Ratte (1985) reported that some insects have direct relationship between weight and temperature. In this study larval size and weight was reported highest during the early summer than monsoon and post monsoon seasons. Higher temperature during the early summer reflected increase in weight of the *S. litura* larvae. Sweeney and Vannote (1981) reported the effect of temperature in the developmental and physiological processes and size and fecundity determination of mayflies. The nutrient contents such as carbohydrate, protein, amino acid and lipids in the selected host plants were also recorded high during the summer seasons. The feeding of nutrient rich host plants during the summer may be one of the reason for the increased length and weight of the *S. litura* larvae at the summer season.

The decline in larval weight and pupal weight of insects by the anti nutritional effect of phenolic compounds such as quercetin (Stevenson *et al.*, 1993; Beninger and Abou-Zaid, 1997) gallicacid , tannic acid (Nomura and Itioka, 2002; Kathuria and Kaushik, 2005 and Mrdakovic*et al.*, 2011) and flavonoids (Hoffman-Campo *et al.*, 2001; Onyilagha*et al.*, 2004) are also reported.

Carbohydrate and amino acids were higher in the castor leaf and lower in the banana leaf. The longer larval duration was observed in banana fed larvae compared to the other selected host plant fed ones. It can be suggested that due to lower amount of nutrients in the banana leaves than the other selected host plant leaves, the banana fed larvae cannot invest sufficient amount of metabolites for its growth which lead to prolonged larval duration (Gogoi and Yadav, 1995).
The *S. litura* larvae showed the shortest larval duration in the summer. This may be due to the high protein and moisture content in leaves and increased food intake by the larvae during summer season. Similarly longer larval duration during post monsoon may be due to low protein and moisture content in the leaves and/or due to the minimal food intake by the larvae during post monsoon. The larval development of *S. litura* varied greatly depending on the host plants and temperature and the development was prolonged under low or high temperatures as reported by Zhu *et al.* (2000); Chen *et al.* (2002) and Seema *et al.* (2004)

The total phenolic content also affect the larval duration. They acts negatively or positively on the larval duration of insects depends upon the individual phenolic compounds. The observations recorded for larval duration in *S. litura* revealed that the larvae fed with the leaves of castor which contain high phenolic content, showed shortened larval period. But larvae fed on banana leaves which have low phenolic content showed extended larval period. Similar variation in the larval duration due to the phenolic compounds such as tannic acid (Kathuria and Kaushik, 2005), gallicacid (Ananthakrishnan, 1997), rutin (Jadhav *et al.*, 2012). and quercetin (Saric *et al.*, 2007) was reported in various insects like *S. litura*, Helicoverpa armigera., Choristoneura rosaceana and Culex pипiens pallens.

Patel *et al.* (1986) reported that pupal development was not affected by host plants on which their larvae fed. However the present results showed that pupae developed faster when the larvae fed with leaves of castor and colocasia than with leaves of papaya, sweet potato and banana ,though the difference was less than one day duration on papaya and sweet potato and more than one day duration on banana. Pupal development was faster in the summer season and slower in the post monsoon season. The Bae and Park
(1999) suggested that temperature also plays a vital role on pupal development.

The pupal weight differed significantly depending on the host plant on which the larvae were fed and differed significantly between males and females when they were fed on the same host plant and also when larvae fed on different host plants. These results showed that larval food directly affects pupal size and weight and the female were generally heavier than their male counterparts. This sexual dimorphism of *Spodoptera* species and other lepidopterans was reported by Mattana and Foerster (1988), Bavaresco *et al.* (2004), Santos *et al.* (2005) and Xue *et al.* (2010). Low pupal weight was reported during post monsoon season. This may be due to the feeding of selected host plant leaves with low quantity of proteins and carbohydrates during the post monsoon season. Similar results were reported by Pandey (1995).

There was no significant difference in the preoviposition and oviposition periods of *S. litura* when fed with selected host plants. But slight variations were observed among the selected host plant fed insects. The adult of castor fed larvae showed shortest pre oviposition and and longest oviposition period but the longest pre-oviposition and shortest oviposition period were noticed in the adult of banana fed larvae. The temperature also affect the preoviposition and oviposition period. In this study the pre-oviposition days of *S. litura* was shortest in the summer and longest in the post monsoon season but oviposition period was longest in summer and shortest in post monsoon. Bae and Park (1999)also reported such changes in oviposition period by females reared on different host plants under different environmental conditions.

Chemical inhibitors present in the host plants also have an important role in the inhibition of oviposition (Chapman, 1974; Stotz *et al.*, 1999). The
variation in the oviposition of insects due to the action of phenolic compounds such as quercetin (Upasani et al., 2003), lactones and flavonoids (Chenniappan and Kadarkarai, 2008), rutin (Haribal and Feeny, 2003), Tannin (Whittaker and Kirk, 2004), flavonoids (Rajkumar and Jebanesan, 2008) and gallic acid (Grant and Langevin, 2002) in different insects were also reported. In the present work the castor showed the highest total phenolic content than the other selected host plants. But the adult of the castor fed larvae showed longest oviposition period than the adults fed with other host plants. This may be due to the variation in concentration of the individual phenolic content in the selected host plants. These findings clearly revealed that the phenolic compounds in different plants have a great influence in the oviposition of *S. litura* when it was fed with different host plant leaves.

The number of eggs oviposited by the *S. litura* females reared on the five selected host plants varied significantly. The nutritional quality of the larval diet influence the egg production (Zucoloto and Fernandes, 1997). Maximum number of eggs were laid by the adults of castor fed larvae and least number of eggs laid by adult of banana fed larvae. This difference may be due to the variation in the nutrient contents of these host plants. The number of eggs laid by the *S. litura* from the larvae fed with selected host plants were generally within the range as reported on various host plants earlier. Bae and Park (1999) reported that the *S. litura* adults oviposited an average 803 eggs per female on artificial diet, 935 on soyabean and 3,467 on cotton (Patel et al., 1986) and 5, 995 eggs per female on different artificial diet (Chu and Yang, 1991). Seasonally, summer was found to be ideal as the fecundity rate of adults of all the larvae fed with selected host plants was found to be high during this season. Opyichalowa et al. (1976) reported the influence of climatic condition on the reproductive dynamics and fecundity of females of colorado potato beetle *Leptinotarsa decemlineata*. Bae and Park (1999) also reported that the oviposition by females varied greatly on
different host plants under different seasonal conditions. Thus the present findings are more or less in agreement with the earlier findings and it showed that the diet influenced the oviposition of *S. litura*.

The longevities of both female and male *S. litura* adults were also significantly affected by the host plants on which their larvae fed and also by the seasonal variation. The highest female and male longevities were recorded on castor and the lowest male and female longevities were found on banana. Bae and Park (1999) and Xue *et al.* (2010) also reported similar differences in longevity of *S. litura*. Male adults lived longer than female adults. Similar findings in *S. litura* reared on cotton were reported by Patel *et al.* (1986). The adult longevity was maximum in the early summer season. But in contrast to the present result, Bae and Park (1999) reported that adult longevity became shorter as the temperature increased.

The survival rate of *S. litura* larvae varied on different developmental stages on the five selected host plants. The highest larval survival percentage was observed on castor in all the instar stages, but it was moderate on colocasia, papaya and sweet potato and lowest on banana. In the present work it was found that among the selected host plants castor is the most nutrient rich host plant compared to the other host plants. So the survival rate of the larvae fed on this host plant may be maximum. These observations were corroborated by the findings of Herms and Mattson (1992) and Slansky (1992) who observed that larval survival and development can be reduced on poor quality host plants due to nutritional composition and/or secondary plant metabolites. This findings also supports the result of Patel *et al.* (1987) who found out that larval or pupal survival rate of *S. litura* varied greatly on different host plants, 100 percent survival was observed on castor. The survival rate for all the life stages of *S. litura* was maximum in the summer season. Bae and Park (1999) found that pupation rates were positively
correlated with high temperature. Similar results were noticed in the present study that pupal survival ranged from 92.1 to 71 percent on castor, colocasia, papaya, sweetpotato and banana during summer season. But it was reduced during the monsoon and post monsoon seasons.

Some phenolic content reduced the egg hatchability of the insects (Manoukas, 1996; Salunke et al., 2005; Sohal and Sharma, 2011). But in the present study among the five selected host plants the higher concentration of total phenolic content was observed in the castor leaf. But comparing the egg hatchability of S. litura larvae fed with different host plants, in castor fed insect the maximum hatchability of eggs was noticed. So here a positive correlation with the total phenolic content of the host plant and egg hatchability was noted. The reason for this difference may be the variation of the individual phenolic compounds of each host plant leaves or the variation in the nutritional content of the different host plant leaves.

The results revealed that the developmental period for all the instars differed significantly in all host plants. The growth rate during the early instars were found to be quite low for all the host plants. It is similar to the work of Poonia (1978) who reported that most of the food consumed during early instars is spent in energy for maintenance. Over all larval development was significantly affected by host plants and was longest on banana followed by sweet potato, papaya, colocasia and shortest on castor. The longest pupal development was observed in banana and shortest pupal development was noticed in castor. Overall adult development was significantly affected by host plants and was longest on banana followed by sweet potato, papaya, colocasia and shortest on castor. Seema et al. (2004) reported that difference in pupal survival, longevity and fecundity may also be affected by temperature and other environmental conditions.
In the present study, the detailed information regarding the influence of nutrient quality and secondary metabolites of selected host plants in the biochemical and biological parameters of *S. litura* larvae during different seasons was recorded which may be useful for the selection of more eco-friendly control measures such as biofensing and trap crop methods in future.