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Population dynamics of pests infesting castor and their natural enemies in Southern Karnataka

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Abstract
Studies on occurrence and population dynamics of insect pests of castor was carried out at ARS, Pavagada during *Kharif* 2013 And the results revealed, twenty two insect species feeding on different parts of the crop. Among them, sixteen species were leaf feeders, five were sucking pests and one capsule borer belonging to families, Pyrgomorphidae, Acrididae, Noctuidae, Geometridae, Arctidae, Nymphalidae, Curculionidae, Agromyzidae, Limacodidae, Cicadellidae, Thripidae, Pentatomidae, Tetranychidae and Pyraustidae besides, three larval parasitoids were recorded on *Achaea janata viz,*. *Microplitis maculipennis* Szepligeti, *Euplectrus leucotomies* Rohwer and *Brachymeria* spp. The relationship between pests and ambient weather parameters revealed minimum temperature, humidity, wind speed and wind direction were significant negative influence on *Tetranychus* spp. (r=0.82**), *Conogethes punctiferalis* (r=0.658* to 0.979**) and *Ergolis merione* (r=0.657* to 0.699*) population buildup. While, maximum temperature, atmospheric pressure, wind speed and minimum temperature were significant positive influence on *C. punctiferalis* (r=0.726* to 0.889**), *Helicoverpa armigera* (0.648*), grass hoppers (0.701* to 0.749*) and *Liriomyza trifoli* (0.819*) population buildup.

Keywords: Population dynamics, pests, castor, weather parameters, natural enemies

1. Introduction
Castor (*Ricinus communis* L.) is an important non-edible oil seed crop belonging to the family Euphorbiaceae. It has gained great potential as the oil is being used for aircrafts as lubricant and also for grease, hydraulic fluids, soaps, Printing inks and for ayurvedic medicine [17]. India is one of the world principal producers of castor, covering 9.16 lakh hectare area with an annual seed production of 11.20 lakh tonnes and an average seed yield of 1223 kg/ha representing 73 per cent of production, followed by China (12 %) and Brazil (6.4%) [2]. Gujarat is the leading state in castor seed production in India with 75 per cent of the total production followed by Rajasthan (14 %) and Andhra Pradesh (13 %) [2].
Castor is a major oilseed crop in dry land areas. The yield loss due to insect pests has been estimated in the range of 35-40 per cent. More than 100 pest species infest castor crop, but only a few major pests are responsible for the crop losses [4]. Number of insect pests, mostly the defoliators and sucking pests at different growth stages have also been reported from Manipur [12]. The castor semiooper, *A. janata* and tobacco caterpillar, *S. litura* are the most common and regular pests of castor, which can cause even the complete defoliation [6, 13].
The variability in pest populations on crops is determined by the natural buildup of pest population and the influence of weather conditions on thrips activity and their multiplication rate [3]. An understanding of the factors that influences such population changes is essential for predicting the incidence and abundance of thrips. Weather variables like rainfall, temperature, relative humidity and wind speed have been reported as important factors, which significantly affect pest numbers [1, 3].
For effective pest management, data generated on the influence of various factors responsible for population fluctuation on a crop might assist in the prediction of its occurrence at a location [14]. As the castor crop is grown in dry lands as rainfed, the probable incidence of major pests need to be managed with appropriate timely measures or strategies. The main objective of the present study was to determine the population fluctuation pattern of pests of castor crop at Pavagada location in Southern Karnataka and to investigate on the relationship between population density of pests and abiotic (ambient weather parameters) factors. The data generated as well would be useful for predicting outbreaks of castor pests under varied climatic conditions and to evolve suitable control or management strategies.

To generate or update our knowledge on the basic aspects of castor pests and in order to cope up with the changes in the practices of castor growers, a study was undertaken on occurrence of insect pests of castor in relation to weather parameters.

2. Material and Methods

To study the occurrence and intensity of various insect pests on castor during *kharif*, 2013, the castor variety 48-1(Jwala) was sown on 25-7-2013 with the row spacing of 90 cm and 45 cm between the plants at ARS, Pavagada and other agronomic practices were followed as per the package of practices [2]. The observations were made at various growth stages of castor at fortnightly intervals to know the occurrence of insect pests on crop from seedling stage till harvest of the crop.

To assess the incidence of semilooper, hairy caterpillar, tobacco caterpillar, slug caterpillar and spiny caterpillar the larval counts were made on randomly selected ten plants.

In case of shoot and capsule borer, incidence of the pest was recorded by counting the number of infested capsules on ten randomly selected plants and was converted into percentage with the following formula.

$$\text{Per cent capsule infestation} = \frac{\text{Number of capsules infested}}{\text{Total number of capsules observed}} \text{X100}$$

The incidence of leaf miner was recorded by counting the number of leaves infested on ten randomly selected plants and was converted into percentage with the following formula.

$$\text{Per cent leaf infestation} = \frac{\text{Number of leaves infested}}{\text{Total number of leaves observed}} \text{X100}$$

The incidence of sucking pest population was estimated by counting the number of leaf hoppers, thrips and mites from three leaves per plant on 10 randomly selected plants. The leaves were selected as one from the top (excluding two top most leaves), middle (medium matured leaves) and bottom (leaving two bottom most leaves) on the main shoot. The thrips population was counted by tapping the leaf on black card board. The incidence of plant bugs and Ash weevil population was recorded by counting the number of plant bugs and Ash weevils on ten plants. Similarly, the incidence of grasshoppers was estimated by making the counts on ten plants.

Observations were also made on the natural enemies of pests on castor. The possible number of egg, larva and pupa of pests were collected from the field. The collected materials were placed in the glass vials for the emergence of the parasitoids. The emerged parasitoids from the egg, larvae and pupae of the hosts were collected and got identified at NBAIR (PDBC), Bengaluru and Department of Agricultural Entomology UAS, GKVK, Bengaluru.

The status of the pests was considered based on number of insects occurring on the plant. To study the instantaneous effect of major abiotic factors *viz.*, maximum temperature, minimum temperature, relative humidity, daily rainfall, wind speed, wind direction and sunshine hours on pest infestation, correlation co-efficient and multiple linear regression were calculated by taking fortnightly pest population as the dependent variable with the fortnightly mean meteorological data as independent variable.

3. Results and Discussion

Occurrence of pests on castor crop revealed that twenty two insect species were feeding on different parts of the crop. Among them sixteen species were leaf feeders, *Attractomorpha* sp., *Pyrgomorpha* sp., *Dittopternis* sp., *Acrotylus* sp., *Chrotogonus* sp., *Cyrtocanthacris tatarica* (L.), *A. janata* Linn., *Spodoptera. litura F., Helicoverpa armigera* Hub., *Ergolis merione* Cramer, *Euproctis* spp. *Liriomyza trifoli* Burgess, *Hyposidra talaca* Walker *Myllocerus* spp. *Latoia lepida* L., *Olene mendosa* Hubber, five sucking pests, *Empoasca* spp., *Scirtothrips dorsalis*, *Tetranychus* spp., *Eutetranychus orientalis* and *Nezara viridula* (Linnaeus) and one capsule borer *Conogethes punctiferalis* (Table 1).

3.1 Occurrence and intensity of pests in relation to ambient weather parameters

The occurrence and intensity of different pests occurred on castor and their relation with weather parameters during the study period are presented in Table 3 & 4.

3.1.1 Grasshoppers

The grasshoppers' population was observed throughout the cropping period with a peak population (0.90 no./Plant) in the first fortnight of August as well as October. The present findings are in conformity with the findings [9].

The correlation revealed that the positive significant relation was observed with respect to maximum temperature (r=0.701*) and wind speed (r=0.749*).

3.1.2 Castor semilooper, *A. janata*

The incidence of semilooper started from first fortnight of September and continued till the first fortnight of December with a peak (2.70 larvae/ plant) population at the first fortnight of October and there after no incidence was observed. The findings were in confirmation with previous studies [15, 0]. The correlation co- efficient revealed that none of the weather parameters had influenced significantly the incidence of castor semilooper.

Table 1: List of pests observed on castor during 2013

SL. No.	Insect pest	Scientific name	Family	order	Status
1	Grasshoppers	*Attractomorpha* sp.	Pyrgomorphidae	Orthoptera	Minor
		Pyrgomorpha sp	Pyrgomorphidae		
		Chrotogonus sp.	Pyrgomorphidae		
		Dittopternis sp.	Acrididae		
		Acrotylus sp.	Acrididae		
		Cyrtacanthacris tatarica (L)	Acrididae		
2	Semilooper	*Achaea janata* Linn.	Noctuidae	Lepidoptera	Major
3	Looper	*Hyposidra talaca* Walker	Geometridae	Lepidoptera	
4	Hairy caterpillar	*Euproctis* spp.	Lymantridae	Lepidoptera	Major
5	Tobacco caterpillar	*Spodoptera litura* Fabr.	Noctuidae	Lepidoptera	Major
6	Spiny caterpillar	*Ariandne merione* Cramer	Nymphalidae	Lepidoptera	Major

7	Gram caterpillar	*Helicoverpa armigera* Hub.	Noctuidae	Lepidoptera	Minor
8	Ash Weevil	*Myllocerus* spp.	Curculionidae	Coleoptera	Minor
9	Leaf miner	*Liriomyza trifolii* (Burgess)	Agromyzidae	Diptera	Major
10	Castor slug caterpillar	*Latoia lepida* L.	Limacodidae	Lepidoptera	Minor
11	Tussock Hairy caterpillar	*Olene mendosa* Hubber	Lymantridae	Lepidoptera	Minor
12	Leaf hopper	*Empoasca* spp.	Cicadellidae	Homoptera	Major
13	Thrips	*Scirtothrips dorsalis*	Thripidae	Thysanoptera	Major
14	Plant bug	*Nezara viridula* (Linnaeus)	Pentatomidae	Heteroptera	Minor
15	Mites	*Tetranychus* spp. *Eutetranychus orientalis*.	Tetranychidae	Acarina	Minor
16	Shoot and capsule borer	*Conogethes punctiferalis* (Guenn.)	Pyraustidae	Lepidoptera	Major

3.1.3 Tobacco caterpillar, *S. litura*

S. litura population started from the second fortnight of September with a peak (2.5 larvae/plant) population during the first fortnight of October and continued till the second fortnight of November and was not observed afterwards. These results were similar with the previous findings [16] but differed with another observations [9] reported that the population was found from first fortnight of August to the first fortnight of November. These variations might be due to weather parameters prevailing in that locality and sowing dates of the crop as it was a transitional zone (IV).

The correlation co-efficient revealed that none of the weather parameter had influenced significantly on the incidence of *S. litura*. The results were not in confirmation with the earlier findings [16] reported minimum temperature and relative humidity were most influencing factors which showed negative effect on pest population build up (Table 3 & 4).

3.1.4 Ash weevil, *Myllocerus* spp.

The population of ash weevil was started from the second fortnight of September and continued till the end of the growing period of crop with a peak population (0.9 adults/ plant) in the first and the second fortnight of October. The Results on correlation revealed that none of the weather parameters had influenced significantly on the incidence of Ash weevil.

3.1.5 Serpentine leafminer, L. *trifolii*

The incidence of leafminer observed during initial growing period of the crop with a peak infestation (40.50 %) during the first fortnight of August and gradual reduction was observed afterwards with no incidence after the first fortnight of September. The results are in confirmation with the earlier findings [11, 9] but differed with other results [8] who observed peak (368.4 larvae/leaf) incidence during September. This variation may be due to change in sowing dates as well as climatic conditions prevailing in their places.

The results on correlation revealed positive significant relation with respect to wind speed (0.819). The results differed with the findings of previous authors [8], who reported that minimum temperature (r=0.718*), RH (r=0.706*) and rainfall (r=0.637*) showed a positive correlation with population of pest

3.1.6 Leaf hoppers, *Empoasca* spp.

The leaf hopper population was observed throughout the growing period of the crop with a peak (3.80/ leaf) population during the second fortnight of October. The results obtained were contradicting with the earlier observations [9] recorded that the peak population was observed during the second fortnight of September. This change may be due to the environmental factors prevailing in their places. The correlation coefficient revealed that none of the weather parameters had influenced significantly on incidence of leafhoppers.

3.1.7 Thrips, *S. dorsalis*

The thrips population was observed throughout the growing period of the crop with a peak incidence (3.30/leaf) during the second fortnight of October. The results on correlation coefficient revealed positive significant relation with minimum temperature (r=0.711*).

3.1.8 Plant bug, *N. virudula*

The incidence of plant bug population started from the second fortnight of September and continued till the end of the growth period of the crop with a peak population (0.70/ plant) during the first fortnight of December. The correlation coefficient revealed that none of the weather parameters had influenced significantly.

3.1.9 Mites, *Tetranychus* spp.

The occurrence of mites was noticed during the first fortnight of December and continued till the end of the growth period of crop with a peak incidence (8.30/ leaf) during the second fortnight of December. The results on correlation revealed that the negative significant relation was observed with respect to a minimum temperature (r=-0.827*) and Relative humidity (r=-0.821*). whereas atmospheric pressure (r=0.644*) expressed positive significant correlation on incidence of mites

3.1.10 Capsule borer, *C. punctiferalis*

The capsule borer incidence was observed from the maturity stage of the crop (during the second fortnight of October) and continued till the end of the growing period of crop, with a peak capsule infestation (15.50 %) during the second fortnight of November. The results obtained were in confirmation with the previous observations [5] but contradicting with the others observation [7] who reported peak infestation during the second week of March. The change may be due to growing season of the crop. Similarly with the results of earlier authors [9] recorded that the infestation starts from the second fortnight of August to the second fortnight of November. The results on correlation revealed negative significant relation with respect to a minimum temperature (r=-0.907*), maximum temperature (r=-0.726*) and humidity (r=-0.658*). Whereas positive significant relation was observed with respect to atmospheric pressure (0.889) indicating highly significant effect on the incidence of capsule borer. The present findings were contradicting with the results [7] reported the maximum temperature was positively significantly correlated with capsule borer infestation. The variation may be due to the environmental factors prevailing in their places (Table 3 & 4).

3.1.11 Castor spiny caterpillar, *A. merione*

The *A. merione* population observed from first fortnight of

October and continued till the first fortnight of December with a peak incidence (1.3 larvae/ plant) during the second fortnight of November. The results differed with results of earlier authors [9] observed that the population from first fortnight of August to the first fortnight of October. This variation may be due to the variation in environmental factors. The results on correlations revealed that the negative significant relation was observed with respect to wind speed (r=-0.657*) and wind direction (r=-0.699*).

3.1.12 Hairy caterpillar, *Euproctis fraterna*

The pest, *E. fraterna* incidence started from the second fortnight of September and continued till the second fortnight of November with a peak population (2.30 larvae/ plant) during the second fortnight of October.

3.1.13 Hairy caterpillar, *O. mendosa*

The pest commonly appeared on the crop during first and second fortnight of the crop with population (0.6) and (0.4) larvae per plant, respectively. The correlation coefficients revealed that none of the weather parameters had influenced significantly on the incidence of *O. mendosa.*

3.1.14 Slug caterpillar, *L. lepida*

The population of slug caterpillar was observed on the crop during the first and second fortnight of November with a population of (0.5) and (0.8) larvae per plant, respectively. The correlation coefficients revealed that none of the weather parameters had influenced significantly on the incidence of *L. lepida*.

3.1.15 Gram pod borer, *H. armigera*

The incidence of *H. armigera* was observed on the crop during the second and first fortnight of September and October respectively with peak incidence (0.4 larvae per plant) during first fortnight of October. The results on correlations revealed positive significant relation with respect to maximum temperature (r=0.648*) (Table 3 & 4).

The damage levels of slug caterpillar, *A. fraterna*, mites, *Olene mendosa*, plant bug, ash weevils and *H. armigera* were negligible and corroborated with the previous results [9].

3.2 Regression between incidence of pests and weather parameters

Prediction equation

The prediction equations were derived through multiple regression analysis for each pest with their population except leafminer and capsule borer which were analyzed for percentage. The prediction equation for different pests is depicted in Table 2.

Table 2: Regression analysis of pest population with abiotic factors during 2013

$\hat{Y}$ (*conogethes punctiferalis*)	**$=0.667+0.989X_1+0.905X_2+0.836X_3+0.789X_4+0.6721X_5+0.992X_6+0.764X_7+0.330X_8$ (R^2=0.975)**
$\hat{Y}$ (*Achaea janata*)	$=75.86-0.05X_1+0.49X_2-0.36-X_3+0.13X_4-0.06X_5-0.34X_6-1.63X_7+0.01X_8$ (R^2= 0.952)
$\hat{Y}$ (*Helicoverpa armigera)*	$=-56.15-0.02X_1-0.04X_2+0.17X_3+0.03X_4+0.06X_5+-0.04X_6+-0.16X_7+0.03X_8$ (R^2 =0.975)
$\hat{Y}$ (*Spodoptera litura)*	$=-253.62+0.09X_1+1.33X_2-0.45X_3-0.18X_4+0.28X_5-0.28X_6-1.01X_7-0.03X_8$ (R^2=0.956)
$\hat{Y}$ (*Euproctis* spp.)	$=203.60-0.01X_1+1.78X_2-1.28X_3-0.34X_4-0.19X_5-0.49X_6-0.89X_7-0.01X_8$ (R^2 =0.989)
$\hat{Y}$ (*Ariadne merione*)	$=163.08-0.02X_1+0.12X_2+0.30X_3+0.02X_4-0.19X_5+0.28X_6-0.49X_7-0.012X_8$ (R^2= 0.967)
$\hat{Y}$ (*Liriomyza trifolii)*	$=7041.15-0.09X_1+3.62X_2-14.19X_3-0.09X_4-7.18X_5+0.45X_6+3.82X_7-0.06X8$ (R^2= 0.995)
$\hat{Y}$ (grasshoppers)	$=119.90+0.08X_1+0.35X_2+0.93X_3+0.093X_4+0.10X_5+0.41X_6+0.15X_7-0.01X_8$ (R^2=0.99)
$\hat{Y}$ (*Latoia lepida)*	$=-108.59+0.02X_1+0.36X_2+0.52X_3+0.13X_4+0.10X_5+0.20X_6+0.05X_7-0.02X_8$ (R^2=0.79)
$\hat{Y}$ (*Olene mendosa*)	$=29.67-0.01X_1+0.36X_2-0.23X_3-0.08X_4-0.02X_5-0.01X_6$ $0.37X_7+0.03X_8$ (R^2= 0.96)
$\hat{Y}$ (*Myllocerus* spp.)	$=56.83-0.01X_1+0.64X_2-0.51X_3-0.17X_4-0.04X_5-0.28X_6-0.44X_7-0.01X_8$ (R^2= 0.827)
$\hat{Y}$ (*Empoasca* spp.)	$=539.74-0.08X_1=0.55X2+0.45X_3+0.02X_4-0.59X_5+0.11X_6-1.56X_7-0.02X_8$ (R^2 =0.742)
$\hat{Y}$ (*Scirtothrips dorsalis*)	$=1280.14+0.01X_1+0.64X_2+1.91X_3+0.23X_4+1.28X_5+0.39X_6+1.64X_7-0.02X_8$ (R^2= 0.99)
$\hat{Y}$ (*Nezara viridula*)	$=-185.67-0.04X_1+0.056X_2+0.19X_3+0.005X_4+0.19X_5+0.056X_6-0.37X_7+0.02X_8$ (R^2= 0.873)
$\hat{Y}$ (*Tetranychus* spp.)	$=77.12+0.01X_1+1.22X_2-3.63X_3-0.83X_4+0.074X_5-1.62X_60.34X_7$ $0.02X_8$ ($R^{2=}$ 0.910)

X_1 – rainfall; X_2 – Min. temp; X_3 – Max. temp; X_4 – Humidity; X_5 –Atmosp. pressure; X_6 –Sun shine hours; X7-Wind speed; X8- Wind direction.

The regression equation explained greater than 70 per cent accountability in population build up of different insect pests of castor as well as per cent damage for leafminer and castor capsule borer (Table 2).

3.3 Natural enemies

In the present investigation three larval parasitoids *viz*, *Microplitis maculipennis, Euplectrus leucostomus* and *Brachymeria spp.* were recorded on the castor semilooper. The parasitoids recorded are presented in Table 5. Among the larval parasitoids, the braconid, *Microplitis maculipennis* appeared to be promising parasitoid attacking *A. janata*. It was an internal and solitary larval parasitoid affecting third instar larvae. The parasitized larvae were seen in the field carrying at the posterior end a brown pupal cocoon of the parasitoid. The parasitized larvae do not feed and die of starvation. The parasitoid was seen from September to December (Table 6) the peak incidence (32.3 %) was during the second fortnight of October, 2013. The present findings were in conformity with the earlier observations [15, 9] but differed with another report [10, 11] that the peak parasitism ranged from 68-98 per cent from August to October. These variations may be due to weather conditions prevailing in their places as well as sowing season.

During rainy season, a gregarious and ecto-parasitoid, *E. leucostomus* was found to parasitise on grown up semilooper. The parasitoid was seen from September to November (Table 6). The peak infestation (4.3%) was recorded during the first fortnight of October, 2013. However *Brachymeria* spp. Caused negligible parasitism.

Table 3: Occurrence and intensity of castor pests during *kharif* 2013

SL. No.	Pests	Population (no./plant) during the Fortnight										
		1-Aug	2-Aug	1-Sep	2-Sep	1-Oct	2-Oct	1-Nov	2-Nov	1-Dec	2-Dec	Mean
1	Grasshoppers (adults/plant)	0.90	1.40	0.20	0.60	0.90	0.10	0.40	0.50	0.70	0.00	0.57
2	*A. janata* (larvae/plant)	0.00	0.00	1.80	2.30	2.70	2.10	0.50	0.40	0.30	0.00	1.01
3	*S. litura* (larvae/plant)	0.00	0.00	0.00	1.30	2.50	2.20	1.90	0.90	0.00	0.00	0.88
4	*Myllocerus* spp. (adults/plant)	0.00	0.00	0.00	0.70	0.90	0.90	0.60	0.20	0.60	0.50	0.44
5	*L. trifolii* (% leaf mined/plant)	40.50	15.50	5.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.15
6	*Empoasca* spp. (nymphs and adults/leaf)	1.20	1.30	1.50	3.20	2.50	3.80	2.30	5.70	1.10	0.50	2.31
7	*S. dorsalis* (nymphs and adults/leaf)	2.70	5.20	2.10	2.80	2.60	3.30	4.20	2.20	0.00	0.00	2.51
8	*N. viridula* (nymphs and adults/plant)	0.00	0.00	0.00	0.40	1.10	0.50	1.00	0.50	0.70	0.60	0.48
9	*Tetranychus* spp. (nymphs and adults/leaf)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40	8.30	1.27
10	*C. punctiferalis* (% capsule damage/plant)	0.00	0.00	0.00	0.00	0.00	7.00	11.60	15.50	14.20	14.40	6.27
11	*E. merione* (larvae/plant)	0.00	0.00	0.00	0.00	0.60	1.00	1.30	1.10	1.10	0.00	0.51
12	*Euproctis* spp. (larvae/plant)	0.00	0.00	0.00	0.80	1.40	2.30	1.00	0.70	0.00	0.00	0.62
13	*O. mendosa* (larvae/plant)	0.00	0.00	0.00	0.00	0.60	0.40	0.00	0.00	0.00	0.00	0.1
14	*L. lepida* (larvae/plant)	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.80	0.00	0.00	0.13
15	*H. armigera* (larvae/plant)	0.00	0.00	0.00	0.30	0.40	0.00	0.00	0.00	0.00	0.00	0.07

N= mean of 15 plants

Table 4: Correlation co-efficient between incidence of different insect pests of castor and weather parameters

Sl. No.	Pest	Pest population	Weather Parameters (correlation co-efficient)							
			rainfall (mm)	Temperature (^{0}C) Min.	Temperature (^{0}C) Max.	Humidity (%)	Atmos. Pressure (h Pa)	Sunshine hours (hrs.)	Wind speed (m/s)	Wind direction (Deg.)
1	Grasshoppers	0.57	-0.113	0.433	0.701*	-0.030	-0.565	0.216	0.749*	0.497
2	*Achaea janata*	1.01	0.3116	0.518	0.378	0.542	-0.354	-0.549	-0.306	0.428
3	*Spodoptrera litura*	0.88	-0.165	0.281	0.175	0.304	0.058	-0.353	-0.424	-0.027
4	*Myllocerus* spp.	0.44	-0.344	-0.145	0.025	-0.178	0.282	-0.365	-0.482	-0.266
5	*Liriomyza trifoli*	6.15	0.0738	0.420	0.269	3.196	-0.559	0.386	0.819**	0.518
6	*Empoasca* spp.	2.31	-0.077	0.168	0.139	0.308	-0.015	-0.440	-0.454	-0.154
7	*Scirtothrips dorsalis*	2.51	0.321	0.711*	0.480	0.616	-0.444	-0.117	0.321	0.431
8	*Nezara virudula*	0.48	-0.625	-0.418	-0.220	-0.391	0.594	-0.056	-0.544	-0.537
9	*Tetranychus* spp	1.27	-0.356	-0.821**	-0.546	-0.821**	0.644*	0.277	-0.158	-0.532
10	*Conogethes punctiferalis*	6.27	-0.508	-0.907**	0.726*	-0.658*	0.889**	0.173	-0.614	-0.979**
11	*Ergolis merione*	0.51	-0.355	-0.381	-0.382	-0.158	0.539	0.055	-0.657*	-0.699*
12	*Euproctis* spp.	0.62	0.018	0.290	0.083	0.363	0.037	-0.322	-0.483	-0.045
13	*Olene mendosa*	0.1	0.009	0.342	0.167	0.202	-0.087	0.080	-0.238	0.241
14	*Latoia lepida*	0.13	-0.351	-0.285	-0.285	-0.032	0.427	-0.054	-0.424	-0.557
15	*Helicoverpa armigera*	0.07	-0.232	0.385	0.648*	0.095	-0.361	-0.461	0.098	0.447

** = significant at 1%; * = significant at 5%

Table 5: Natural enemies recorded on castor semilooper, *Achaea janata*

Sl. No.	Scientific name	family	order	status
1	*Microplitis maculipennis* Szepligeti	Braconidae	Hymenoptera	Major
2	*Euplectrus leucostomus* Rohwer	Braconidae	Hymenoptera	Minor
3	*Brachymeria* Spp.	Braconidae	Hymenoptera	Minor

Table 6: Occurrence and intensity of natural enemies recorded on *A. janata* during 2013

SL. NO.	Fortnight	*A. janata* (no. of larvae/plant)	Per cent parasitisation	
			M. maculipennis	*E. leucostomus*
1	Aug-1	0.00	0.00	0.00
2	Aug-2	0.00	0.00	0.00
3	Sep-1	1.80	0.00	0.00
4	Sep-2	2.30	18.80	1.20
5	Oct-1	2.70	32.30	4.30
6	Oct-2	2.10	17.80	3.60
7	Nov-1	0.50	8.20	2.30
8	Nov-2	0.40	0.00	0.00
9	Dec-1	0.30	0.00	0.00
10	Dec-2	0.00	0.00	0.00
Mean		1.01	8.19	1.28

4. Conclusion

The present study generated data on the population fluctuation of pests on castor crop and the influence of ambient weather conditions on their build-up and activity. The castor crop is being grown as a rainfed crop in dry land areas and the probable incidence of these major pests need to be addressed with appropriate management strategies, particularly on the early stage crop for leafminer incidence, middle aged crop for semilooper, hairy caterpillar, *S. litura* and throughout the cropping period for sucking pests like, thrips & leafhoppers during kharif season.

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