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Windfield related light-trap catches of *Nephotettix* spp. (*N. virescens* Distant and *N. nigropictus* Stål), vectors of rice tungro virus in West Bengal

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सार — पश्चिम बंगाल में धान की खेती में अगस्त माह में लगभग 14 दिन की घट-बढ़ के साथ मानसून की अधिकतम वर्षा के 60 दिन के बाद हल्के फाँद में अक्सर काफी बड़ी संख्या में हरित लीफहॉपर, नेफोटेटिक्स वाइरेसेन्स (डिस्टेंट) तथा एन निगरोपिक्टस (स्टल) पाए जाते हैं । इतनी बडी संख्या में लीफहॉपर पाए जाने के अतिरिक्त 1986 में 17 सितम्बर तथा 10 नवम्बर को भी अधिक संख्या में लीफहॉपर पाए गए । 17 सितम्बर को इनके अधिक संख्या में पाए जाने का कारण संभवतः इनकी स्थानिक संख्या तथा आकाश में मेघ छा जाने के कारण फाँद का प्रभाव क्षेत्र दूर तक बढ़ना है । 10 नवम्बर के इनके अधिक संख्या में पाए जाने का कारण चक्रवातीय पवनों के साथ बड़ी संख्या में इनका आगमन तथा फाँद क्षेत्र के निकट हल्की और परिवर्ती पवनों (अभिसरण) के क्षेत्र में इनका जमाव है । प्रक्षेप पथ विश्लेषण से पता चलता है कि लीफहॉपर फाँद के स्थान से लगभग 280 कि.मी. दूर उत्तर पूर्व से आए होंगे ।

ABSTRACT. Regular peak catches of rice green leafhoppers, *Nephotettix virescens* (Distant) and *N. nigropictus* (Stål) are usually obtained in a light-trap 60 ± 14 days after the peak monsoon rains in August in West Bengal. In 1986, in addition to this peak catch, very high catches were obtained on two different dates, 17 September and 10 November. The high catch on 17 September was probably due to the increase of the effective trap radius caused by the overcast sky and by the presence of a resident population. The high catch on 10 November was due to the transport of the insects by cyclonic winds and deposition in a zone of light and variable winds (at a convergence) near the trapping site. Trajectory analysis indicates that these insects may have been brought from the north-east, upto about 280 km away from the trapping site.

Key words — Rice green leafhoppers, *Nephotettix*, Light trap, Windfield, Rice tungro virus.

1. Introduction

Mukhopadhyay and Mukhopadhyay (1987) and Mukhopadhyay *et al*. (1988) found regular peak catches of rice green leafhoppers, *Nephotettix virescens* (Distant) and *Nephotettix nigropictus* (Stål), 60 ± 14 days after the peak monsoon rains during August, irrespective of years and locations within the experimental area between 22°19′ N to 23°58′ N and 86°59.5′ E to 88°50′ E. In a 9-year study, from 1976 to 1987, peak monsoon rains were found to occur on varying dates in August and the corresponding peak catches of *Nephotettix* spp. occurred in varying dates in October. In addition to the monsoon rain related peaks, occasional high catches were also recorded on certain other dates in September and November. Mukhopadhyay (1991) found that occasional increases in light-trap catch during the rice cropping seasons were mostly due to the increase in the effective trap radius on no moon and new moon nights. It was further observed that light-trap catches often increased in other lunar phases when the night illumination was reduced by overcast sky, which also increased the effective trap radius (Mukhopadhyay and Mukhopadhyay 1992) the authors could not, however, explain the unusual high catch recorded only in

TABLE 1

Estimated trap radii in moonless clear sky and moonless overcast sky for a light trap (100-watt tungsten circular bulb)

Source of illuminate values in different sky condition	Night illumination (lux) as provided	Calculated values		
		square root transformation	trap radius (m)	trap radius ratio
Moonless clear sky Middleton (1957)	.001	.03162	232.64	1.00
Moonless clear sky Bowden (1973)	.0009	.03	245	1.05
Moonless overcast sky Middleton (1957)	.0001	.01	735.62	3.162

November 1986 beyond the cropping season. In no other case in the period from 1976 to 1987, such a peak in November was observed in any location (Mukhopadhyay *et al.* 1988). A high catch on 10 November 1986 in the phase-group of 12, about six days before full moon (see Bowden 1973 for explanation of moon phase groups), at a time when few insects were expected to be caught, remained unexplained, although there was an increase in wind speed to 7.8 km/hr which was conductive to the dispersion of the leafhoppers. This paper examines the unusually high catch on 10 November by analysing wind fields at the time.

2. Materials and methods

Daily light-trap catches of *Nephotettix* spp. at Kalyani from August to November 1986 were used in this analysis. Effective trap radii were calculated using the illumination values provided by Middleton (1957) and Bowden (1973). Windfields were analysed to investigate the association of a high wind speed with the high catch obtained in the light-trap on 10 November when there were no resident population of green leafhoppers (GLH). The light-trap catches were analysed by dividing this period into four lunar months and by grouping the catch according to 32 lunar phase groups (following Bowden 1973 and IMD 1986). Dusk is known to be the take-off time for GLH (Bowden *et al.* 1988, Perfect and Cook 1982), so synoptic weather maps at 1730 IST at 0.3 km from 8 to 10 November 1986 were collected from the Meteorological Office, India Meteorological Department (IMD), Calcutta. These showed the major wind patterns during those three days. To describe the paths of parcels of air, back trajectories were drawn using wind speed and direction from the weather map of 9 November. These were drawn following the streamline (line parallel to airflow) - isotach (line of constant wind speed) technique (Rosenberg and Magor 1983). Bowden *et al.* (1988) found that 85% of GLH activity took place in the first five hours after sunset but with some planthoppers flying for longer. Ten hour back trajectories were calculated from arrival at the trapping site (22° 50'N and 88°20'E) to show the direction and maximum likely distance of downwind migration, and the likely source from where GLH would have been transported.

3. Results and discussion

Three incidents of high catches were observed, one in phase group 17 of the second lunation at full moon but on a cloudy night, a second in phase group 15 of the third lunation, two nights before the full-moon on a rainy night, and a third in phase group 12 of the fourth lunation, three nights after the first quarter of the moon. The first incidence of high catch, which corresponds to the 17th phase of the moon or fullmoon condition in September 1986 gives the effective trap radius as low as 16.72 metres (Mukhopadhyay 1991). Normally there should be a low catch on this date. Climatic records showed that the sky condition on this date was cloudy. The influence of cloud cover in reducing the night illumination and thereby increasing the effective trap radii was determined using the illumination values for different sky conditions following the method described in Bowden 1973.

TABLE 2

Lagged correlations between wind speed and light trap catches of rice green leafhoppers for four, three, two and one lunation

Lag	All the four lunations (n = 127)	Last three lunations (n = 95)	Last two lunations (n = 63)	Last lunation (n = 32)
0	– 0.1138	– 0.0691	– 0.0270	– 0.0689
1	– 0.0687	– 0.0193	– 0.0514	– 0.0686
2	– 0.0177	+ 0.0510	+ 0.0465	+ 0.0222
3	+ 0.1837	+ 0.2903	+ 0.5339	+ 0.8148
4	+ 0.0321	+ 0.0704	+ 0.0277	+ 0.0608
5	– 0.0495	+ 0.0011	– 0.0518	+ 0.0378

Thus it was calculated that the clouded sky increased the trap radius by a factor of 3.162 (Table 1) and more insects were trapped as the horizontal trapping area on this date increased to 8812.32 sq metres instead of 881.39 sq metres which explains the high catch in 17 September. The second high catch corresponds to the scheduled seasonal peak catch as per rice crop calender in West Bengal (Mukhopadhyay and Mukhopadhyay 1987). To explain the third high catch in 10 November, the wind circulations during 10 and preceding two dates, ninth and eight November were analysed.

According to the India Meteorological Department (IMD), the equatorial trough over the southern and central Bay of Bengal became active from the last week of October. In this trough, a depression developed over the west central and south-west Bay of Bengal on 7 November. It moved northerly and then north-easterly towards Bangladesh. The system intensified into a cyclonic storm on the morning of 9 November and at 0830 IST was centred very close to the Bangladesh coast, near 21.7°N, 89.5°E. The 0530 IST winds at 0.9 km asl at Calcutta and Chittagong were 025° 80 kph and 170° 72 kph respectively. The cyclone crossed the Bangladesh coast near 89.5°E and then weakened to a depression over Bangladesh, centred about 40 km south-west of Agartala at 1730 IST. It further weakened in the night over Nagaland, Manipur, Mizoram, Tripura and neighbourhood (Das *et al.* 1988). The position of the trapping site was very close to the point where the depression gradually weakened.

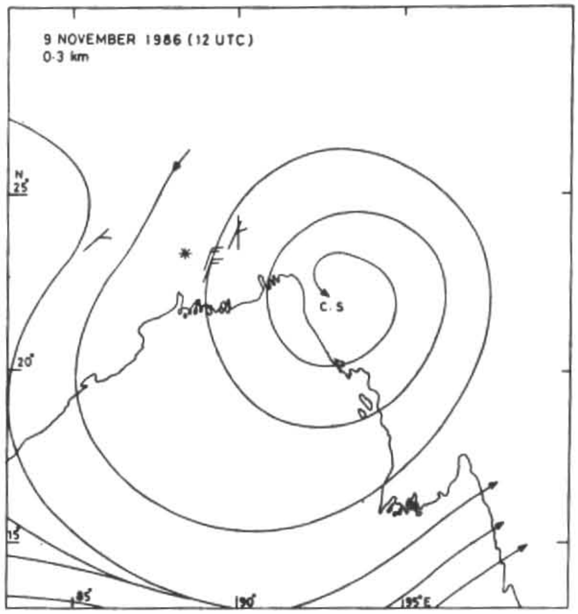

Fig. 1. Airflow at 300 m over northeast India and neighbouring Bangladesh at 1730 hr IST on 9 November 1986 (*Trapping site at Kalyani)

The synoptic weather maps at 0.3 km and at 1730 IST on 9 and 10 November showed the pattern of the windfield circulation and the convergence of the field in close proximity of the trapping site (Figs. 1 & 2). On 9 November when the depression was over Bangladesh, the winds at the trapping site were north-easterly 28 km/hr. By 10 November the depression had moved towards north and winds at the trapping site had backed to south-easterly direction. Surface winds became light, not exceeding about 9 km/hr. Airborne particles, including migrating insects, carried from the northwest by the converging winds were likely to land as the wind backed and decreased to near calm. Analysis of catches at different wind speeds from July to December 1986 showed highest light-trap catches at a wind speed below 2 km/hr (Table 3).

When the lagged correlations between the wind speeds and the catches were computed together for a lag of 0 to 5, correlation was found to be positive at lag 3 for all the 4 lunations taken together or taken in different combinations (Table 2). Negative correlation between the wind speed and light trap catches at low lags suggest dispersive condition of insects under the influence of wind. On the contrary at a higher lag, light trap catches are positively correlated to wind speed, where wind might have

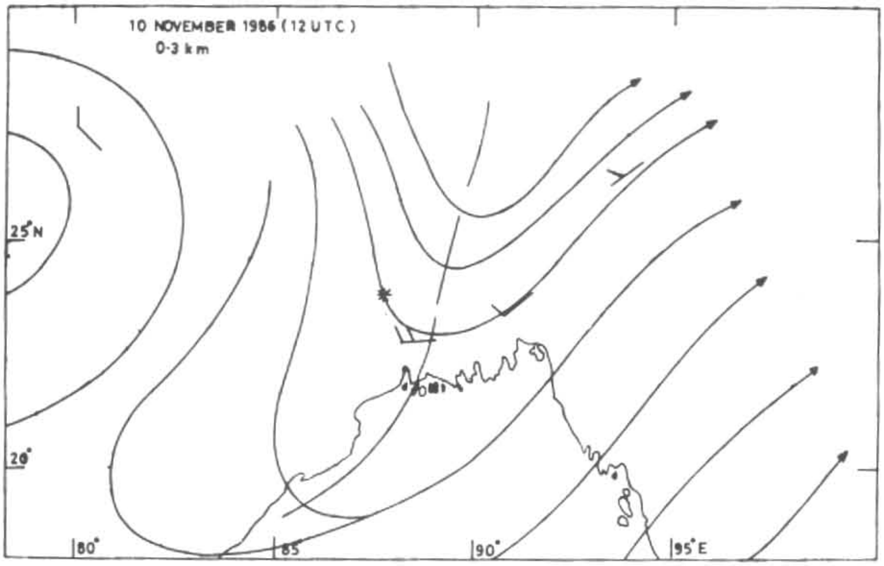

Fig. 2. Airflow at 300 m over northeast India and neighbouring Bangladesh at 1730 hr IST on 10 November 1986 (*Trapping site at Kalyani)

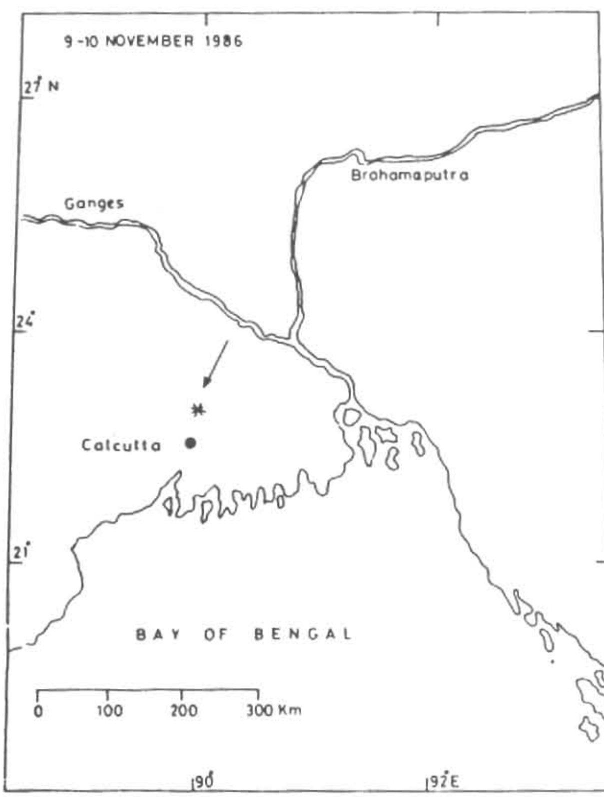

Fig. 3. Back trajectory showing the likely direction of rice green leafhopper's flight track on 9 November 1986 at 1730 hr IST (*Trapping site at Kalyani)

been subjected to special circumstances which allowed the insects to settle into the trapping area resulting in the higher light trap catches. When 10-hour back-tracks were drawn, assuming that GLH flew at 300 m above the height of the trapping site at 1730 IST on 9 November, with a wind speed of 28 km/hr, it appeared that the insects could have been transported from a distance about 280 km north-east of the trapping site which is clear from Fig. 3 depicting the back trajectory showing the likely direction of rice green leafhopper's flight track drawn with the weather chart of 9 November 1986 at 1730 IST. Thus GLH brought from the north-eastern region by the convergent wind on 9 November could have arrived within the effective radius of the light trap resulting in the sudden high catch.

High catches of GLH obtaining on three different dates in 1986 were thus due to three different reasons. The first two occurred when resident populations were present, but the third one was probably due to long distance transportation of insects by air currents (Table 4).

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TABLE 3

Surface wind speed and catches of rice green leafhoppers (*Nephotettix* species) in the light-trap at Kalyani for a period of days during July to December 1986

	Percentage of surface wind speed (km/hr)								
	2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	12-13
Insects trapped	83.31	9.53	1.36	4.27	Nil	0.38	0.99	0.07	0.09
Trapping days	70	14	6	6	1	1	1	1	1

TABLE 4

Factors associated with high light-trap catches of rice green leafhoppers (*Nephotettix* spp.) during the post-monsoon months at Kalyani in 1986

No. of sets	Dates	Light trap catches	Lunar phase group (Bowden 1973)	Trap radius (metres) (Mukhopadhyay 1991)	Night sky condition	Increase factor of trap radius (Mukhopadhyay & Mukhopadhyay 1992)	Surface wind speed* (km/hr) 3 nights before the trapping date	Explanation
I	16 Sept	88	16	18.57	Rain	-	1.4	High catch due
	17 Sept	1554	17	16.72	Cloud	3.162	1.4	To increased
	18 Sept	113	18	19.80	Clear	-	1.1	Trapping area (Bowden *et al.* 1988)
II	14 Oct	374	14	23.39	Rain	-	1.2	Expected peak
	15 Oct	2211	15	20.83	Rain	-	1.0	At a lag of 65 days
	16 Oct	1064	16	18.57	Clear	-	1.2	After peak August
	17 Oct	202	17	16.72	Lunar Eclipse	-	2.2	Rain (Mukhopadhyay & Mukhopadhyay 1987)
III	09 Nov	9	11	34.42	Cloud	3.162	1.3	Wind assisted high catch (present study)
	10 Nov	24.86	12	29.74	Clear	-	7.8	
	11 Nov	203	13	26.19	Clear	-	1.6	

*Recorded by the cup anemometer (Lynx) installed in the field observatory at the Plant Virus Experimental Field, Kalyani.

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