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RESEARCH PAPER

Spatio-temporal assessment of cotton leafhopper in North-Eastern districts of Karnataka using GIS technology

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Abstract: Spatio-temporal distribution of cotton leaf hopper, *Amrasca biguttula biguttula* (Ishida) in five Districts (Ballari, Kalaburagi, Koppala, Raichur and Yadgir) of North-Eastern Karnataka was assessed using GIS technology. Pest surveillance data (5648) on target pest gathered through *e*SAP (Electronic Solutions against Agricultural Pests) from 2012-13 to 2015-16 and was utilized in developing distribution maps and its incidence with weather parameters (temperature and rainfall) as the risk assessment maps for precise pest management at Department of Agricultural Entomology, UAS, Raichur. When the data was observed through spatial analysis, the incidence level of leafhopper varied in all the Districts across different years. Overall observation on distribution and level of incidence of cotton leaf hopper across the five Districts of Kalyana-Karnataka region indicated that the pest incidence was low and less than ETL during 2012-13 and 2013-14. However, in next two years i.e. 2014-15 and 2015-16 the pest become very serious and widespread reaching ETL as well as more than ETL in all cotton growing regions. The rainfall and maximum temperature are the most influencing factors on population of *A. biguttula biguttula*. Overlay analysis indicated that rainfall of more than 300 mm with one month lag time and maximum temperature above 30°C with 10 days lag time favoured the higher incidence of pest.

Key Words: Global positioning system, Kriging, Spatial distribution, Temporal distribution

Introduction

Cotton leafhopper, *A. biguttula biguttula* (Ishida) is one of the primary and early season sucking insect pests of cotton. It occurs at all the stages of the crop growth and responsible for indirect yield losses. Since, it sucks the sap from the plants is leads to reduction in growth and vigour of the plants. In severe case of infestation, the plants get dried up and eventually die (Selvaraj *et al.* 2011). To develop efficient area wide pest management strategies, it is essential to understand the population dynamics and spatial distribution of the pest, so that control measures can be focused at specific sites where population densities are highest (Emmen 2004). GIS (Geographic information system) is a computer application capable of assembling, monitoring, storing, manipulating and displaying geographically referenced information. In agriculture, it can also be used for various purposes including understanding the distribution pattern of a pest over a space and time. There are several reports that support the utility of GIS in studying the spatial distribution of insects for their effective management (Shepherd *et al.* (1988), Midgarden and Youngman (1993), Ohnmar *et al*. (2002), Yonglin *et al*. (2009), Duarte *et al*. (2015) and Martins *et al*. (2017)). Hence, the present study was undertaken to develop risk assessment maps through GIS by correlating weather parameters.

Material and methods

The archived pest data in relation to Economic Threshold Level (ETL) of five districts, *viz*., Kalaburagi, Yadgir, Raichur, Ballari and Koppal over four years (2012-2015) collected by *e*SAP (Electronic Solutions against Agricultural Pests) was used. Later the data was filtered and processed for construction of distribution maps. Meteorological data at hobli level from 2012-16 on temperature on daily basis and rainfall data on monthly basis for all five districts was obtained from Karnataka State Natural Disaster Management Centre (KSNDMC) website (http://dmc.kar.nic.in/). The processing and analysis of surveillance data of leaf hopper was carried out in 'ArcGIS 10.4' software. The data from *e*SAP was added to the GIS environment by 'Add data tool' in the 'ArcGIS' Software. Later, the data sheet was entered into the software with x and y coordinates and Geographic Coordinate System (GCS) 'WGS 1984' was selected. Once the point data were overlaid with the outer boundary, then geostatistical analyst tool was used, in which geostatistical wizard was selected. In geostatistical methods 'kriging' was selected to predict the unsampled locations with known data points. With this 'kriging method' spatial distribution of insects pest map was generated. The spatio-temporal distribution maps were generated for four years *viz*., 2012-13, 2013-14, 2014-15 and 2015-16. Distribution maps were constructed to compare the field sample distribution with the distribution maps estimated by kriging. Each sampling point was located and the same colour was used as in the GIS maps. Risk assessment maps of leafhopper were developed by overlaying pest distribution maps with the distribution maps of maximum temperature and rainfall. As per the analysis, 10 days lag maximum temperature and one month lag rainfall were selected and distribution maps of these were developed for the observation period.

Results and discussion

The incidence level of leafhopper varied in all the districts across different years. During 2012-13 leafhopper incidence was low in Raichur and Doedurga talukas of Raichur district, whereas, in remaining parts, it was at economic threshold (ETL) and less than ETL (Fig.1). Similarly, during 2013-14, low incidence level was observed in eastern and western part of Raichur

Table 1. Surveillance data generated on cotton leafhopper in different talukas of Raichur district from 2012-13 to 2015-16 through *e*SAP

Taluka	Number of survey points generated across different years																			
	2012-13					2013-14					2014-15					2015-16				
	Low	<ETL	ETL	>ETL	Total	Low	<ETL	ETL	>ETL	Total	Low	<ETL	ETL	>ETL	Total	Low	<ETL	ETL	>ETL	Total
Raichur	51	136	3	0	190	192	354	17	0	563	52	344	35	8	439	39	43	227	11	320
Deodurga	24	113	3	0	140	0	50	6	0	56	0	40	162	13	215	0	5	238	13	256
Lingsugur	0	23	9	0	32	16	73	1	1	91	0	22	201	11	234	0	1	131	18	150
Manvi	0	45	3	0	48	0	76	0	0	76	3	14	214	10	241	0	79	219	4	302
Sindhanur	0	7	1	0	8	0	29	26	0	55	0	6	234	20	260	0	13	87	4	104
Total	75	324	19	0	418	208	582	50	1	841	55	426	846	62	1389	39	141	902	50	1132

(Fig.1), whereas, the incidence was at less than ETL in Kalaburagi (Fig.2), Yadgir (Fig.3), and Koppal (Fig.4) Districts. However, during 2014-15 the pest has reached ETL in all five Districts and even crossed ETL in Ballari (Fig.5) and Kalaburagi (Fig.2) Districts. Similarly, during 2015-16 the pest has reached ETL and above ETL in all five Districts. When the leaf hopper incidence was overlaid with rainfall and maximum temperature in all five districts across the years showed a different scenario. During 2012-13 in Raichur District major had cotton growing region recorded with leafhopper incidence with either low or less than ETL, however, the pest incidence level did not show any relation with the rainfall pattern so also with the maximum temperature (Fig.6). Similar trend was noticed during 2013-14 survey in which once again rainfall pattern did not influence the pest population and mainly showed incidence low or less than ETL (Fig.6). However, during 2014-15 the regions of Raichur District showing leafhopper incidence in the range of ETL majorly falls under the rainfall pattern of 441.7 to 556.5 mm. In the remaining area in which the leafhopper population falling below ETL comes under rainfall pattern of 537.18 mm and above (Fig.6).

Results clearly indicates that in those cotton growing regions of Raichur district which received less than 556.5mm rainfall recorded higher pest population compared to other regions which received

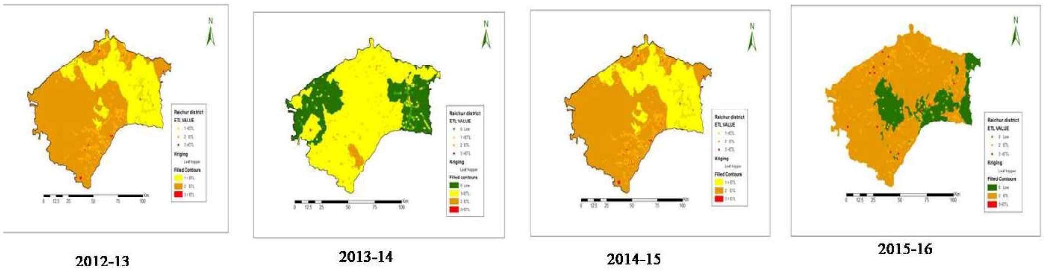

Fig.1. Spatial distribution maps of leafhopper in Raichur district across the years 2012-16

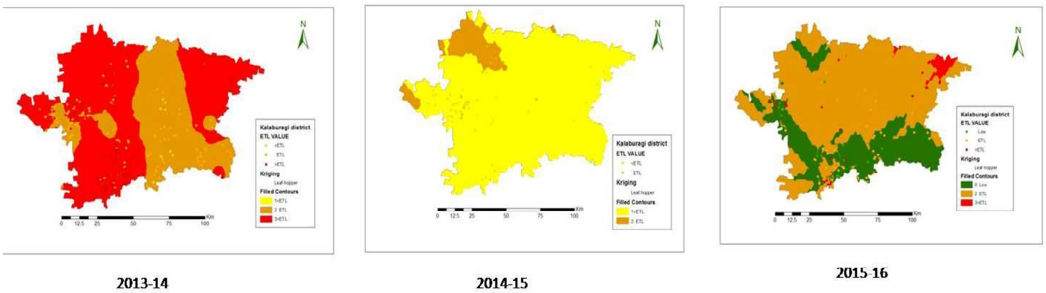

Fig.2. Spatial distribution maps of leafhopper in Kalaburagi district across the years 2013-16

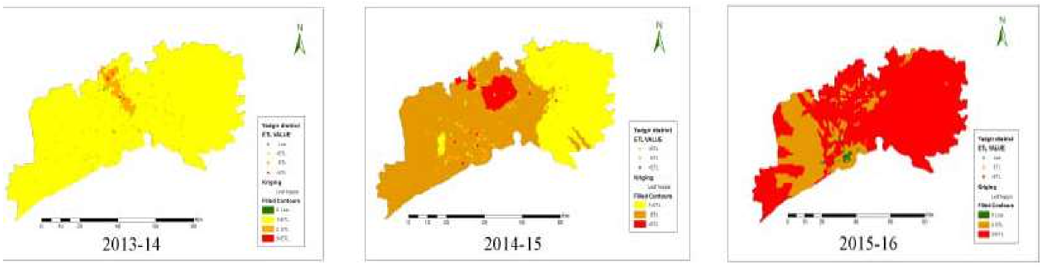

Fig.3. Spatial distribution maps of leafhopper in Yadgir district across the years

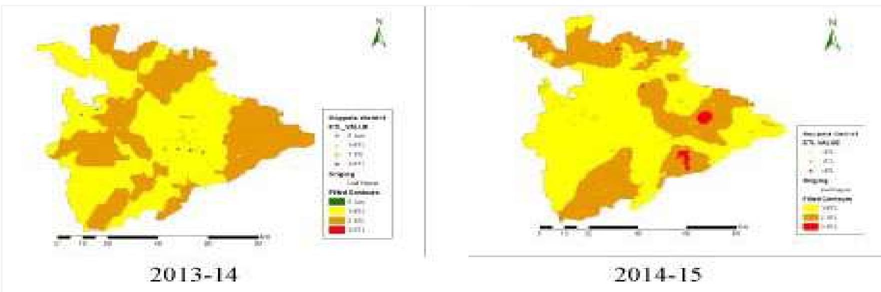

Fig.4. Spatial distribution maps of leafhopper in Koppal district

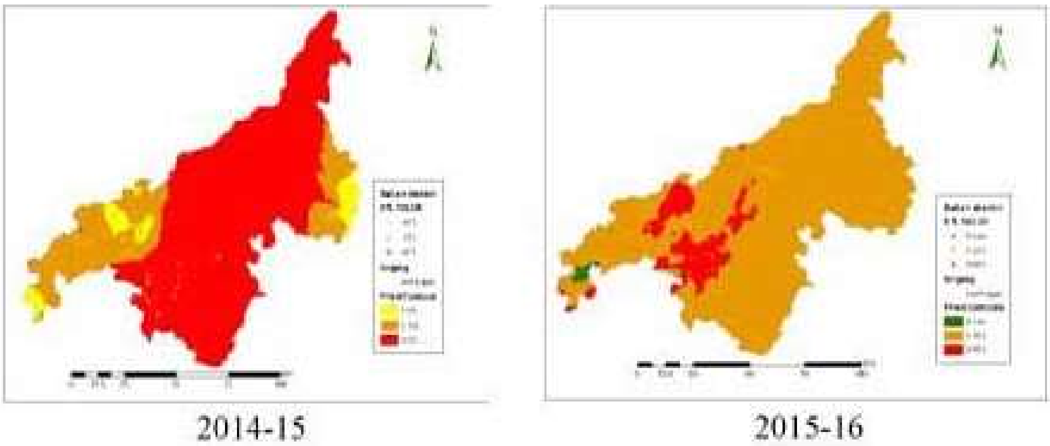

Fig.5 Spatial distribution maps of leafhopper in Ballari district

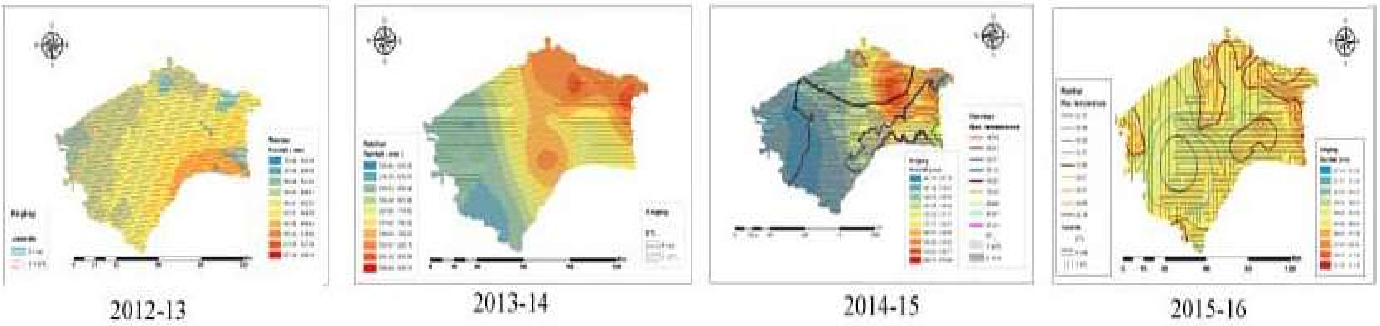

Fig. 6. Risk assessment map on incidence of leafhopper overlaid with rainfall and maximum temperature in Raichur district during across the years 2012-16

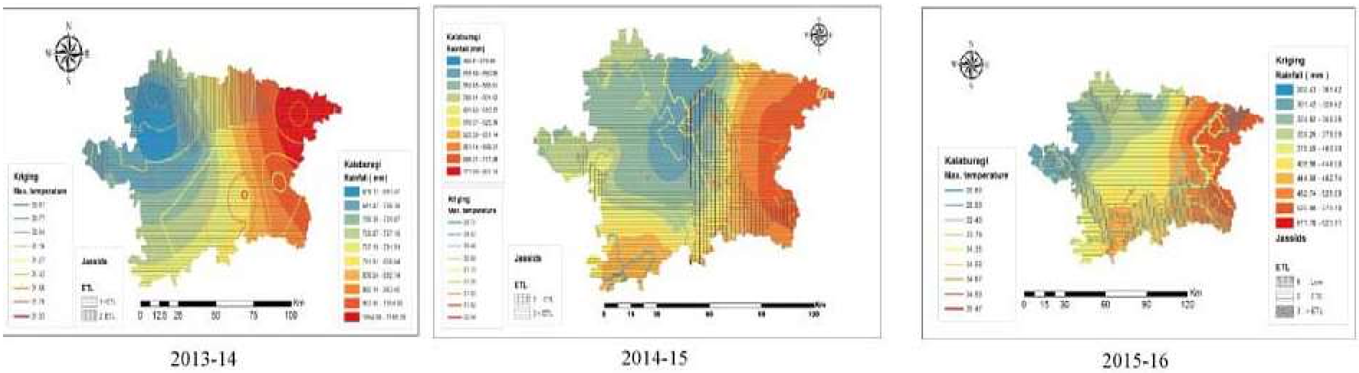

Fig. 7. Risk assessment map on incidence of leafhopper overlaid with rainfall and maximum temperature in Kalaburagi district across the years 2013-16

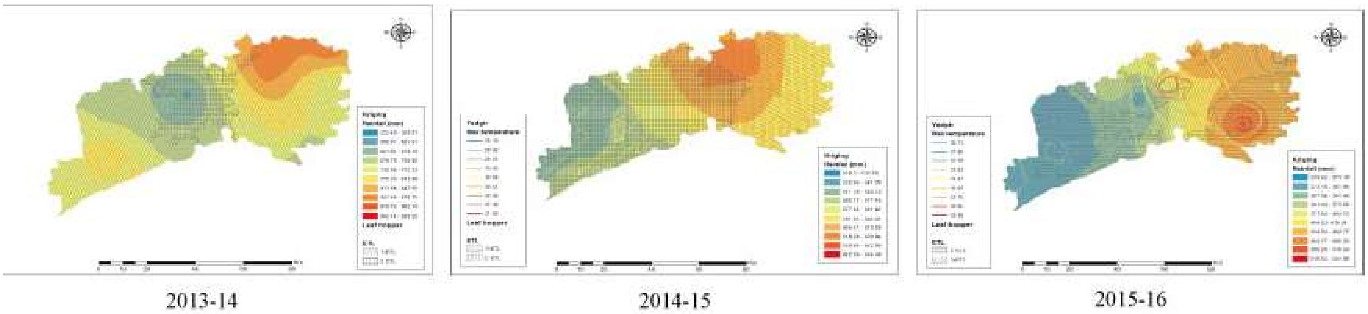

Fig. 8. Risk assessment map on incidence of leafhopper overlaid with rainfall and maximum temperature in Yadgir district across the years

Table 3. Surveillance data generated on cotton leafhopper in different talukas of Koppal district during 2013-14 and 2014-15 through *e*SAP

Sl. No	Taluka	Number of survey points generated according to thresholds									
		2013-14					2014-15				
		LOW	<ETL	ETL	>ETL	Total	LOW	<ETL	ETL	>ETL	Total
1	Kushtagi	0	10	4	0	14	0	16	61	4	81
2	Koppal	2	26	2	1	31	0	2	12	0	14
3	Gangavathi	0	8	6	0	14	0	35	71	10	116
4	Yelburga	2	15	3	0	20	0	118	0	1	119
5	Total	4	59	15	1	79	0	171	144	15	330

Table 2. Surveillance data generated on cotton leafhopper in different talukas of Ballari and Kalaburagi districts from 2014-15 and 2015-16 through *e*SAP

Sl. No.	District	Taluka	Number of survey points generated across different years									
			2014-15					2015-16				
			Low	<ETL	ETL	>ETL	Total	Low	<ETL	ETL	>ETL	Total
1	Ballari	Ballari	0	16	16	4	36	0	0	11	1	12
		Hadagali	0	3	25	3	31	16	22	14	10	62
		Hagaribommanahalli	0	55	38	0	93	0	0	22	4	26
		Hosapete	0	3	0	95	98	0	0	27	1	28
		Kudligi	0	1	30	34	65	0	0	14	21	35
		Sandur	0	1	3	18	22	0	0	0	0	0

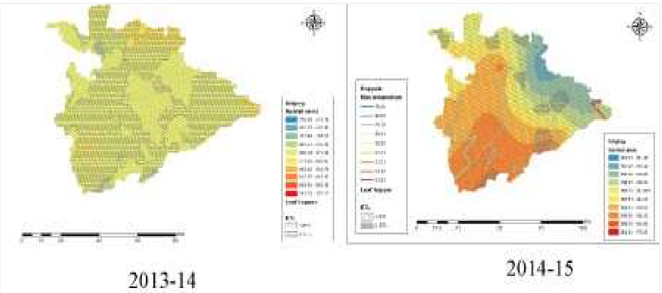

Fig. 9. Risk assessment map on incidence of leafhopper overlaid with rainfall in Koppal district

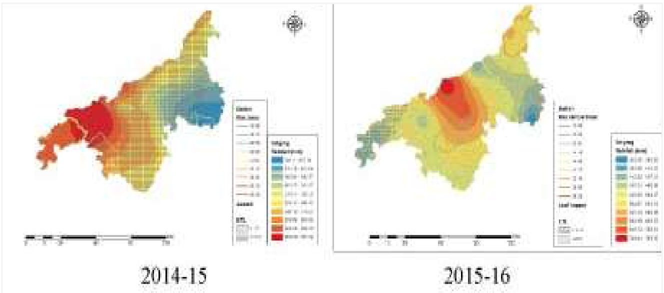

Fig. 10. Risk assessment map on incidence of leafhopper overlaid with rainfall and maximum temperature in Ballari district

more rainfall. During 2015-16 the majority of the area falling under leafhopper incidence equivalent to ETL comes under the rainfall pattern of 359.27 to 389.51mm (Fig.6). Whereas, leaf hopper population with low incidence falls under the rainfall pattern of 373.63 mm and above. Further, the maximum temperature pattern did not show any relation with the pest incidence.

There appears to be a gross variation in the rainfall pattern between 2014-15 and 2015-16 in Raichur district. In 2014-15 the total rainfall during the cropping period ranged between 441.7 and 674 mm, whereas, during 2015-16 the total rainfall during the cropping period ranged between 307.14 and 471.56 mm. This clearly indicates that the total rainfall was considerably less in 2015-16 as compared to 2014-15; this might have resulted in the eruption of the population in 2015-16.

In Ballari district leafhopper incidence with more than ETL was noticed in the rainfall pattern between 341.3 and 698.59 mm, whereas, the incidence of ETL was noticed either in a very high rainfall of 698.59 to 813.54 mm or 341.3 to 463.04 mm (Fig.10). However, a clear cut relation between the incidence level and rainfall pattern was not observed during 2015-16 (Fig.10). This variation would be attributed to a widespread distribution of pest population over a larger area of cotton growing region. Similarly, in cotton growing regions of Kalaburagi also did not show a clear cut relation between the leafhopper incidence and rainfall pattern as well as maximum temperature (Fig.7). The possible reasons could be reduction in surveillance data points in this District as compared to Raichur, hence, it can be attributed that it is very essential to generate large number of surveillance data points in order to obtain a clear picture. The same attribution can also be extended to leafhopper incidence in Yadgir (Fig.8) and Koppal (Fig.9) Districts.

Looking into the overall observation, it appears that the pest incidence was low and less than ETL during 2012-13 and 2013-14. However, in next two years *i.e.* 2014-15 and 2015-16 the pest becomes very serious, widespread reaching ETL and more than ETL. It is well known fact that leafhopper population is positively related with maximum temperature and negatively related with rainfall. In the current observation the maximum temperature between June and December of all the four years varied considerably, the average maximum temperature was significantly higher during 2014-15 and 2015-16 compared to previous two years. This increase in temperature had a favourable environment for the rapid build up of leafhopper population reaching ETL and exceeding ETL in some districts.

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