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Taxonomic Documentation and Population Dynamics of Major Phototactic Insect Pests of Medicinal Crops with Special Reference to effect of Ecological Factors on *Helicoverpa armigera* Hub. and *Agrotis ipsilon* Huf.

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ABSTRACT
The experiment was conducted during 2016-2017 at experimental field, JNKVV, Jabalpur by using the Jawahar light trap with 80 W. M.V. lamp to study the Seasonal incidence of prevalent phototropic insect pests of medicinal crops. A total of 13 phototropic insect pests were recorded from November 2016 to April 2017. As per the taxonomic documentation these species belongs to 4 orders and 10 families. Based on number of species collected, largest collection was represented by order Lepidoptera (5 species) followed by orders Hemiptera (3 species), Orthoptera (3 species) and Coleoptera (2 species). Major polyphagous pests of medicinal crops viz. Helicoverpa armigera and Agrotis ipsilon were active from November to April with peak catches during 5th & 8th and 49th & 8th standard week respectively. Correlation regression analysis with abiotic (weather) factors revealed that evening relative humidity and evening vapor pressure were significantly positive effect on H. armigera and A. ipsilon population while rest of the abiotic factors were non significant. The present findings will serve as valuable source of information for surveillance, monitoring and also in use of light trap as IPM tool against these pests of medicinal crops.
Keywords: *Seasonal incidence, Phototropic Insect Pests, Medicinal Crops*

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INTRODUCTION

In India, the use of different parts of several medicinal plants to cure specific ailments has been in vogue from ancient times. According to the World Health Organization, 80 per cent of the population of developing countries relies on traditional plant-based systems of medicine to provide them with primary health care needs [1].

Madhya Pradesh is veritable niche of growing healing herbs, which are being used, in Indian system of medicine like Ayurveda, Siddha and Unani. These plants, shrubs and roots of immense medicinal value are abundantly found in Chattisgarh plain Satpura, Vindhyachal, Amarkantak, Pachmarhi and Patalkot areas.

In Madhya Pradesh medicinal and aromatic crops are grown in 22,900 hectare area with production of 0.137 million metric tons and productivity of 6 metric tons/ha[2]. Insect pests generally infest their hosts to a lesser extent in their natural homes. Medicinal plants now-a-days are being cultivated in the fields to meet the increasing demand for pharmaceutical industries. Thus, they are likely to be attacked by a more number of insect pests in the man made agro ecosystems [35]. Insect infestation on the medicinal plants reduces yield as well as quality of the product. This loss can be minimized by using insecticides.

[13] have documented the infestation of 34 species of phytophagous mites on 79 medicinal plants in Varanasi. The extensive and indiscriminate application of chemical insecticides results into deleterious problems like Biomagnifications and Eutrophication etc. High residual deposition of chemical pesticide on the medicinal products which are directly consumable, can lead to more hazardous effect in place of cure of patient. Therefore there is a urgency to use non-chemical approach, which is economically viable and environmental friendly. Use of light trap is one of such approach. One of the most apparent behavior of insects is flying towards a light source at night known as phototaxis[24].

Light trap can occupies an important place in monitoring and management of insect pest population in Agro-ecosystem. Phototropic behavior of insects are being largely used to monitor pest activity for their effective suppression. The present study is put forth to identify phototactic insect pests of medicinal crops and describe them on the basis of taxonomic and economic aspects, in order to provide theoretical basis for the preparation of forecasting module for sustainable management of medicinal crop pests.

MATERIAL AND METHODS

The experiment was conducted during 2016-2017 at experimental field, JNKVV, Jabalpur by using the Jawahar light trap with 80 W. M.V. lamp to study the seasonal incidence of major phototropic insect pests of medicinal crops. Light trap was operated every night but collection of single day per week was recorded from November 2016 to April 2017.

In order to study the population dynamics, daily trap catches of all the major phototropic insect pests were observed and converted into monthly totals. Effect of weather factors on seasonal activity of *Helicoverpa armigera* (Hubner) and *Agrotis ipsilon* (Hufnegle) was studied by converting the daily catches into mean per day per week (weekly mean/day). Week divisions were based on standard meteorological week.

This observation method is similar to the method adopted by [34]. Observations of weather data (maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, wind velocity, morning, rainfall and number of rainy days etc.) were recorded on daily basis from JNKVV meteorological observatory. The correlation coefficient between various insect population and meteorological parameters was calculated as per the method proposed by [17].

RESULTS AND DISCUSSION

Season's trap catch observation revealed the occurrence of 13 phototropic insect pest species were recorded throughout the period from November 2016 to April 2017. According to taxonomic analysis these species belongs to 4 orders and 10 families. Based on number of species collected, largest collection was represented by order Lepidoptera (5 species) followed by orders Hemiptera (3 species), Orthoptera (3 species) and Coleoptera (2 species).

Similarly [23] also reported a record of 62 species belonging to 11 orders and 36 families through light trap catches Lepidoptera was the largest order with 31 species, followed by Hemiptera (13 species), Coleoptera (11 species) and Orthoptera (6 species).

[25] reported a total of 42 insect pest species were recorded. These insect pest species belongs to 5 orders and 22 families. Lepidoptera was the largest order with 24 species.Other orders were Hemiptera (9 species), Coleoptera (4 species) and Orthoptera (4 species) and Isoptera with single species only. Among these phototropic insect pests 16 species were recorded as major and minor pests of vetiver (*viz., Chillo partulus* S., *Spodoptera litura* Fab., *Mythimna separata* C., *Sesamia inferens* Wal, *Scirpophaganivella* Fab., *Tryporyza* sp.,*Nephotettix* sp., *Leptocorisa* sp.,*Cletus punctiger* (Dallas), *Aulacophora fovecollis* L., *Holotrichia insularis* B., *Mylobris pustulata* T., *Trilophidia cristella* S., *Gastrimargus transversus* T., *Gryllus* sp., *Microtermes obesi* Hol.).The season's trap catch collection also includedthe phototropic insect pests of Medicinal crops (15), Paddy (14) Polyphagous (6), Pulses (7), Cereals (6), Oilseeds (5), Sugarcane (4), Fodder crops (8) and Forest trees and others (7).

[7] & [6] also reported the per cent distribution of light trap catches [Lepidoptera (38.8%), Coleoptera (27.7%), Hemiptera (20.0%) and Orthoptera (18.2%)].

[28] reported all fifteen insect species belonging to four orders were observed to be associated with ten medicinal plants in different parts of Himachal Pradesh. All these insect-pests were recorded in low to medium numbers causing moderate damage. Seven

insect species viz., *Henosepilachna vigintioctopunctata* (Fabr.), *Nezara viridula* (Linn.), *Dysdercus cingulatus* (Fabr.), *Helicoverpa armigera* (Hübner), *Drosicha mangiferae* (Green), chrysomelid, *Podagrica bowringi* Baly and one unidentified pentatomid bug were recorded feeding on *Withania somnifera*. On *Saussurea costus, Thysanoplusia orichalcea*, *Condica conducta* (Walker), *C. albigutta* (Wileman) and *Alcidodes crinalifer* (Marshall) were found associated at different locations in Himachal Pradesh. *Papilio* sp. was recorded damaging *Aegle marmelos* at Shimla. *Digitalis lanata, Rauwolfia serpentina, Celastrus paniculatus* and *Bacopa monerii* showed low degree of damage by a scale insect, *Drosicha,* Pyrrhocorid bug and *Spodoptera litura.*

[20] revealed that the occurrence of five insect species on ashwagandha (*Leptocentrus* sp.*, Acrosternum gramineum* Fab., *Tetranychus urticae* Koch, *Helicoverpa armigera* Hub., *Deilephila nerii* Linn.), three species on Solanum (*Leptocentrus* sp., *Nezara viridula* Fab., *Aphis gossypii* Glov.) and one species on shatavari (*Lema* sp.) at Machenhalli. At Shivamogga dairy, four species on sarpagandha (*Indomia cretaceous* Fst.*, Deilephila nerii* Linn.*, Trilophida annulata* Thumb.*, Riptortus pedestris* Fab.) and two species on Amruthaballi (*Neorthacris acuticeps* Bol.*, Kolla ceylonica* Melichar.) were recorded and similarly four species were found on Ashwagandha (*Henosepilachna vigintioctopunctata* Fab., *Elasmolomus pallens* Dallas., *Spilostethus hospes* Fab., *Dolicoris indicus* Stal) at Shivamogga.

Order Lepidoptera

Order Lepidoptera was the highest with 2 families and 5 species. Among these *Helicoverpa armigera* (Hub.) (554), *Agrotis ipsiton* (Huf.) (435), *Spodoptera litura* (Linnaeus) (562) and *Plusia orichalcea* (Fabricius) (636) belongs to family noctuidae. All these species were active from November to April with monthly peak in March. [28], [31] and [19] also reported these noctuids as major pests of medicinal crops. *Spilarctia obliqua* Walker (173), family Arctiidae, also had the highest peak during April.

[9] reported *Spilarctia obliqua* (Arctiidae) as pest of Coleus, *Costus speciosus* Linn. [3] and [27] also reported these species through light trap catches.

[15] reported *Helicoverpa* sp. was found feeding on leaves and also boring into buds, flowers and fruits with its head.

Order Hemiptera

Order Hemiptera was the second highest order of pest species in trap catch with 3 families and 3 species. The family Cicadellidae was represented by *Nephotettix virescens* (Distant) with highest trap catch of 11,351 hoppers with peak catches in November followed by *Dysdercus koenigii*, Fabricius (502 bugs) and *Nezara viridula* Linnaeus (299 bugs) with monthly peaks in December and March respectively.

[9] recorded both nymphs and adults of Cicadellids on tender parts of Ashwagandha (*Withania somnifera*). [32] recorded *Nezara virudula* as pest of *Withania somnifera*. [21] also observed the population densities of 92 hemipterous insect species belonging to 58 genera of 16 families including Cicadellidae pyrrhocoridae and pentatomidae by using Robinson light trap at Al-Arish city, North Sinai during 1994-96.

[15] reported green plant bug, *Nezara virudula* Fab. is a polyphagous pest, where nymphs and adults were observed to suck the sap from leaves, buds of Ashwagandha.

Order Orthoptera

Order Orthoptera was represented by 3 families and 3 species. Among these highest trap catch was of field cricket, *Euscyrtus concinnus* (de Haan) (1177 crickets) followed by short horn grass hopper, *Trilophidia cristata* S. (908 hoppers) and Mole cricket, *Gryllotalpa orientalis* Burmeister (311 crickets). *E. concinnus* and *T. cristata* registered peak catches during March.

[10] also reported *Trilophida* sp. as pest Ashwagandha. In accordance with the present findings [22] reported that order Orthoptera was represented by 3 families in which highest trap catch was of *Gryllus* sp. (3854) (fam. Gryllidae) followed by grass hoppers, *Trilophidia cristella* S. (311) & *Gastrimargus transversus* T. (387) and *Gryllotalpa gryllotalpa* Linn. (213) through light trap at Jabalpur. Similarly [29] reported that the nocturnal Orthopteraus were represented by six families including Gryllidae, Gryllotalpidae and Acrididae in light trap catches. Gryllidae was found dominant as compared to other families.

Order Coleoptera

Order Coleoptera was represented by 2 families and 2 species. In terms of relative size of trap catch red pumpkin beetle, *Aulacophora foveicollis* (Lucas) had the highest trap catch of 296 beetles followed by blister beetle *Mylobris pustulata* T. (222 beetles).

[23] also recorded highest trap catch of *Aulacophora foveicollis* (331 beetles) among coleopterous at Jabalpur. [18] reported that coleopterans dominate the light catches, followed by hemipterans, hymenopterans and lepidopterans.

[15] reported three species of Coleopterans were found feeding on the leaves of Ashwagandha. *Henosepilachna vigintioctopunctata* (Coleoptera: Coccinellidae) was predominant at early stage of the crop both adults and grubs cause damage to the leaves and tender parts by scraping the epidermal layer in a very characteristic manner leaving a netted pattern. The incidence of Epilachna beetle resulted incomplete skeletinized leaf during heavy infestation at later stage of the crop growth. Finally the plants dried and wither up.

Population dynamics of *H. armigera* and *A. ipsilon* in relation to ecological weather factors:

***Helicoverpa armigera* (Hubner)**

The activity period of *H. armigera* was observed from November to April with two distinct peaks during 5th and 8th SW respectively. In conformity to this Sharma et al. (2015) also reported two distinct peak of H. armigera in trap catch during 5th and 8th SW. [8] also observed peak catches of *H. armigera* during 1st to 8th SW through light trap while [5] reported four peaks of *H. armigera* from the 3rd week of May to 2nd week of September.

The highest peak was observed in 8th SW, during this period maximum and minimum temperature were 29.60C and 100C respectively, whereas morning & evening relative humidity, wind speed, sunshine, morning & evening vapor pressure (mm) and evaporation were 83.4% & 26.2%, 3.3Km/h, 10.2, 8.9 & 8, and 4 respectively. There was no rainfall during this week.

Correlation between *H. armigera* and weather factor evening relative humidity and evening vapor pressure were found significantly positive while rest of the abiotic factors were non significant.

In accordance with present findings [30] also reported that relative humidity had a significant impact on moth catches. [26] maximum temperature which showed a significant negative effect while morning relative humidity and evening relative humidity showed the positive effect on moths catches of *H. armigera* respectively. [34] reported that rainfall had no effect on moth catches. While [4] indicated that peak catches of *H. armigera* were observed when maximum temperature and minimum temperature was 32-340C and 17-190C respectively.

***Agrotis ipsilon* (Hufnugel)**

The activity period of *A. ipsilon* was observed from November to April with two distinct peaks during 49th and 8th SW (highest) respectively. In accordance with the present findings [8] also reported the highest weekly peak trap catches during 8th SW while [26] reported peaks of *A. ipsilon* in 4rth and 8th SW in trap catch.. Similarly [33] and [16] also reported the activity of *A. ipsilon* from November to April.

During the highest peak (8th SW), during this period maximum and minimum temperature were 29.60C and 100C respectively, whereas morning & evening relative humidity, wind speed, sunshine, morning & evening vapor pressure (mm) and evaporation were 83.4% & 26.2%, 3.3Km/h, 10.2, 8.9 & 8, and 4 respectively. There was no rainfall during this week.

Correlation between *A. ipsilon* and weather factor evening relative humidity and evening vapor pressure were significantly positive while rest of the abiotic factors were non significant.

In conformity with this [26] and [14] reported that relative humidity had significant positive effect on *A. ipsilon* moth catches. In contrast to this [12] observed that relative humidity was negatively correlated with moth catches. Rest of the weather parameters were found non significant in the present findings. On the contrary [11] observed that rainfall exhibited the negative impact on moth catches.

The present investigation has provided voluble base line information on presence occurrence, distribution and population dynamics of 14 phototropic insect pests in medicinal crops at Jabalpur. The present study also indicated the effect of weather factors

on major phototactic polyphagous pests viz. *H. armigera* and *A. ipsilon* of medicinal crop ecosystem. This will be very useful for the future surveillance and monitoring of insects for forecasting and also in incorporating light trap as Integrated Pest Management tool against these pests of medicinal crops. With added advantage of light trap which can overcome the problem linked to the use of chemical insecticides and cementing the strength of medicinal crops as potential therapeutic mile stone.

Table 1: Taxonomic distribution of insect pests of medicinal crops collected in light trap

S.No.	Name of the species	Family	Season's total trap catch*	Host crops
(A)	**ORDER:LEPIDOPTERA**			
1.	*Helicoverpa armigera* (Hubner)	Noctuidae	554	Muskdana, Sarpgandha **Opium popy**
2.	*Agrotis ipsilon* (Hufnugel)	Noctuidae	435	Muskdana,Sarpgandha, **Belladona, Opium popy**
3.	*Spodoptera litura* (Fabricius)	Noctuidae	562	Brahmi, **Glory lilly**
4.	*Plusia orichalcea* Fab.	Noctuidae	562	Babchi, Beal
5.	*Spilosoma obliqua* Walk.	Arctiidae	150	Sarpgandha, Sedasuhegan
(B)	**ORDER: HEMIPTERA**			
6.	*Nephotettix virescens*(Distant)	Cicadellidae	10889	Babchi, Beal
7.	*Nezara viridula* (Linn.)	Pentatomidae	279	Sarpgandha, Pudina
8.	*Dysdercus koenigii* (Fabricius)	Pyrrhocoridae	401	Muskdana, Sarpgandha
(C)	**ORDER: ORTHOPTERA**			
9.	*Trilophidia cristata* S.	Acrididae	814	Lemon grass
10.	*Gryllotalpa orientalis* Burmeister	Gryllotalpidae	262	Safed mushli
11.	*Gryllus bimaculatus* De Geer	Gryllidae	1296	Beal
(D)	**ORDER: COLEOPTERA**			
12.	*Mylobris pustulata* T.		205	
13.	*Aulacophora foveicollis* (Lucas)	Chrysomelidae	296	Muskdana

*Light trap catches from November 2016 to April 2017

Table 2: Correlation coefficient of weather factors on light trap catches of *Helicoverpa armigera* (Hubner) and *Agrotis ipsilon* Hufnegle.

Weather Parameter	*H. armigrera*		*A. ipsilon*	
	R	**byx**	**r**	**Byx**
Maximum temp. (°C)	-0.34 NS	-	-0.26 NS	-
Minimum temp. (°C)	-0.09 NS	-	-0.09 NS	-
Morning RH. (%)	0.29 NS	-	0.29 NS	-
Evening RH. (%)	0.473*	0.139	0.451*	0.1003
Rainfall	0.33 NS	-	0.34 NS	-
Sunshine Hour	-0.01 NS	-	-0.23 NS	-
Wind Velocity	0.12 NS	-	0.01 NS	-
Morning Vapor Pressure	-0.08 NS	-	0.04 NS	-
Evening Vapor Pressure	0.444*	0.834	0.507*	0.717
Evaporation	0.36 NS	-	0.15 NS	-
Number of Rainy Days	-0.23 NS	-	-0.25 NS	-

*Correlation is significant at the 0.05 level NS= Non - Significant

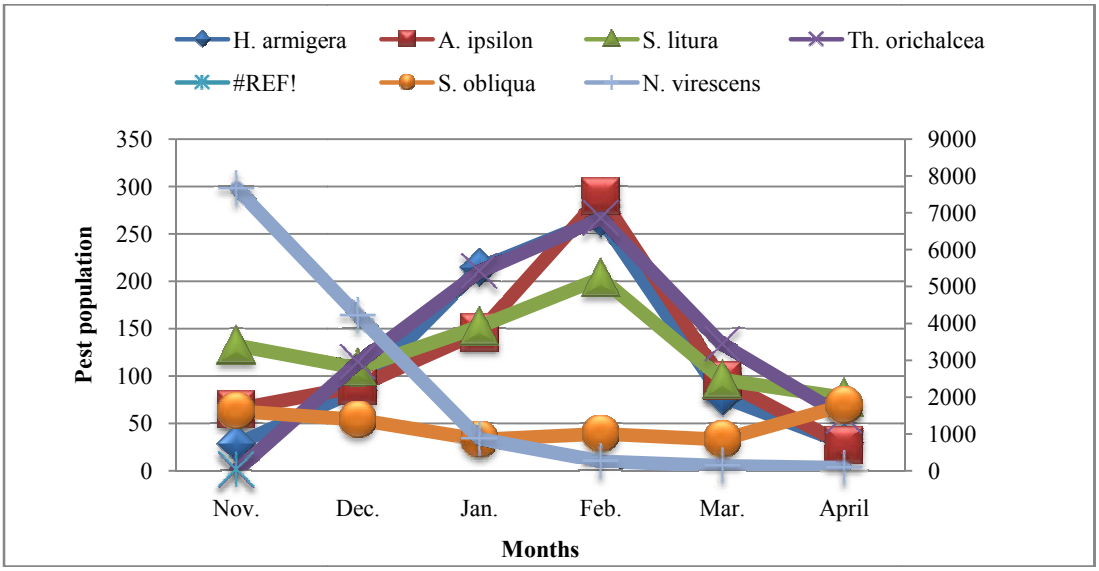

Fig. 1: Monthly distribution of light trap catches of major insect pests of medicinal crops during 2016-2017 at Jabalpur.

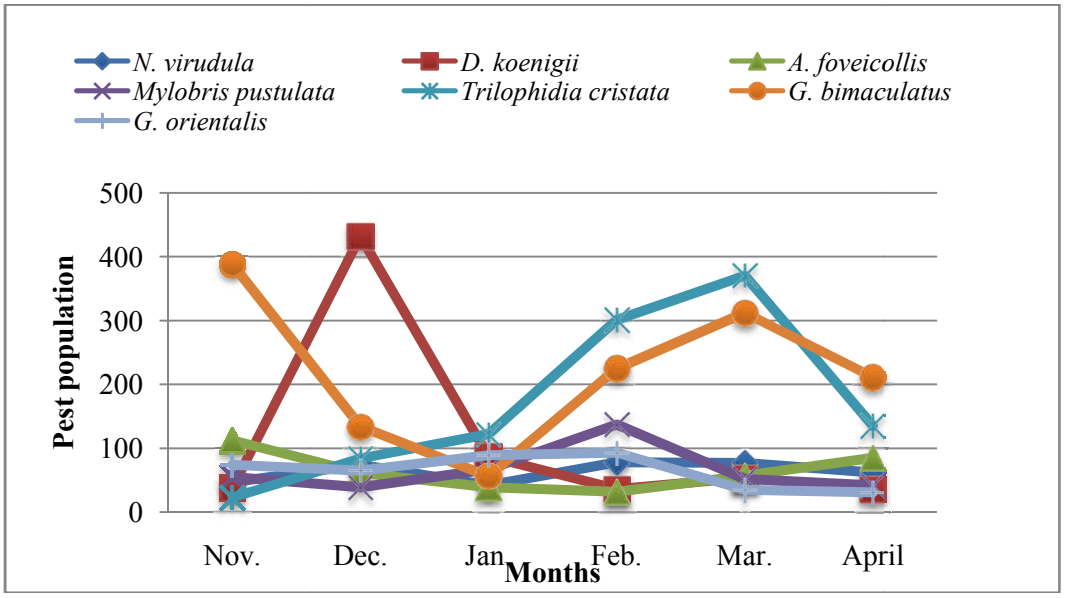

Fig. 2: Monthly distribution of light trap catches of major insect pests of medicinal crops during 2016-2017 at Jabalpur.

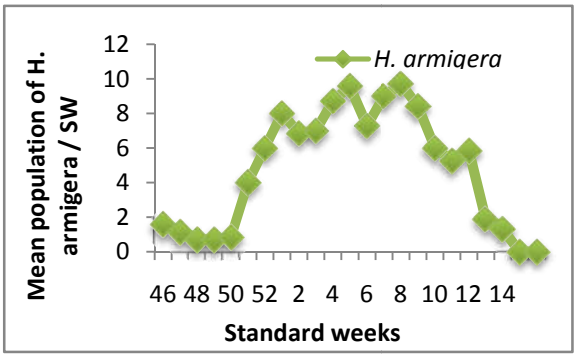

Fig. 3: Mean population of *H. armigera* in light trap during 2016-2017

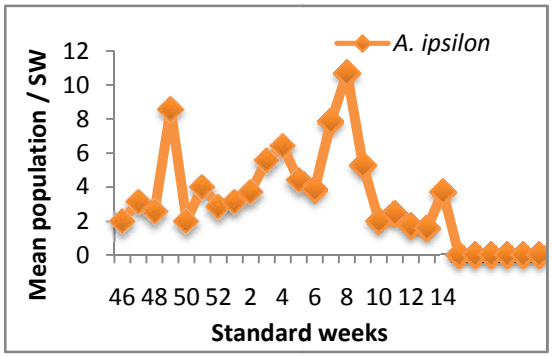

Fig. 4: Mean population of *A. ipsilon* in light trap during 2016-2017

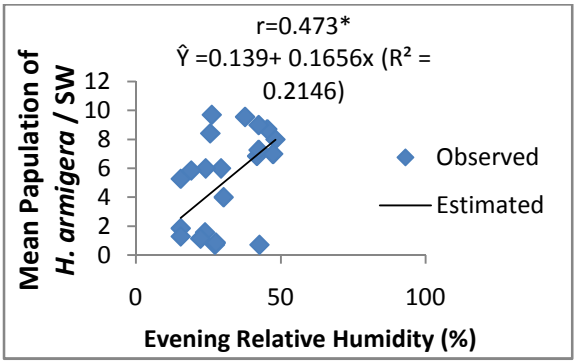

Fig. 5: Regression of evening relative humidity on *H. armigera* trapped in light trap

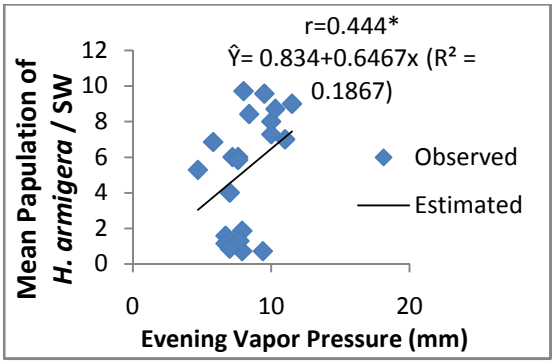

Fig. 6: Regression of evening vapor pressuere *H. armigera* trapped in light trap

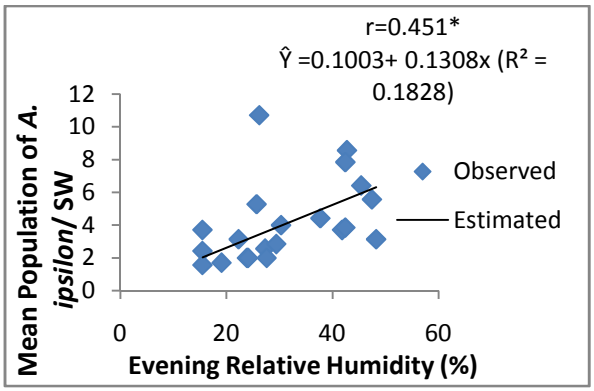

Fig. 5: Regression of evening relative humidity on *ipsilon* trapped in light trap

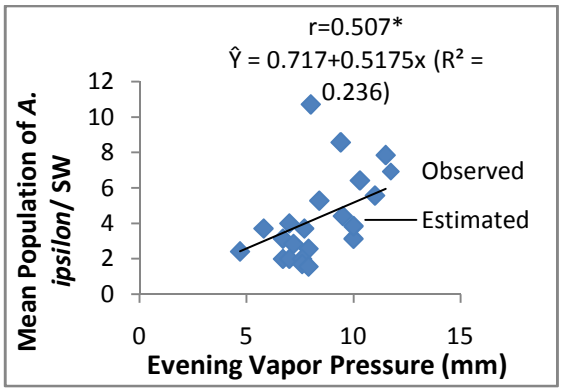

Fig. 6: Regression of evening vapor pressure *A. A. ipsilon* trapped in light trap

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