

OBSERVATIONS

BIOENERGETICS

UTILIZATION OF FOOD (Fig. 1-20):

(i) Body weight:

The larvae of *Trichoplusia ni* passed through six instars with the average stadial period of 20.31 ± 0.522 days.

The stadial period for the male and female caterpillars remained 20.96 ± 0.47 and 19.66 ± 0.28 days respectively. On live weight basis, both the male and female caterpillars from I to VI instars, show the successive increase in body weight which has been 0.284 ± 0.042 to 450.769 ± 23.272 mg per individual per day (ind/d) for the male and 0.253 ± 0.028 to 436.772 ± 16.992 mg/ind /d for the female.

Thus, the male caterpillars show a better increase in body weight over the female. However, the average live weight of a caterpillar from I to VI instars has been

0.268±0.035 to 443.770±20.132 mg/ind/d (Table-I). It has further been observed that the live body weight of a caterpillar throughout its larval period also remained better in the male than female, being 3530.208 mg and 3137.986 mg, respectively (Table-IV).

The gain in body weight each day graphically has been progressive for both, the male and female sexes from I instar up to the middle of the VI instar and decreased in the last three days while entering into the prepupal stage.

On dry weight basis, the body weight of caterpillars of *Trichoplusia ni* show the successive increase, from I to VI instars, both in the male and female, being 0.024±0.001 to 99.829±5.809 mg/ind/d and 0.024±0.001 to 97.629±4.871 mg/ind/d, respectively. The male caterpillars maintained superiority over the female in all the six instars (Table-II). Further observation revealed that the body weight of a male caterpillar on dry weight basis throughout its larval period also remained higher than the female, being

706.818 mg for male and 632.889 mg for female (Table-IV). The per day graphics of dry body weight also observed progressively increasing in both the male and female caterpillars throughout the larval period, from I to VI instars, except the last three days when the caterpillars enter into the prepupal stage, following the similar trend as observed in the live body weight.

The caterpillars of *Trichoplusia ni* accumulate 0.252 ± 0.016 cal/ind/d at I instar and 605.328 ± 20.800 cal/ind/d at the last instar. In all the six instars male carries excessive calories over the female (Table-III). It has further been analyzed that an individual throughout its larval span of 20.31 days achieved 3786.449 calories from 403.102 mg of dry food consumed by the caterpillar (Table-IV). The male with higher calories proved to be better herbivore than the female in the food chain (3992.984 cal and 3585.212 cal, respectively) (Table-IV). The per day graphics of body weight on energy basis in both, the male and female, followed the similar trend as described for body weight on live and dry weight basis.

(ii) Tissue Growth:

As the development proceeds, the tissue growth successively increased from first to last instar. The average value of tissue growth of an individual caterpillar remained 0.181 ± 0.021 mg/ind/d during the I instar and 58.640 ± 9.707 mg/ind/d during the VI instar on live weight basis. In tissue growth a male larva was observed superior over the female in succeeding instars with an exception of IV instar, where the female is superior than male (17.627 ± 2.972 and 15.088 ± 3.742 mg/ind/d, respectively) (Table-I). The total tissues growth throughout the larval span by an individual caterpillar has been 24.80% of consumption and 33.03% of assimilation on an average live weight basis (Table-IV).

Almost negligible values of tissue growth observed prior to each moult in both sexes are due to corresponding low level of feeding. After casting off its exuviae's in each moult, the caterpillar feeds vigorously and attains the peak value on first or second day of successive instar stage. However, approaching the

prepupal stage. The tissue growth has been observed below recognizable limit in both the sexes.

A successive increase in tissue growth from first to last instar was observed on dry weight basis. Taken together, the I & II instar values of tissue growth suddenly jumped in III & IV instar which is turned again erupted to the maximum in V & VI instar stages, (0.050 ± 0.001 mg/ind/d) and 11.902 ± 1.990 mg/ind/d in I and VI instars, respectively. The male caterpillar has shown a better growth at I, III and V instars (0.056 ± 0.001 , 1.059 ± 0.078 and 12.004 ± 1.0007 mg/ind/d respectively) than a female (Table-II). Significantly, the male caterpillar in its total larval span has much better tissue growth (137.151mg) than the female (126.738mg) on an average dry weight basis. It has further been observed that the total tissue growth has been 32.71 % of food consumed per individual throughout its, larval period, with female having much better value (32.87%) than the male (32.58%) (Table-IV).

The per day graphic representation of tissue growth follows almost the same pattern as for live weight basis.

The net productivity in the form of tissue growth carried 0.199 ± 0.011 to 58.769 ± 2.889 cal/ind/d from first to last instar larval on an average where the male larval show a better grow than I, V, and VI instars (0.214 ± 0.010 , 47.287 ± 2.088 and 65.1667 ± 2.689 cal/ind/d, respectively) over the female remained superior at remaining II, III and IV instars (1.261 ± 0.089 , 6.039 ± 0.299 and 14.100 ± 1.006 cal/ind/d respectively) (Table-III). The total tissue growth shown by an individual caterpillar throughout its larval span was recorded 634.276 cal and 41.43% of consumed food. The male has better growth (43.54% of consumption) over the female (39.27% of consumption) (Table-IV). The tissue growth curve shows almost parallel graphics in first three instars, with peak growth in the middle of IV and V instars, however, with peak values in the earlier days of VI instars in both, the male and female larvae.

(iii) Consumption:

Corresponding to the live body weight the average per day consumption by an individual caterpillar successively increased from I to VI instars on live weight basis (5.394 ± 0.838 to 329.591 ± 27.994 mg/ind/d respectively). Because of inconsistent feeding, the male caterpillar ingests more of food at I, III and VI instars where as the female has more feeding values on the remaining instars of II, IV and V (Table-I). Being in basic parameter, the food ingested provides gain in body weight of a caterpillar. Further calculations revealed that the consumption throughout the larval period is different at two sex levels. Male caterpillar Consumed 2939.514 mg food throughout its larval period of 20.96 days while the female caterpillar 2717.892 mg in its total larval span of 19.66 days (Table-IV). Per day graphics show that during each instar both the male and the female consumed successively high value with peak being on a day earlier to the day of moult in III, IV and V instar and on the second day of VI instar but with little

consumption on the day of moult with distinct demarcations. Besides the poor feeding on the last day of each instar (I to V instars) till the caterpillar enters in to the next stadia the VI instar after attaining its peak feeding on the second day, also show a high decline feeding till the caterpillar enters into the next stage i.e prepupa.

On dry weight basis, the average per day consumption by an individual caterpillar increased from 0.617 ± 0.006 mg in I instar to 47.546 ± 3.398 mg in VI instar, the male caterpillar has been Superior in feeding over the dry matter in I, III, V and VI instars. On the other hand, female retained IC superiority in II and IV instars (Table-II). An individual caterpillar in its larval span of 20.31 days, on an average, consume, 403.102 mg, increasing the dry body weight by 669.346 mg. Having comparatively greater larval span (20.96 days) than the female (19.66 days), the male caterpillar consumes much higher than one female (420.997 mg for male and 385.538 mg for female), and increasing the dry

body weight by 706.818 mg and 632.889 mg for male and female caterpillars, respectively (Table-IV). The graphic consumption patterns for the two sexes distinctively show a single peak value, both in the male and female corresponding to the data as observed for live weight basis.

The caloric values of consumed cabbage foliage by the caterpillar from I to VI instars remained 2.454 ± 0.192 to 181.330 ± 5.425 cal/ind/ day on an average basis. In III and V instars males accumulated more of energy (11.912 ± 0.697 and 74.213 ± 2.685 (cal/ind/d) while in the remaining instars of I, II, IV and VI females maintained superiority in accumulated energy (2.451 ± 0.201 , 4.557 ± 0.305 , 29.658 ± 1.465 and 181.346 ± 5.053 cal/ind/d, respectively, (Table-IV). In its complete larval span, the total consumption by an individual caterpillar remained 1530.653 calories on average basis. The quantum of food required for a male had more calories (1587.138 cal) than a female (1476.201 cal). (Table-IV). It has further been analysed

that a unit mg of food provides 2.80 calories of body weight to a herbivorous primary consumer i.e., the caterpillar, on an average (Table-IV). The daily graphics of consumption followed the single peak system in each stadial period.

(iv) Egestion:

After assimilating most are eliminated from the body of the caterpillar as the development proceeds, the amount of egesta successively increases from first to last instar stage in accordance to the consumption. On an average the excreta increases from 0.016 ± 0.002 mg/ind/d during instar to 126.399 ± 12.649 mg/ind/d during the VI instar on live weight basis.

The male caterpillar egests more from II to V instars (0.172 ± 0.027 , 0.708 ± 0.042 , 6.008 ± 1.274 , 21.170 ± 4.339 mg/ind/d respectively). While the female on I and VI instars (0.017 ± 0.002 and 126.967 ± 10.914 mg/ind/d) (Table-I).

The total average egestion by a caterpillar throughout its larval period was observed 27.48% of the food consumed while 36.60% of food assimilate owing to its shorter larval period (19.66 days) and also having comparatively lower values of food consumption than the male (2717.892 mg) a female caterpillar egests lesser than male throughout its larval stage being. 748.314 mg/ind/d and 804.628 mg/ind/d respectively (Table-IV). With poor values of excretion on the day of moult the curvature shows the peak values of egestion a day earlier to moult upto V instar following the trend of consumption and assimilation in both the sexes. Although the VI instar male larva has peak egestion on its second day and also fluctuates with the consumption and assimilation pattern, the VI instar female larva was observed to have peak value a day later than male i.e. on the third day rather than the second and therefore does not follow the curves for consumption and assimilation.

Although II, III, IV and V instars male caterpillar excrete more than female on dry weight basis during the remaining instars (I and VI) than male. However on an average the successive increase in excretion by the caterpillar was recorded from first to last instar (0.001 ± 0.002 to 35.982 ± 1.923 mg/ind/d) (Table-II). Further analysis revealed that on an average dry weight basis, an individual caterpillar throughout its larval span (20.31 days) resorted 54.35% of food consumed Table-IV). The daily dry weight graphic representation for egesta in both the sexes followed the curvature trend as illustrated for the live weight basis. Since eliminated from the body of the caterpillar as the waste product of cellular, metabolism the excreta is treated by soil microorganism (e.g. decomposers and transformers) and in turn maintain the soil fertility.

The excreta carries 0.006 ± 0.001 to 113.367 ± 3.992 cal/ind/d from first to last larval stage on an average where the male caterpillar excretes more of calories from II to V instars (0.060 ± 0.003 , 0.359 ± 0.019 , 4.812 ± 0.201

and 21.006 ± 1.889 cal/ind/d, respectively) than the female (Table-III).

The male caterpillar throughout its larval period of six instars excreted more than female on energy basis being 712.194 and 689.014 . cal/ind/d respectively (Table-IV). Because in the graphic representation for daily averages values, the curves for different parameters are quite close with each other in the first three instars, a clear differentiation could be made out in the last three instars. However almost the some pattern of curvature as described for live weight basis was followed on energy basis excreta too, the curves of VI instar in both sexes show more fluctuations.

(v) Assimilation:

Most of the food consumed by the caterpillar from first to last instars is assimilated in its body. The assimilation successively increased from I to VI instars, being 5.363 ± 0.794 mg/ind/d to 213.135 ± 27.627 mg/ind/d on an average live weight basis. The male has better assimilatory values than the female during I, III

and VI instars i.e. 5.402 ± 0.869 , 18.445 ± 1.795 , 233.340 ± 33.518 mg/ind/d, respectively the female maintained superiority in assimilation during II, IV and V instars i.e. 8.291 ± 0.832 , 48.709 ± 8.345 , 127.690 ± 20.368 mg/ind/d, respectively (Table-I). It was observed that 75.08% of ingested food has been assimilated by the caterpillar throughout its larval period on an average live weight whereas the male assimilated 77.79% and female 72.34% (Table-IV). The curve for daily assimilation by an individual caterpillar lies in close approximation to the consumption curve in both sexes from first to fourth instars, however, with some lower values of assimilation during V and VI instars.

The value of assimilation on dry weight basis remained successively higher on an average (0.637 ± 0.009 mg/ind/d at the I instar to 17.163 ± 1.345 mg/ind/d at the VI instar where in the male caterpillar has been superior at I, V and VI instars over the female. The female caterpillar retained superiority at II, III and IV instars in assimilating the ingested food (Table-II). A

caterpillar in its total larval span assimilates 39.31 % of the ingested food on an average where the male assimilates 39.51 % and the female 39.04% (Table-IV). Furthermore, although the assimilation curve in two sexes corresponds to the consumption, with peak being a day earlier to moult in first five instar and on the second day of last instar, the assimilation curve on dry weight basis is much lower than the consumption curve and does not lie in close approximation, a different observation than the one observed on live weight basis.

On caloric basis, each caterpillar assimilates 2.567 ± 0.105 to 83.354 ± 3.729 calories from first to last instar on an average basis where the rate of assimilation remained higher for the male in I, V and VI instars (2.604 ± 0.108 , 40.807 ± 2.868 , 84.936 ± 3.775 cal/ind/d). In the remaining instars of II, III and IV, female retained the higher rate of assimilation (3.540 ± 0.205 , 6.983 ± 0.295 , 18.899 ± 1.006 cal/ind respectively) (Table-III). Further analysis on assimilation throughout the larval period of the caterpillar shows that 50.69%

(775.898 cal) of consumption is assimilated by a caterpillar. The male larva was observed much efficient in assimilating the calories than the female i.e. 51.48% (817.183 cal) and 46.02% (735.707 cal) of ingested food, respectively (Table-IV). The per day graphics of assimilation on energy basis followed the similar trend as observed on dry weight basis.

GROWTH EFFICIENCIES (Fig. 21-38)

(i) Efficiency Of Conversion Of Ingested Food (ECI):

The larvae of *Trichoplusia ni* have successively higher ECI up to third instar (4.132 ± 0.464 , 23.763 ± 4.635 and 39.916 ± 1.552 per individual per day (ind/d), respectively on an average live weight basis. In the later larval life (IV to VI instars), the ECI decreases but not successively, because the V instar caterpillars were observed to have better efficiency than the IV instar (the values being 25.292 ± 4.725 , 30.814 ± 5.396 and 13.612 ± 2.624 per ind/d from IV to VI instars). Yet the values for VI instar is 3.29 times higher than the I instar. The male caterpillar is more efficient in digesting

the ingested food at I, III, V and VI instar (4.728 ± 0.562 , 40.722 ± 1.589 , 33.683 ± 5.751 and 14.224 ± 3.061 per ind/d, respectively) where as the female leads at II and IV instars (23.841 ± 4.319 and 26.158 ± 4.886 per ind/d (Table-V). Further more the curvatures for digestive efficiency show single peak value upto V instar while two peak value in the sixth instar in both sexes. It has also been observed that the highest value of ECI was on the first day where as the lowest on the last day, in each instar caterpillar on an average lives weight basis in both sexes.

Having the highest ECI during V instar (38.597 ± 2.435 per ind/d) the caterpillar of *Trichoplusia ni* recorded a successive increase from I to III instars while almost similar values at IV and VI instars on an average dry weight basis. The calculation show that the sixth instar larva was 2.58 times more efficient then the I instar (Table-VI). The digestive efficiency of male caterpillar was observed more than the female during I, V and VI, instars (10.523 ± 0.594 , 37.698 ± 2.754 and

23.321±1.388 per ind/d respectively) where as in the remaining instars of II to IV female super sides the male (23.125±1.697, 32.067±2.000 and 21.451±1.437 per ind/d, respectively) (Table-VI). The per day graphic representation revealed almost the some trend of dry ECI curvatures as for live ECI in both sexes.

On energy basis, the caterpillars of *Trichoplusia ni* observed with fluctuating values of ECI i.e., successive increase up to III instar, during decrease at IV instar and again increase and decrease during V and VI instars (viz. 4.166±0.247, 34.825±3.205, 92±4.445, 34.051±2.716, 53.188±5.414 and 42.016±3.996 per ind/d, respectively) on an average. As calculated the VI instar larva has been 10.09 times more efficient than I instar larva in digesting the ingested food (Table-VII). Except at II instar when the female supersedes the male in ECI (i.e. 41.482±3.110 per ind/d), the male caterpillar retained superiority throughout the larval period (Table-VII). Identical pattern of calories based curvatures are achieved in both sexes as for the lives and dry weight basis.

(ii) Efficiency of Conversion of Digested food (ECD):

Following the trend of ECI, after attaining the maximum at III instar (39.973 ± 1.958 per ind/d), the value of ECD fluctuated in the later larval life (from IV to VI instars) on an average live weight basis (viz, 26.944 ± 5.015 , 32.831 ± 5.632 and 15.354 ± 2.804 per ind/d, respectively). Though the growth efficiency of male caterpillar observed higher than the female at I, III and V instars but nearly identical values are calculated for both the sexes at sixth instar, an observation different from ECI (Table-V). During II and IV instars, the female caterpillar was observed to lead in growth efficiency (the values being 24.495 ± 4.481 and 28.402 ± 5.303 per ind/d, respectively) over the male. Further analysis shows that however, the ECD of III instar remained highest (9.61 times more than I instar), the value of growth efficiency at VI instar is 3.69 times more than the I instar caterpillar on an average. While comparing the ECI and ECD, besides having almost identical values of digestive efficiency and growth efficiency at the III instar stage

(39.916 ± 1.552 and 39.973 ± 1.958 per ind/d, respectively) the digestive efficiency decidedly stands higher than the growth efficiency in all instars and during the whole larval life of an individual on an average.

The graphs plotted for ECI and ECD separately for the male and female support the observations, (Table-V). The ECD graphics showed an identical pattern as the ECI graphics in both the sexes however, with a contrasting observation at the III instar where the ECD supersedes the ECI in male larva while ECI supersedes the ECD in female larva. The calculated ECI and ECD values of III instar larva for male, female and average basis also support this observation (Table-V).

The growth efficiency of the caterpillar also followed the ECI trend having the highest ECD at V instar (80.626 ± 4.502 per ind/d) on an average dry weight basis.

The male possessed better growth efficiency than the female at II and III instar (19.537 ± 1.114 and 71.535 ± 3.994 per ind/d respectively), while the female

caterpillar at the remaining instars of I, IV, V and VI (5.325 ± 0.329 , 49.700 ± 2.690 , 81.177 ± 4.319 and 50.823 ± 3.002 per ind/d, respectively). The last instar has 9.83 times better ECD than the first instar (Table-VI). While comparing the ECI and ECD for an individual caterpillar on dry weight basis although, the growth efficiency of I and II instars observed lesser than the digestives efficiency, yet the caterpillar in its larval period of III to VI instars remained more than double efficient in ECD in comparison to ECI in both the sexes. There observations are very clear in the daily graphics platted for male and female larvae separately (Table-VI).

Likewise the live and dry weight basis the ECO of larva has also increased upto III instar (7.444 ± 0.478 , 29.710 ± 2.086 and 55.508 ± 6.390 per ind/d, respectively) on an average energy basis. Though fluctuated calories based growth efficiency was sufficiently higher from IV to VI instars (37.152 ± 4.110 , 59.471 ± 4.493 and 49.710 ± 5.390 per ind/d respectively), being 6.68 times more better at VI instar than the I instar. In the first

three instars, male caterpillar supersedes the female 8.679 ± 0.519 , 31.258 ± 2.172 and 60.058 ± 5.984 per ind/d respectively), where as in the last three instars, female caterpillar supersedes the male (38.058 ± 3.322 , 61.271 ± 3.998 and 53.799 ± 5.832 per ind/d, respectively) in ECD (Table-VII). When compared with an exception of II instar (29.710 ± 2.086 per ind/d), the ECD was observed higher than the ECI in all instars and in the total life of the caterpillar on an average calories basis. More over significant graphics of ECO has been observed in both the sexes. A single peak upto V instar and double peaks in VI instar are observed in both the male and female like the ECI, ECD was observed almost zero by the IV and V instars female caterpillar a day before moulting into next instars but the caterpillar retained sufficiently high rate of ECD even on the last day of these instars (IV and V). Even so, the male caterpillar was observed with lower ECD in comparison to ECI during VI instar while the female caterpillar with comparatively lower ECD than ECI during II and III instars. A bird's eye view of daily graphics for ECI and

ECD on caloric basis shows that with an exception of III instar the female larva has wide range in between these two parameters of ecological efficiencies (i.e. ECI and ECD) than the male larva.

(iii) Approximate Digestibility (AD):

The approximate digestibility successively from I to VI instars (from 99.606 ± 0.037 per ind/d at I instar to 52.849 ± 5.465 per ind/d at VI instar) on an average live weight basis. The male caterpillar remained higher than female in AD at I and VI instar (99.623 ± 0.034 and 53.008 ± 6.478 per ind/d, respectively). Whereas in the remaining instars (II to V) the female caterpillar is observed efficient than the male in the digestibility (98.220 ± 0.427 , 96.346 ± 0.198 , 73.721 ± 7.590 and 67.829 ± 8.131 per ind/d, respectively) (Table-V).

The AD on dry weight basis has also been recorded with successive decline from I to VI instars on an average ranging between 89.883 ± 4.853 and 28.721 ± 2.797 per ind/d. Although the male caterpillar shows better digestibility I and V instars (92.647 ± 5.008

and 31.698 ± 1.999 per ind/ d, respectively), the female caterpillar supersedes the male in II, III, IV and VI instars the respective values being 92.327 ± 4.485 , 53.927 ± 3.911 , 41.004 ± 2.487 and 30.408 ± 2.819 per ind/d, (Table-VI).

A perfect declining sequence of approximate digestibility has also been observed from I to VI instars (97.585 ± 8.435 to 31.702 ± 3.143 per ind/d) on an average caloric basis. The male caterpillar being superior in AD at I, III and V instars (98.602 ± 8.887 , 59.521 ± 5.012 and 42.656 ± 4.101 per ind/d respectively) over the female, however, the female possesses higher AD at the remaining instars of II, IV and VI (98.185 ± 7.114 , 43.934 ± 3.882 and 33.723 ± 2.885 per ind/d respectively) in comparison to male (Table-VII).

(iv) Growth Rate (GR):

Having almost identical values in the first three instars. The growth rate of caterpillars of *Trichoplusia ni* on cabbage has been in accordance to the ECI and ECD trends on an average live weight basis i.e. successive increase upto III instar (viz, 0.481 ± 0.019 , 0.499 ± 0.032

and 0.518 ± 0.060 per ind/d, respectively), decrease at the IV instar (viz, 0.326 ± 0.049 per ind/d) and again increase and I decrease during V and VI instars (0.326 ± 0.049 and 0.128 ± 0.024 per ind/d, respectively). The GR of the III instar caterpillar is observed maximum (0.518 ± 0.060 per ind/d) where as the last instar with the minimum (0.128 ± 0.024 per ind/d). (Table- V).

The values of growth rate are better in the male caterpillar over the females in I, III, V and VI instar (0.507 ± 0.014 , 0.531 ± 0.112 , 0.341 ± 0.053 and 0.132 ± 0.028 per ind/d, respectively) while the female caterpillars are observed superior in GR at II and IV instars (0.513 ± 0.027 and 0.331 ± 0.053 per ind/d, respectively) than the male (Table- V).

The growth rate of the caterpillar on an average dry weight basis after reaching to the maximum at II instar (2.160 ± 0.164 per ind/d, successively declines in the later instars and reach to the minimum at VI instar (0.118 ± 0.006 per ind/d), a trend different than the ECI and. ECD. Also not following the live weight based GR

the value of II instar is observed more than double the I instar (1.080 ± 0.058 and 2.160 ± 0.164 per ind/d for I and II instars, respectively) (Table- VI). Moreover, the male caterpillar established superiority at I, V and VI instars (1.205 ± 0.069 , 0.583 ± 0.205 and 0.128 ± 0.006 per ind/d respectively) over the female where as the female caterpillar in II, III and IV instars (2.182 ± 0.189 , 1.422 ± 0.098 and 0.902 ± 0.044 per ind/d, respectively) over the male (Table- VI).

The calories based growth trend is like that of the dry weight on an average i.e. after reaching maximum at II instar (2.170 ± 0.208 per ind/d) successively decline in the later instars of larval, period and leads to the minimum at VI instars (0.200 ± 0.020 per ind/d). Likewise the II instar value of GR is found more than two times than that of the I instar (viz, 1.036 ± 0.086 and 2.170 ± 0.208 per ind/d, respectively for I and II) (Table- VII).

Although the male caterpillar is observed superior at I and V instars (1.188 ± 0.97 and 0.465 ± 0.042 per

ind/d, respectively) over the female the female caterpillar was calculated to have more GR at II, III , IV and VI instars (2.187 ± 0.199 , 0.850 ± 0.067 , 0.538 ± 0.037 and 0.203 ± 0.019 per ind/d, respectively), than the male an observation not following the live and dry weight pattern in the two sexes (Table- VII).

(v) Consumption Index (CI):

The consumption index has been calculated successively declining from I to VI instars (14.028 ± 1.292 to 0.657 ± 0.055 per ind/d) on an average live weight basis. Though observed maximum at I instar (15.019 ± 1.278 per ind/d for female and 13.038 ± 1.306 per ind/d for the male), both the male and the female followed this decreasing trend in later larval life leading to minimum of CI at VI instar (0.650 ± 0.046 and 0.665 ± 0.064 per ind/d for the female and male, respectively). With an exception of VI instar, female supersedes the male in the values of CI from I to V instars on live weight basis (Table- V).

Following the pattern of live weight, the dry weight

CI is observed in a perfect declining sequence from first to last instar caterpillar (21.675 ± 1.345 to 0.466 ± 0.026 per ind/d) on an average. The female caterpillar is observed superior in I and II instars (23.400 ± 1.688 and 12.464 ± 0.988 per ind/d respectively) than the male where as the male caterpillar maintained superiority from III to VI instars (2.669 ± 0.195 to 0.476 ± 0.032 per ind/d) over the female an observation very different from the live weight basis CI (Table- VI).

Also following the pattern of live and dry weight, the energy based CI shows successive decreasing trend from I to VI instars (8.830 ± 0.797 to 0.269 ± 0.018 per ind/d) on an average corresponding to the dry weight but not in accordance with live weight, the calories based CI of male caterpillar is observed higher in III, IV, V and VI instars (1.222 ± 0.071 , 0.969 ± 0.062 , 0.618 ± 0.039 and 0.285 ± 0.018 per ind/d respectively) than the female where as the female caterpillar retained superiority in CI at I and II instars (9.600 ± 0.795 and 5.645 ± 0.431 per ind/d respectively) over the male (Table- VII).

C. FOOD ENERGY BUDGET:

The energy flow in a simple food chain from one trophic level of producers (viz, *Brassica oleracea* var *capitata*) to the other trophic level of heterotrophs or primary consumers as herbivores (viz., different larval stages of *Trichoplusia ni*) is illustrated.

The total consumption throughout the larval period is observed 1530.653 cal/mg on an average. Male caterpillar consumed more of calories (1587.138 cal) than the female (1476.201 cal) of the total energy consumed (i.e. 1530.653 cal) 50.69% is assimilated by a caterpillar on an average. However, with shorter larval life (19.66 days) the female caterpillar assimilated lower calories (49.84%) than the male (51.49%), an observation not following the consumption pattern on energy basis.

The egestion by the male caterpillar remained higher (44.87% of consumed calories) than the female (46.67% of consumed calories), however the average egestion by an individual caterpillar of *Trichoplusia ni* in its total larval span being 45.79% of the consumed

energy and eliminated to the soil as unutilized by the body of the caterpillar.

Following the consumption and egestion, tissues growth or net productivity also considered as the secondary productivity is observed higher in the male larva (691.082 cal) in comparison on to that of the female (579.748 cal). However, on an average, the TG of an individual caterpillar throughout its larval period remained 634.276 cal (16.75% of body weight). This stored energy in the form of tissue growth of the caterpillar remains available to the next trophic level i.e. the secondary consumers.

The caloric values of various developmental stages of *Trichoplusia ni* (viz. all the larval stages and their faeces, the prepupa, pupae and adults of both sexes) along with the host plant material (i.e. leaves of *Brassica oleracea* var capitata) have also been analysed on cal/mg dry weight basis. The cal/mg dry weight successively decreases from I to V instars (10.458 ± 0.132 to 4.181 ± 0.027 cal/mg) and then increases in the VI instar

(6.017±0.036 cal/mg) though more than the last instar caterpillar, almost identical caloric values of pupae and adults of both sexes are calculated. Of course, the female is observed with more of energy than the male in both the pupae (6.528±0.088 and 6.228±0.057 cal/mg, respectively). The average caloric value of faecal matter of different instars remained 3.199±0.022 cal/mg while that of cabbage leaves 3.968±0.048 cal/mg dry weight.

TOXICOLOGY

For observations scientific methodology has been followed for accuracy and success of the present investigation and to assess the impact of synthetic pesticide (endosulphan) and leaf extract of *Parthenium hysterophorus* on the most harmful stage of the life cycle of *Trichoplusia ni* on *Brassica oleracea* var *carpitata*.

LC₅₀ EVALUATION (Fig. 39)

LC₅₀ determination for *Trichoplusia ni* after treatment with endosulphan (35%EC)

To calculate the value of LC₅₀ of endosulphan

against *Trichoplusia ni* the larva of 10-15mm in size have been treated with different concentrations of endosulphan. The different concentrations have been selected (Table IX). The survival number and percentage has been noted after 24hours. The mortality percentage is calculated from the survival number (Table IX). It is clear from the table IX that the mortality percentage increases with the increase in concentration of endosulphan against *Trichoplusia ni*.

LC₅₀ determination for *Trichoplusia ni* after treatment with acetone and alcoholic leaf extract of *P. hysterothorus*

To determine the LC₅₀ value of acetone and alcoholic leaf extract of *P. hysterothorus*, the larva (10-15mm size) of *Trichoplusia ni* have been treated with different concentrations i.e. 200, 500, 1000, 2000 and 3000 μ gmL⁻¹.

The survival number and percentage of larva have been recorded after 24hours. From the survival number, the mortality percentage is calculated (Table X and XI). It

is clear from the table X and XI that the mortality percentage increases (in both acetone and alcoholic extracts) in number with increase in concentration of leaf extract of *P. hysterophorus*. Table X and XI also suggests that the mortality percentage of *Trichoplusia ni* is little higher in alcoholic leaf extract as compared to acetone extract.

It is clear from the fig. 39 That the value of LC₅₀ is significantly greater in acetone leaf extract (2082.23 μgmL^{-1}) as compared to alcoholic extract (1644.15 μgmL^{-1}).

Relative toxicity of synthetic pesticide (endosulphan) and plant's leaf extract to *Trichoplusia ni* (Table-XII)

It is evident from the experimental findings that synthetic pesticide (endosulphan) is more toxic than plant extract but for environmental hazards problem we should use bio-pesticide. These findings indicate that acetonic leaf extract of *Parthenium hysterophorus* is better than alcoholic leaf extract.

Because leaf extract of *P. hysterophorus* also act as pest control but no so more as synthetic pesticide but for sustainable development and for maintain fertility of soil we should use bio-pesticides.