ISSN: 0976-3031

Available Online at http://www.recentscientific.com

International Journal of Recent Scientific Research
Vol. 6, Issue, 8, pp.5573-5577, August, 2015

International Journal of Recent Scientific Research

RESEARCH ARTICLE

FEEDING PATTERN AS AN INDEX TO EVALUVATE THE EFFICAY OF PLANT EXTRACT AGAINST FOREST INSECT PESTS

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ARTICLE INFO

Article History:

Received 14th, July, 2015
Received in revised form 23th, July, 2015
Accepted 13th, August, 2015
Published online 28th, August, 2015

ABSTRACT

The bio-efficacy of plant extract of Parthenium was analyzed by studying the nutritional indices such as weight gain, consumption index (CI), approximate digestibility (AD), efficiency of conversion of digested food (ECD), efficiency of conversion of ingested food (ECI) in the larvae of *Hyblaea puera* and *Eutectona machaeralis*. The aqueous extract of Parthenium significantly reduced the food ingestion in the larva of *H.puera* when compared to control. The level of food ingestion was very low in 1% treatment whereas in other concentrations, the nutritional indices were increased. Though the food ingestion and weight gain were increased in the 5% treatment, the consumption index was lower than the control. The same plant extract in the larva of *E. machaeralis* increased the CI but the ECD and ECI were very less as compared to control. The heterogeneous levels of nutritional indices revealed the various responses of the *H.puera* and *E.machaeralis*.

Key words:

Parthenium, *Hyblaea puera*, *Eutectona machaeralis*, nutritional indices

INTRODUCTION

Insect pests cause heavy damages like defoliation, growth retardation, weakening of young saplings, drastic reduction of seed formation, etc., (Browne,1968) and manifest heavy loss. The loss has been increasing every year. To avoid the heavy loss, organic synthetic chemicals have been widely used to control the insect pests. The continuous use of insecticides against insect pest probably in the long run develops some form of genetic variations. To prevent the undesirable changes, alternative efforts have been explored to investigate the possibility of utilizing prevalently available plants in the nature as a source for the control of insect pests. Plants contain a number of chemicals which are not only a nutrient category but also a category of secondary metabolites. They are considering as an alternative source to synthetic organic pesticides. The secondary metabolites possess properties like anti- microbial, insect repellent and herbivore deterrent, etc. Currently a number of plant derivatives have been screened and utilized as bio-pesticides to combat insect pests. Plant derived chemicals are environmentally safe in nature. The present work attempts to investigate the possibility of utilizing prevalently available plants in the nature as a source for the control of insect pests. Since our country is rich biodiversity of flora and fauna, focus has been given to find out the active substances present in the plants which are potential to control the insect pest population. In recent past a number of plant species have been screened and marketed as medicines, cosmetics, dyes and pesticides. The plant world comprises a rich store house of secondary chemicals which could be used as insecticides. To find out the efficacy of plant derivative as bio-pesticide, plant like Parthenium (Parthenium *hysteriophorus* L (F: Asteaeae) prevalently available as weed in the various places, has been selected for the present study.

Tectona grandis Linn. (F: Verbenaceae), one of the economically important forest trees, harbors a variety of insect pests. Among them, the two major pests, the defoliator *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae) and skeletonizer *Eutectona machaeralis* (Walker) (Lepidoptera: Pyralidae) cause severe damage in the form of repeated defoliation and skeletonization of teak leaves in nursery plantations and grown up trees. The larvae of *E.machaeralis* feed on slightly matured leaf tissue between the networks of veins while *H.puera* feed on tender leaves. Due to heavy infestation of such pests in the commercially important forest tree, retardation in the growth occurs which accounts for nearly 13 % of loss in the annual yield (Beeson, 1941). Nair *et al.*, (1993) also reported the

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volume decrement in the teak due to insect pest attack. To control such pest attack in the vast area of plantations and in nurseries, an attempt has been made to study the efficacy of chosen plant derivative of parthenium by analyzing the feeding behavior of *H. puera* and *E. machaeralis* since the nutritional indices in the plant extracts treatment prove to be an index to control the insect pests.

MATERIALS AND METHODS

The plant extract preparation and experimental procedures were as follows:

Maintenance of insect culture

Healthy larvae of forest insect pests such as *Hyblaea puera* and *Eutectona machaeralis* were collected separately from teak nurseries. They were cultured in our laboratory with the maintenance of temperature between 25˚ C and 27˚ C throughout the study period. The fresh eggs were collected and kept in a sterilized glass jar for hatching. Newly emerged larvae were transferred to a sterilized glass jar with fresh tender teak leaves. The early and second instar larvae of *H.puera* and *E.machaeralis* were used for the present study.

Preparation of aqueous extract of *Parthenium hysteriophorus* l

Fresh leaves of *Parthenium hysteriophorus* of 10gms were plucked from the garden and gently washed with tap water. It was macerated and placed in a conical flask with distilled water for extraction. The extract from the conical flask was collected and considered as stock solution. From the stock, different dilutions such as 1%, 2%, and 5% were prepared for the experimental purposes.

Experiment: I

Freshly plucked tender teak leaves from the teak nursery were brought to laboratory and different concentrations of the aqueous extract of *P. hysterophorus* such as 1%, 2% and 5% were sprayed separately to the three leaves marked 1, 2 and 3. The remaining leaf was considered as control with the spray of distilled water. All the leaves, after shade drying were kept in a glass chamber separately. The tip of the petiole was twined with water soaked cotton to avoid the drying of the leaves.

Fresh and healthy early instar larvae of *H. puera* were collected from the stock culture maintained in the laboratory and released ten larvae into the leaves marked with 1, 2 and 3. They were kept in a sterilized glass chamber to study the feeding pattern for 24hrs.

Experiment: II

Fresh and healthy second instar of *Eutectona machaeralis* were collected from the stock culture and grouped into four batches. Four teak leaves of uniform size and age from the same plant were selected. Water soaked cotton was twined around the petiole of all the leaves to avoid drying. The different concentrations of *Parthenium* extract such as 1%, 2%, and 5% were sprayed separately to three leaves and remaining one was kept as control with water spray. After shade drying the leaves, selected healthy ten larvae were released separately.

The data such as leaf weight, larval weight and excreta weight before and after the experiment were recorded for the calculation of consumption index (CI), approximate digestibility (AD), efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) as per the procedure of Waldbauer (1968). The data obtained from this study were subjected to t- test to understand the significance of the results.

RESULTS

Nutritional indices of *H.puera*

Nutritional indices were analyzed in the control and in the *Parthenium* treated *Hyblaea puera* (Fig.1-3). The control larva gained the weight approximately 0.007 mg. by ingesting 0.573 mg of leaf and in turn, the ingested food was digested nearly equal to the level of food intake.

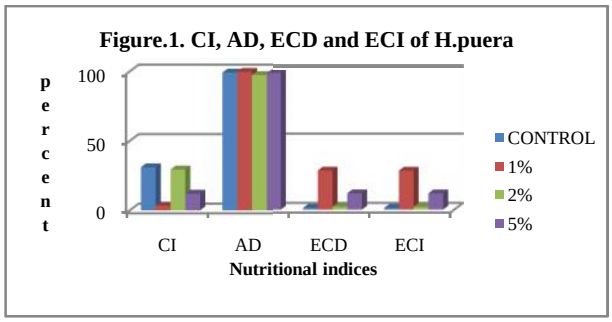

Fig. 1 Consumption index (CI), approximate digestibility (AD), efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) of *H.puera* in the different concentrations of Parthenium

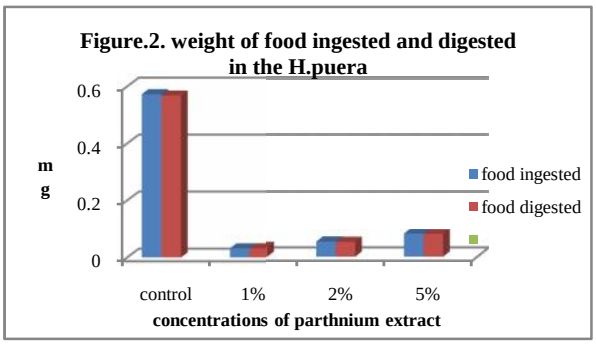

Fig.2 Weight of food ingested and digested in the *H.puera* at different concentrations of Parthenium extract

The analysis revealed that the approximate digestibility was 99.1%. However, the efficiency of conversion of digestibility is 1.2%. The trend of nutritional index of the control was altered due to the treatment of Parthenium at various concentrations. In 1% treatment, food ingestion by the insect was reduced to 0.032 mg. The other nutritional indices such as weight of food digested, weight gain and weight of excreta were also declined and all these values are significant at $P<0.05$ level. The efficiency of conversion of digested food in the treatment showed nearly 28.2% i.e., the insect taken very little amount of

food which was efficiently utilized to derive the energy for sustaining the life. In other treatments, the food ingestion was slightly increased when compared to the control and it was 0.050mg in 2% treatment and 0.077 mg in 5% treatment. Simultaneously the excreta was slightly increased in the both the treatments. The food digested was also increased to 0.076mg when compared to the 1% treatment where it was 0.032mg. The trend of food digestion was slightly increased from 1% treatment to 5% treatment. However the value was very less as compared to control value of 0.568mg. The efficiency of conversion of digested food was increased in 1% treatment and at the same time it was decreased in 2% and 5% treatments. The efficiency of conversion of ingested food was equal to the efficiency of conversion of digested food in all treatments. The ECD was low in the 2% treatment and found to increase in the 5% treatment. Similarly ECI also showed increase in both treatments of 2% and 5%. The values when subjected to t-test showed significance at P <0.05 level. Among the different concentrations, 5% treatment showed the increase of all the nutritional indices than the nutritional indices observed at 1% and 2% treatments.

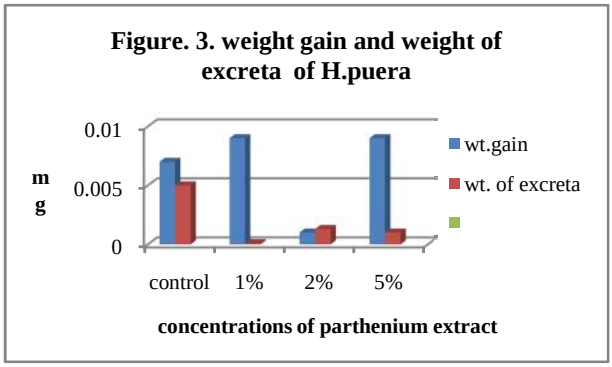

Fig.3 Weight gain and Weight of excreta of *H.puera* at different concentrations of Parthenium

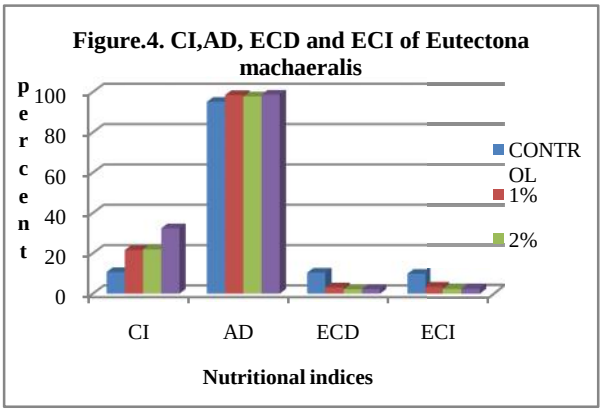

Fig.4 Consumption index (CI), approximate digestibility (AD), efficiency of conversion of digested food (ECD) and efficiency of conversion of ingested food (ECI) of *E.machaeralis* in the treatment of different concentrations of Parthenium

Nutritional indices of *E.machaeralis*

Nutritional indices of *Eutectona machaeralis* in the various concentrations of *Parthenium* treatment were observed (Fig. 4-6). In the control animal, the food ingestion was 0.122mg at the end of the 24 hrs. This level was increased to 0.194mg in the 1% treatment. Similarly the food ingestion was also increased in 2% and 5% treatments and statistically found significant at (P<0.05) level. Among the various concentrations, the food intake was high in 5% treatment. In the same way, the food digestion was also increased from 1% to 5% i.e., 0.191 mg to 0.304 mg respectively. The percentage of food digestion was statistically significant at P<0.05 level. Though the food ingestion and food digestion were increased, the weight gain was slightly decreased when compared to control where it was decreased nearly 50% in the 1% treatment, 58% in 2% treatment and 41.75 % in the 5% treatment. The other nutritional index, i.e., weight of excreta showed more or less equal in all the treatments. The results revealed that the 5% treatment increased the consumption index and it was statistically significant (P<0.05). Among the various nutritional indices, the approximate digestibility was not significant when compared to control where as all other parameters were significant at P<0.05 level. The ECD and ECI were same level in all the treatments and they were reduced nearly 70% and 78.7% respectively in 1% treatment. Among the two insect pests the *Parthenium* extracts showed some feeding deterrence activity in the *H.puera* than in the *E.machaeralis*.

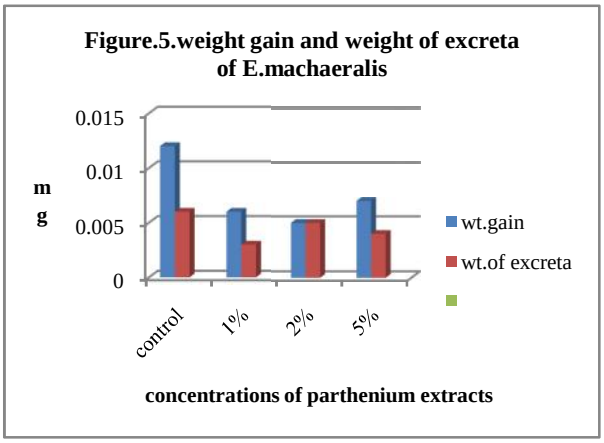

Fig.5. Weight gain and weight of excreta of *E.machaeralis* in the various concentrations of Parthenium extract

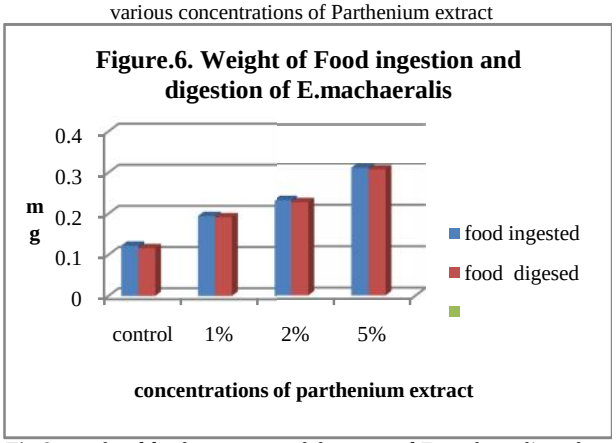

Fig.6. weight of food ingestion and digestion of *E.machaeralis* in the parthenium extract of various concentrations.

DISCUSSION

Most insect defoliators belong to the order Lepidoptera, whose larval stages feed on leaves. They are generally very high reproductive potentials and short life cycles. Hence rapid population build-ups can be expected within a very short period. The majority of the insects' pests occur in the months when the trees put on new flushes of leaves. Some of the

insects feed only on the epidermis and avoid the veins; thereby the insects leave only the skeletons. Others may eat away entire leaves whilst few may wander from leaf to leaf, feeding only on part of the leaves. Recently, studies on the damage and the control of defoliation in teak plantation have been taken up in a little way to protect the loss of annual growth of the trees. As an index to control the forest insect, nutritional indices have been analyzed in the larval stages of *H.puera* and *E.machaeralis* in the treatment of *Parthenium* extract for a period of 24hrs. In control, the developmental stage of the larvae of *H. puera* consumed very low level in the *Parthenium* treatment. Similar observation has also been reported in the 5% treatment of *Calotropis procera* by Meshram (1995). The low level of feeding may be due to the fact that the secondary metabolites available in the aqueous extract block the bioavailability of nutrients (Broadway and Duffey, 1986) whereas in the present study the 5% concentration of *Parthenium* , significantly increased the consumption level by 87% than in 1% and 2% treatments, however the growth rate showed significantly higher than the control except in 2% treatment of *Parthenium*. Though the food consumption was low in the early instar of *H.puera* in 1%, the weight gain was increased to 29%. Meshram (1995) has also tested plant leaves extracts of 0.5% of *Jatropha curcus, Alove vera* and *Anona squomosa* for their anti-feedent property against third instar larva of teak skeletonizer, *E.machaeralis* and found that *Alove vera* followed by *Anona squomosa* of 0.5%, deterred the larva from feeding. The degrees of digestibility and growth have also been well related to the water content. Mattson and Scriber (1987) have suggested that the digestion and absorption of nutrient component of food is reduced by the presence of fiber and also the variation in the digestion is due to nitrogen and water content of the leaves which influence greatly the nutritional and allelochemical status of the leaves (Tabashnik and Slansky, 1987). The chemical constituents present in the plant extract may be a phagostimulant or deterrent which play an important role in the consumption and digestion of food and these properties may alter the feeding rate and weight gain in *H.puera* and *E.machaeralis*.

The larva of *H.puera* consumed lesser amount of food in 1% of prathenium treatment than the control and the feeding inhibition by 94% may be related to the complex behavior which mainly rests in gustatory stimulus by modifying sensory input of the insects. The same trend of marked reduction of food digestion and weight gain have also been reported in *Taragama siva* when leaves were treated with 0.05% methanol extract of neem seed kernel powder (Sundararaj *et al.*, 1995). The deterrent effect may also be judged by the relative loss in body weight of the larvae. This might be due to loss or slow feeding of foliage and diversion of energy from the production of biomass to detoxify the plant extracts. Instead of decreasing level, the feeding rate was high and correspondingly the food digestion was also increased in 5% of Parthenium treatments. In the same experiment the weight gain showed slightly more than the control larvae. The conversion of food into body mass was also considerably increased particularly in1% treatment. Probably the lower concentration of plant extract i.e., 1% tends to act as attractants while 2% concentration acts as deterrents. This view also supports the findings of Harborne (1982) who reported that the availability of common flavonoid, glycosides including rutin, quecitrin and isoquecitrin are known to act as toxins to a number of insects.

The efficiency of conversion of ingested food of early instar of *H. puera* in Parthenium treatment was higher in 1% and 5% than the control. The higher AD, ECD and ECI values in treatments may be attributed to the fact that as a physiological event the larvae defecate excessively the leaves containing toxic substances and hence relatively less quantity of food material is allocated to body tissue (Sundararaj *et al.*, 1995). In 2% of Parthenium treatments the ECI level was nearly equal to control. The higher concentrations of Parthenium i.e., 5% may be a stimulant rather than deterrent among the various concentrations of Partheuium treatments. Sundararaj *et al*, (1995) also reported higher AD in *Taragama siva* when fed with high concentrations. The Parthenium extracts of various concentrations in the *E. machaeralis* influenced the food ingestion than the control larvae and the study revealed that as the concentrations increased from 1%, the rate of food ingestion was also increased gradually when compared to control. The same trend was also observed in the weight of food digested, CI and AD where as ECD and ECI were also showed low levels in various concentrations and suggested that the utilization of food for conservation of energy for various life activities have been challenged by the chemicals present in the plant extracts. Among the two species of forest insect pests, the *E.machaeralis* in parthenium extracts of all concentrations act as stimulant whereas in *H.puera*, all the concentrations act as deterrent except in 5% which acts as stimulant. In the present investigations, the parthenium extract acts differently in *H.puera* and *E.machaeralis*. The differences may be attributed to the differential biochemical constituents of larval tissues at various developmental stages.

In the present study, the Parthenium extract elicited heterogeneous responses in the larvae of *H.puera* and *E.machaeralis*. The extract, shows promising results of decrease in the level of nutritional parameters and supports the view of Nummel (1989) who claimed that plant product controls some groups of pest which are developing resistance rapidly against conventional pesticides.

Based on the findings, the active compound of parthenium may be isolated and screened because in crude extracts, the potency of the compound may not be exhibited. In the crude extract, active compound along with other secondary metabolites may synergize or antagonize. To understand such property, screening and utilization of plant based bio-pesticides have been much concern in the present scenario. Since rich potential of flora in our country may be properly screened and utilized with criteria of certain advantages.

Acknowledgement

Authors thank the Principal, Head & staff of the Department of Zoology, Arignar Anna Government Arts College, Cheyyar - 604407 for the facilities provided to carry out the work.

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How to cite this article:

Sathiyaraj V ., Feeding Pattern as an index to evaluvate the Efficay of plant Extract against Forest Insect Pests. *International Journal of Recent Scientific Research Vol. 6, Issue, 8, pp.5573-5577, August, 2015*

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