



RESEARCH COMMUNICATION

Crop weather-pest relationships on cowpea under varied climatic factor regimes in Tamil Nadu

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Abstract

Experiments results revealed that in inland ecosystem, maximum number of leafhoppers, thrips, spotted pod borer larva and coccinellids were recorded in 14th standard mean week and higher population of aphid was peak in 15th standard mean week, pod bug in 13th standard mean week and spider 12th standard mean week. In coastal ecosystem during 2019, higher population of leafhopper, aphid, thrips and spotted pod borer larva in 15th standard mean week. The peak population of pod bug was recorded in 16th standard mean week. Inland ecosystems during 2020, maximum peak activity of sucking pest and natural enemies were recorded in 42nd standard mean week. The peak activities of pod bug and spotted pod borer larvae were also recorded in 41st and 43rd standard mean week. In Coastal ecosystem during 2020, the leaf hopper and aphid was peak attained in 43rd standard mean week. Thrips and pod bug /pant was peak was observed on 42nd standard mean week and spotted pod borer and spider per plant was peak on 44th standard mean week and coccinellid beetle was peak on 41st standard mean week. In inland and coastal ecosystem, the percentage contributions for the multiple regression equations were 46.00–98.30 % and 60.60–97.20 %, respectively, during rabi, 2019 and 0.40–99.20 % and 76.30–99.40 %, respectively, showing the influence of weather parameters on pest populations.

Keywords: abiotic factors; cowpea; correlation; multiple regression; natural enemies; pests; temperature regimes

Introduction

Cowpea is annual and tropical with herbaceous legume, it comes under family Fabaceae (Leguminosae), order Fabales and genus *Vigna*. The cowpea is one of the most importance considered a grain legume (1). The grain cowpea contains 23–25 % protein and carbohydrates are around 50–67 % (2). During the pod developing stage, we observed pest damage from flower thrips, *Megalurothrips sjostedti* (Trybom) (Thysanoptera: Thripidae), pod borer (*Maruca vitrata* (Fabricius) (Lepidoptera: Crambidae)) and pod suckers (*Riptortus dentipes* (Hemiptera: Coreidae) (3). The changing climate, with increased temperatures, elevated CO₂ levels and decreased soil moisture, will have a significant impact on the diversity and abundance of insect pests. This can lead to a wider geographic range for these pests, improved survival over the winter and an increase in the number of generations per year. As a result, crop losses may intensify. These changes could disrupt the ecological balance by causing unpredictable shifts in insect pest populations and affecting their natural enemies (4, 5). The increase in climatic variables has heightened the frequency and intensity of insect-pest outbreaks. Abiotic factors play role for determine the population dynamic and its damage caused by insect pests in cowpea due to different climatic condition/regions and insect show the varying trends their population in naturally and reduction the yield (6).

Hence, the present study was carried out to determine the weather parameters influence for insect pests of cowpea ecosystem under two environment regimes of inland and coastal ecosystems.

Materials and Methods

The field experiments of inland and coastal ecosystem were conducted at farmer's field during rabi seasons 2019 and 2020 under two environmental regimes at Srivilliputtur (Latitude, 9.512° N, Longitude, 77.633° E, Altitude, 252 m MSL, distance from seashore 132 km) and at Kamuthi (Latitude, 9.419° N, Longitude, 78.370° E and Altitude, 40 m mean sea level, distance from seashore 30 km) in Tamil Nadu, India. The varieties TNAU Vamban 2 (cv. VBN 2) with spacing was 30 × 10 cm and 1 acre field. Necessary recommended agronomic practice was applied as per TNAU package. Observations of major insect pests of cowpea (cv. VBN 2) were recorded early in the morning from 5 plants per plot at weekly intervals from 15 days after germination till harvesting of crop. The estimating insect pests as given as sucking pest like Aphid, (*Aphis craccivora* Koch.) numbers were recorded on three randomly selected twigs (10 cm length) from each tagged plant and mean number of aphids per 10 cm twig was worked out. Observations on leafhopper, *Empoasca kerri* Pruthi were recorded from 3 leaves each from top, middle and bottom

region of each selected plant. Thrips, *Megaleurothrips usitatus* Bagnall numbers were assessed by randomly selecting 10 flowers on each selected plant and numbers of thrips per flower was worked out. All stages of pests (both nymphs and adults) were observed and counted with the help of magnifying lens. A hand-held magnifying lens (6x) with LED illumination was used to count the flower thrips in the field (7). The Pod bugs (*Clavigralla gibbosa* Spinola) were by sudden trapping of flowers/pods with bags. Major insect pests were recorded at weekly interval from sowing till the harvest of the crop from randomly selected 5 plants per plot. The Pod borer larval number was recorded by counting the number of larvae per plant from five randomly selected plants per plot. The observations were made at weekly interval (7). The numbers of natural enemies mostly spiders and predatory coccinellids were recorded. *In situ* counts were recorded on five randomly selected plants per plot leaving the border rows at weekly intervals. The total number of natural enemies was counted and expressed as number per plant (8). The data related to weather parameters viz., temperature, rainfall, relative humidity and daily sunshine hours throughout the period of investigation were collected from Agro Climatology Research Centre, Tamil Nadu Agricultural University, Coimbatore and correlation coefficients and linear regression models were worked out. The statistical analysis as correlation and multiple linear regressions was done in SPSS software.

Results

During rabi 2019

The peak activity was recorded in both inland and coastal ecosystems during the 14th and 15th standard mean week. The pest like leafhopper (No./3 leaves), Aphid (10 cm twig/plant), Thrips (10 no./flower), Pod bug/plant, Spotted pod borer (larvae/plant), Coccinellid/plant and Spider/plant were measured as 6.43, 26.47, 2.14, 2.14, 3.40, 2.78 and 1.70, respectively. Additionally, the

temperature, wind velocity, rainfall and relative humidity were found to be correlated with these pest populations. An analysis using multiple regression equations showed that weather parameters accounted for 73.60 %, 85.20 %, 77.77 %, 98.30 %, 78.10 %, 67.10 % and 46.0 % of the population variation of the pests in inland ecosystems. In the coastal ecosystem, the percentage contributions for the multiple regression equations were 61.30 %, 70.40 %, 60.60 %, 97.20 %, 72.50 %, 91.40 % and 91.00 %, showing the influence of weather parameters on pest populations (Table 1 and 2).

During rabi 2020

In the inland ecosystem, the mean population of pests peaked during the 42nd standard mean week with leafhopper (No./3 leaves), thrips (10 no./ flower) and coccinellid/plant (5.48, 3.40, 2.10 Nos/plant). Aphid (10 cm twig/plant) and spotted pod borer larvae/plant reached their peak during the 43rd standard mean week and 44th standard mean week (24.32 and 5.37). The pod bug/plant also peaked at 42nd (2.58) and 41st standard mean week, with spiders/plant peaking at 2.17 (Fig.1 and 2). In the coastal ecosystem, leaf hopper and aphid (4.32 and 18.20) peaked during the 43rd standard mean week. Thrips and pod bug/plant were observed at their peak during the 42nd standard mean week (3.51 and 2.68) and spotted pod borer and spiders per plant (4.32 and 1.62) peaked during the 44th standard mean week, with coccinellid beetle per plant reaching its peak during the 41st standard mean week (1.48). The multiple regression analysis indicated that the percent contribution values for leafhopper (No./3 leaves), aphid (No./10 cm twig/plant), thrips (No./10 flowers), pod bug (No./plant), spotted pod borer (larvae/plant), coccinellid (No./plant) and spider (No./plant) were 88.5 %, 96.1 %, 82.3 %, 70.4 %, 93.4 %, 81.1 % and 99.2 %, respectively, for all the weather parameters in the inland ecosystem. Alternatively, in the coastal ecosystem, the multiple regression analysis indicated that the percent contribution values for leafhopper (No./3 leaves), aphid (No./10 cm twig/plant), thrips (No./10 flowers), pod bug (No./plant), spotted pod borer (larvae/plant), coccinellid (No./plant) and spider

Table 1. Correlation and regression between major insect pests and natural enemies in cowpea (cv. VBN 2) and weather parameters in inland ecosystem - Srivilliputtur (2019)

Pest	Correlation coefficients (r)					R ²	Regression equation
	Temperature °C		Relative Humidity (%) (X ₃)	Wind velocity (km/hr) (X ₄)	Rainfall (mm) (X ₅)		
	Max. (X ₁)	Min. (X ₂)					
Leaf hopper	0.418	0.822	-0.165	0.547	-0.117	0.736	Y= 21.22+1.01 (X1) -2.13 (X2)-0.134 (X3)+1.49 (X4)+0.55 (X5)
Aphid	0.163	0.233	-0.038*	0.290	-0.127	0.852	Y= 326- 12.62 (X1)+9.79 (X2) -2.23(X3)+10.03 (X4)-1.74 (X5)
Thrips	0.12*	0.007**	-0.036*	0.048*	-0.240	0.777	Y= -4.93- 0.23 (X1)-0.235 (X2)+0.57 (X3) +0.058 (X4)+0.052 (X5)
Pod bug	0.18	0.337	-0.066	0.460	-0.612	0.983	Y= 20.02 - 0.102 (X1) - 0.640 (X2)- 0.18 (X3)+2.49 (X4)+0.359 (X5)
Spotted pod borer	0.361	0.771	-0.138	0.978	-0.058	0.781	Y= 14.62+ 0.87 (X1) -0.183 (X2) - 0.099 (X3)+1.43 (X4)+ 0.22 (X5)
Coccinellids	-0.607	-0.287	-0.994	-0.205	-0.604	0.671	Y=15.91+0.80 (X1) - 1.83 (X2) -0.061 (X3)+1.20 (X4)+0.41(X5)
Spiders	-0.298	-0.298	0.545	0.201	0.915	0.460	Y= 5.76+1.77 (X1) - 0.37 (X2)+0.003 (X3) -0.35 (X4)+ 0.10 (X5)

** - correlation is significant at the 1 % level (2-tailed); * - correlation is significant at the 5 % level (2-tailed).

Table 2. Correlation and regression between major insect pests and natural enemies in cowpea (cv. VBN 2) and weather parameters in coastal ecosystem - Kamuthi (2019)

Pest	Correlation coefficients (r)					R ²	Regression equation
	Temperature °C		Relative humidity (%) (X ₃)	Wind velocity (km/hr) (X ₄)	Rainfall (mm) (X ₅)		
	Max. (X ₁)	Min. (X ₂)					
Leaf hopper	0.103	0.262	-0.238	0.053	0.00	0.613	Y=-10.382+0.20 (X1) - 0.03 (X2)+0.04 (X3)+1.20 (X4)+0.00 (X5)
Aphid	0.147	0.195	-0.113	0.023*	0.00	0.704	Y=-14.12+0.19 (X1) -0.048 (X2) -0.15 (X3)+5.21 (X4)+0.00 (X5)
Thrips	0.122	0.092	-0.101	0.088	0.00	0.606	Y=-8.94+0.06 (X1)+2.00 (X2) -0.038(X3)+0.92 (X4)+0.00 (X5)
Pod bug	0.11*	0.009**	-0.006**	0.079	0.00	0.972	Y=-7.13+0.106 (X1)+0.20 (X2) -0.04 (X3)+0.38 (X4)+0.00 (X5)
Spotted pod borer	0.212	0.064	-0.148	0.027*	0.00	0.725	Y=-8.93 -0.034 (X1)+0.24 (X2) -0.021 (X3)+1.13 (X4)+0.00(X5)
Coccinellids	-0.344	-0.016*	0.667	-0.886	0.00	0.914	Y=11.42 -0.040 (X1) -0.327 (X2) -0.03 (X3)+0.030 (X4)+0.00 (X5)
Spiders	0.15*	0.056	-0.10**	0.050	0.00	0.910	Y=-3.03+ 0.092 (X1)+0.037 (X2) -0.038 (X3)+0.48 (X4)+0.00(X5)

** - correlation is significant at the 1 % level (2-tailed); * - correlation is significant at the 5 % level (2-tailed).

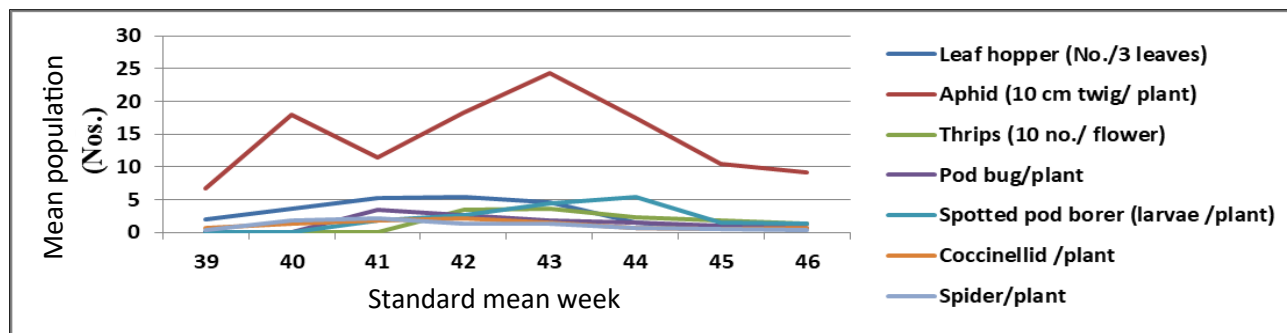
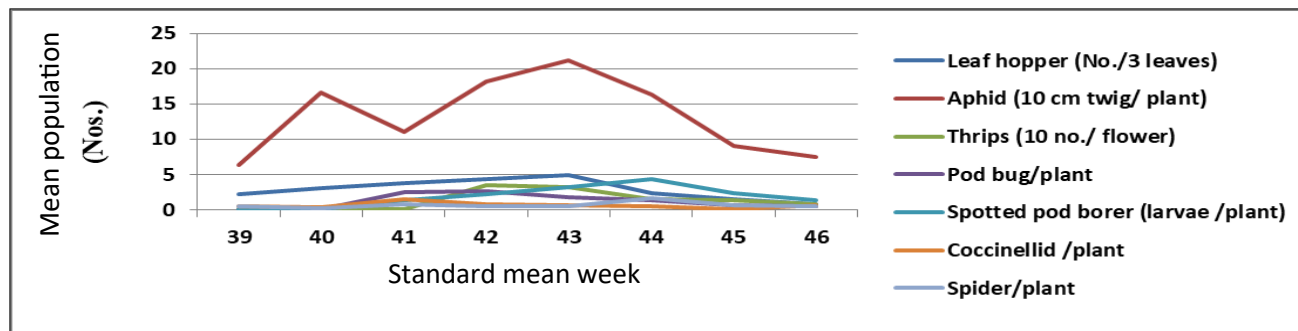


Fig. 1. Population dynamics of pest in cowpea at inland ecosystem during 2020.



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(No./plant) were 91.8 %, 94.7 %, 89.3 %, 99.4 %, 76.3 %, 91.6 % and 98.9 %, respectively, for all the weather parameters (Table 3 and 4). Overall, the results show that pests like leaf hopper, aphid, thrips, pod bug and spotted pod borer have a significant positive correlation with maximum temperature, minimum temperature and wind velocity and a negative correlation with relative humidity and rainfall in both ecosystems. Coccinellids and spiders showed a positive correlation with relative humidity and a negative correlation with maximum temperature, minimum temperature, wind velocity and rainfall in both ecosystems.

Discussion

In rabi 2019, the highest populations of leafhoppers, thrips, spotted pod borer larvae and coccinellids in inland ecosystems were recorded in the 14th standard mean week. A larger population of aphids was observed in the 15th standard mean week, pod bugs in the 13th standard mean week and spiders in the 12th standard mean week (Fig. 3). Previous researchers suggested that factors such as rainfall, relative humidity, bright sunshine hours and vapor pressure had a negative influence on the population of leafhoppers and thrips, whereas temperature and wind speed had a positive influence (9). Previous reports also indicated that the population of

Table 3. Correlation and regression between major insect pests and natural enemies in cowpea (cv. VBN 2) and weather parameters in inland ecosystem - Srivilliputtur (2020)

Pest	Correlation coefficients (r)					R ²	Regression equation
	Temperature °C		Relative humidity (%) (X ₃)	Wind velocity (km/hr) (X ₄)	Rainfall (mm) (X ₅)		
	Max. (X ₁)	Min. (X ₂)					
Leaf hopper	0.469	0.047*	-0.135	-0.033*	-0.398	0.885	Y = -46.17 + 0.83 (X ₁) + 1.19 (X ₂) + 0.19 (X ₃) - 5.34 (X ₄) + 0.33 (X ₅)
Aphid	-0.331	0.463	-0.411	0.134	0.616	0.961	Y = 161.60 - 3.63 (X ₁) + 1.69 (X ₂) - 0.57 (X ₃) - 7.28 (X ₄) + 0.58(X ₅)
Thrips	-0.736	-0.184	-0.736	0.995	-0.598	0.823.	Y = 111.98 - 1.56 (X ₁) - 1.16 (X ₂) - 0.38 (X ₃) + 0.02 (X ₄) - 0.24 (X ₅)
Pod bug	-0.646	-0.951	0.695	-0.323	0.928	0.704	Y = -20.08 + 0.70 (X ₁) + 0.13 (X ₂) + 0.21 (X ₃ - 4.87 (X ₄) + 0.19 (X ₅)
Spotted pod borer	-0.045*	-0.264	0.588	-0.842	0.057	0.934	Y = 78.28 - 0.87 (X ₁) - 0.76 (X ₂) - 0.17((X ₃) - 0.35 (X ₄) + 0.16 (X ₅)
Coccinellids	0.579	0.076	-0.223	-0.073	-0.455	0.811	Y = -17.59 + 0.22 (X ₁) + 0.45(X ₂) + 0.07 (X ₃) - 1.39 (X ₄) + 1.07(X ₅)
Spiders	0.793	0.143	-0.491	-0.073	-0.667	0.992	Y = -43.29 + 0.54 (X ₁) + 0.84 (X ₂) + 0.19 (X ₃) - 2.42 (X ₄) + 0.23 (X ₅)

** - correlation is significant at the 1 % level (2-tailed); * - correlation is significant at the 5 % level (2-tailed).

Table 4. Correlation and regression between major insect pests and natural enemies in cowpea (cv. VBN 2) and weather parameters in coastal ecosystem - Kamuthi (2020)

Pest	Correlation coefficients (r)					R ²	Regression equation
	Temperature °C		Relative humidity (%) (X ₃)	Wind velocity (km/hr) (X ₄)	Rainfall (mm) (X ₅)		
	Max. (X ₁)	Min. (X ₂)					
Leaf hopper	0.463	0.415	-0.420	-0.523	0.546	0.918	Y = -19.87 + 0.67 (X ₁) + 2.30 (X ₂) - 0.72 (X ₃) - 0.81 (X ₄) - 5.00 (X ₅)
Aphid	-0.828	0.496	-0.203	-0.272	0.045*	0.947	Y = 126.44 - 1.78 (X ₁) + 1.73 (X ₂) - 1.17 (X ₃) - 2.71 (X ₄) + 26.06 (X ₅)
Thrips	0.477	-0.430	-0.035	-0.079	0.114	0.893	Y = 25.49 - 0.70 (X ₁) - 1.05 (X ₂) + 0.38(X ₃) - 0.91 (X ₄) + 7.20 (X ₅)
Pod bug	0.043*	-0.394	-0.540	-0.003**	0.705	0.994	Y = 5.96 + 0.50 (X ₁) + 0.38 (X ₂) - 0.38 (X ₃) - 0.57 (X ₄) - 3.11 (X ₅)
Spotted pod borer	0.364	-0.632	-0.744	-0.101	0.105	0.763	Y = 28.67 - 0.16 (X ₁) - 0.65 (X ₂) - 0.03 (X ₃) - 0.61 (X ₄) + 8.35(X ₅)
Coccinellids	0.522	0.586	-0.348	-0.121	-0.699	0.916	Y = - 3.19 + 0.11 (X ₁) + 0.66 (X ₂) - 0.20 (X ₃) - 0.38 (X ₄) - 2.13 (X ₅)
Spiders	0.966	0.392	-0.069	-0.399	0.776	0.989	Y = 6.41 + 0.24 (X ₁) + 0.82 (X ₂) - 0.44 (X ₃) - 0.18 (X ₄) - 2.04 (X ₅)

** - correlation is significant at the 1 % level (2-tailed); * - correlation is significant at the 5 % level (2-tailed).

A. craccivora on cowpea increased rapidly as the crop grew, reaching its peak during peak pod formation (10). The pests appeared in the first week after germination and continued to increase throughout the crop growth, reaching a peak during the fifth week of October, as reported previously (11). In 2019, in coastal ecosystems, higher populations of leafhoppers, aphids, thrips and spotted pod borer larvae were recorded in the 15th standard mean week. The peak population of pod bugs was observed in the 16th standard mean week and coccinellids in the 13th standard mean week (Fig. 4).

In inland ecosystem during 2020, the maximum peak activity of sucking pest and natural enemies like leaf hopper, thrips, coccinellids and spiders were recorded in 42nd standard mean week. The peak activities of pod bug and spotted pod borer larvae were also recorded in 41st and 43rd standard mean weeks (Fig. 1). Earlier researchers found that *Coccinella septempunctata* Linn was most active during the third week of March (12th standard mean week) at the pod formation stage in summer (12). Earlier researchers also reported a negative correlation between *Cheilomenes immaculata* (Fab.) and cowpea, with both maximum and minimum temperatures (13). Whereas during 2020, in Coastal ecosystem, Maximum peak activity was recorded in sucking pests and natural enemies like leaf hopper in 43rd, aphids in 43rd, thrips in 42nd, pod bug in 43rd, spotted pod borer in 44th, coccinellids in 41st and spiders in 44th standard mean week (Fig. 2). A study on cowpea was conducted earlier and found that aphids, jassids, thrips and pod borers were major pests, with high infestation rates in different parts of the cowpea plant (14). The presence of these pests was influenced by factors such as temperature, relative humidity, rainfall and sunshine hours. For instance, the population of aphids and pod borers was positively influenced by relative humidity, whereas jassids were affected by temperature and sunshine hours. Negative correlations were observed between aphids and maximum temperature, sunshine hours and wind speed; jassids and thrips with relative humidity; and pod borers with maximum temperature and wind speed. Additionally, the study found that *C. septempunctata*, a type of ladybug, was the most abundant predator of cowpea aphids and had a negative correlation with aphid population. According to

previous studies, a population of whiteflies (*Bemisia tabaci*) on cowpea was observed from the first week of March (9th week) to the first week of April (13th week), with higher incidence during the second half of March (11th–12th weeks) (15, 16). Additionally, they reported the occurrence of spotted pod borer during the middle of March (10th week) at the pod-setting stage and the infestation reached its peak during the fourth week of March (12th week) and persisted until harvest. Further, the results of indicated a significant correlation between minimum temperature and the population of *Riptortus* spp. nymphs, *Riptortus pedestris* adults and *Nezara viridula* adults (4).

Conclusion

The pests and natural enemies showed significant positive correlation with maximum temperature, minimum temperature and wind velocity and negatively correlated with relative humidity and rainfall both the ecosystem. Coccinellids and spiders showed positive correlation with relative humidity and negative correlation with maximum temperature, minimum temperature and wind velocity and rainfall in both ecosystems.

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Authors' contributions

SK and GKG designed the manuscript and carried out the investigation. MP, SA and US performed statistical analysis and meteorological data processing. TS, KA and SB contributed to manuscript revision, corrections and analytical work. All authors contributed significantly to the study and read and approved the final manuscript.

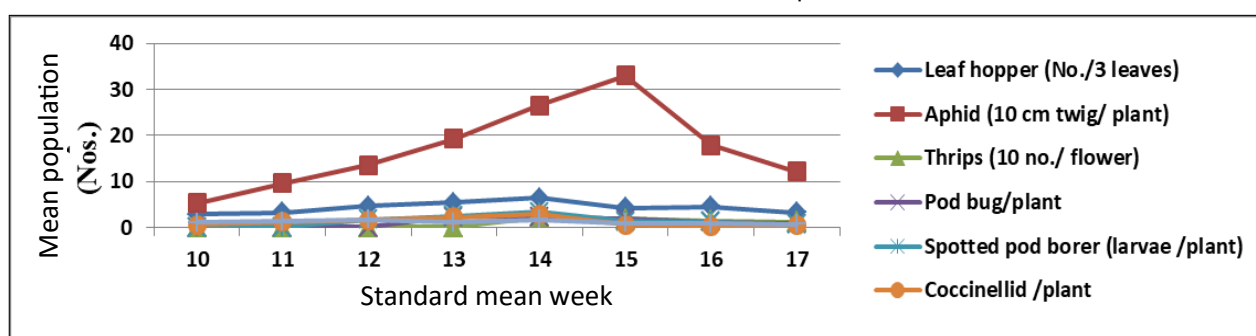


Fig. 3. Population dynamics of pest in cowpea at inland ecosystem during 2019.

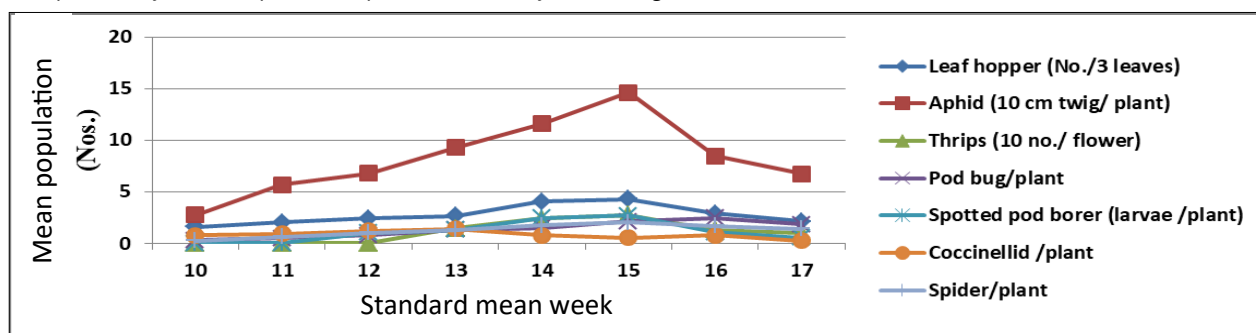


Fig. 4. Population dynamics of pest in cowpea at coastal ecosystem during 2019.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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