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STATISTICAL STUDIES OF LIGHT TRAP CATCHES OF ZYGINIDIA QUYUMI (AHMED) (CICADELLIDAE:HOMOPTERA) ON WHEAT IN PUNJAB

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Abstract. Light trap studies were made on the leafhopper species *Zyginidia quyumi* (Ahmed on wheat, at Tandlianwala (Distt. Lyallpur, Punjab). The species is quite abundant on the crop and was particularly prevalent between March 28, 1972 –April 6, 1972, when the studies were made. Five coloured lights (60W each) red, green, yellow, blue and ordinary lights were used to attract leafhoppers for a period of about 30 min from sunset. The arrangement of lights was rotated daily, and the catches continued for 10 days. The daily catches have been analysed statistically for the relative preference of light colours by the leafhoppers, the involvement of sex in light attraction, and the interaction of sexes and lights. It has been concluded that there is no significant sex effect on the attraction of *Z. quyumi* to various light colours, the overall effect of colours on *Z. quyumi* is highly significant and the interaction of sex and light is not significant.

The use of light traps for studying various aspects of insect populations is both old and wide spread. It has lead to the development of a variety of complicated and comprehensive light traps, such as Rothamsted,[7] non-ultraviolet,[3] Robinson[5] and quite a few modified forms of simpler traps. The number of insects attracted to light sources of various colours varies so considerably sometimes that careful selection has to be made before any light source is utilised for the purpose of estimating abundance of any particular species. Special precautions are taken to modify experimental techniques so as to suit the habits of any species. The use of light traps in insect population studies is subject to all limitations and rather more than those conceived for other methods of sampling. Even the best traps show such day to day fluctuations in number of insects attracted by them, that as Love and Smith[4] and Breyev[2] have pointed out, their reliability as a basis of assessing natural population in the field has to be carefully evaluated.

The present studies on light attractancy behaviour of *Zyginidia quyumi*, a tiny leafhopper (3.00 mm) pest of wheat, were done in the dates when the insect is available in the field in abundance, and in the locality where its population on wheat had already been ascertained to be quite high. At suitable temperature (80°F), low humidity and calm atmospheric conditions, the insect is highly active in the evenings and is readily attracted to artificial lights.

The study included the relative preference by the leafhopper, of any particular colour of light over other colours, and the interaction of sexes in catches. It was a part of our overall studies on the population of *Z. quyumi* on wheat. It was intended to discover the colour of light to which the leafhopper is attracted in highest numbers, and which could be utilised in studying the fluctuations in natural population of the leafhoppers and their relationship with environmental factors. The statistical analysis of the entire data collected, was done with the help of computer, and the results are explained in the following pages.

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Material and Method

It is always considered that larger figures in light trap catches are more acceptable for statistical analysis. The site and dates of light attractancy experiments were carefully selected to have the highest numbers of leafhoppers attracted to them. The experiments were conducted from March 28, 1972 to April 6, 1972, at Tandlianwala (Distt. Lyallpur, Punjab) where the leafhopper is highly abundant on these dates. The lights were exactly set at points located midst the wheat fields.

The light trap design was simple with minor modifications to that used by Bang and Kae[1] for *Nephotettix* sp. A 4 ft high wooden frame (Fig. 1) was used for placing a petri dish of 6 in dia over it. The petri dish was half-full of 50:50 mixture of kerosene oil and water. A wooden rod projecting for about 2 ft above its top was fitted on one side of the frame. A 60W bulb was kept suspended from this rod about 6 in above the surface of killing mixture in the petri dish. Electric bulbs of five colours—ordinary, blue, yellow, green and red were used for attracting the leafhoppers. Wooden frames with complete light trap of one colour on each were placed in a straight-line, 10 ft apart in the field.

The position of coloured lights was changed daily as shown below:

Days	Colour of Lights				
1	Red	Green	Yellow	Blue	Ordinary
2	O	R	G	Y	B
3	B	O	R	G	Y
4	Y	B	O	R	G
5	G	Y	B	O	R

The experiment was replicated, and the leafhopper data of light trap catches of 10 days was procured.

The leafhoppers that happened to fall down in the mixture in petri dish got immediately killed. The light traps were operated daily for a period of 30 min from sunset. The insects killed in the petri dish were filtered and preserved in alcohol (70%). By a subsequent analysis the number of *Z. quyumi* collected were counted separately into males and females, for each light and night (Tables 1 and 2).

Observations and Results

Analysis of the Data

In order to study the response of male and female *Z. quyumi* towards various lights, the following model is used.

$$Y_{ijk} = \mu + si + I_j + (sl)_{ij} + \varepsilon_{ijk} \qquad (1)$$

Where i=1,2 (sexes); j=1,2.....5 (lights); and k= 1,2.....10 (nights) and, Y_{ijk} denotes the number of *Z. qs.* caught belonging to ith sex under jth light on kth night, μ is overall average number of *Z. qs.*, si, l_j and $(sl)_{ij}$ denote respectively the response of ith sex, jth light effect and the combined effect of ith sex towards jth light.

ε_{ijk} is the error effect. l_1, l_2, l_3, l_4, l_5 stand for red, green, yellow, blue and ordinary lights respectively.

Estimation of Missing Values. Since the experiment contains two missing values that belong to the same light and the same night, these missing values were first obtained as follows:

$$\hat{X}_{ijk} = \frac{2\times(sl)'_{ij} + 10\times 2(SD')_{ik} + 10\times 5(LD)'_{jk} - 2S'_i - 5L'_j - 10D'_k + G'}{(10-1)\quad(2-1)\quad(5-1)}$$

in this experiment i = 1 and 2; and j = 4,K—5. These estimates are 32 for females and 50 for males.

The sums of squares of main effects and interactions have been computed with two estimated values.

S.S total	=	343440.24
S.S (sex)	=	10444.84
S.S. (light)	=	92859.14
S.S. (sex, light)	=	3776.46
S.S. (error)	=	236359.80

The analysis of variance table has been constructed on the basis of model (1).

Estimates of the Parameters. Various parameters have been estimated for obtaining expected total of *Z.qs.*

$\hat{s}_1$	=	10.24	$\hat{s}_2$	=	10.24
$\hat{l}_1$	=	—49.83	$\hat{l}_2$	=	—9.88
$\hat{l}_3$	=	—4.2	$\hat{l}_4$	=	29.52
$\hat{l}_5$	=	37.27	$\hat{\mu}$	=	50.43
$\hat{(sl)}_{11}$	=	10.04	$\hat{(sl)}_{21}$	=	—10.05
$\hat{(sl)}_{12}$	=	2.09	$\hat{(sl)}_{22}$	=	—2.10
$\hat{(sl)}_{13}$	=	0.04	$\hat{(sl)}_{23}$	=	—0.05
$\hat{(sl)}_{14}$	=	—4.26	$\hat{(sl)}_{24}$	=	4.25
$\hat{(sl)}_{15}$	=	—8.36	$\hat{(sl)}_{25}$	=	8.35

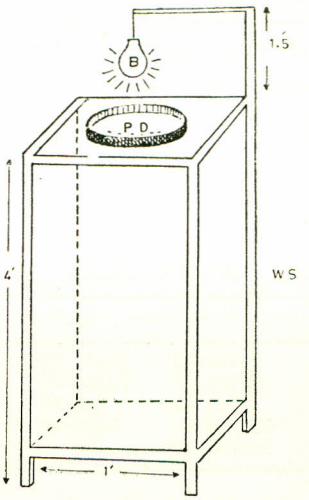

Fig. 1. Light trap equipment: WS, wooden stand; PD, perti dish; B, electric bulb.

TABLE 1. NUMBER OF *Z. quyumi* ATTRACTED ON VARIOUS COLOURED LIGHT SOURCES (60W) AT TANDLIANWALA ON WHEAT DURING 18:50–19:20 hr.

Date	Light colours					Total of *Z.qs.*
	Red	Green	Yellow	Blue	Ordinary	
28.3.72						
Females	1	58	25	28	74	447
Males	1	85	55	51	69	
29.3.72						
Females	0	100	105	174	187	1438
Males	0	137	150	250	335	
30.3.72						
Females	0	29	18	47	70	430
Males	0	72	50	84	60	
31.3.72						
Females	1	40	73	138	127	824
Males	1	47	101	168	128	
1.4.72						
Females	0	5	5	Damaged	10	75
Males	2	14	8		31	
2.4.72						
Females	1	16	12	22	16	150
Males	0	14	16	21	32	
3.4.72						
Females	0	4	3	7	7	79
Males	0	10	15	15	18	
4.4.72						
Females	0	16	39	49	73	466
Males	1	35	52	71	130	
5.4.72						
Females	1	39	59	96	89	701
Males	1	26	75	133	182	
6.4.72						
Females	0	17	22	28	38	332
Males	2	47	43	57	78	
Total: Males	8	487	565	850	1063	2973
Females	4	324	361	589	691	1969
Grand total	12	811	926	1439	1754	4942

TABLE 2. TOTAL CATCHES OF *Z. quyumi* (OBERVED).

	Red	Green	Yel-low	Blue	Or-dinary	Total	Aver-age
Female	4	324	361	589*	691	1969	40·2
Male	8	487	565	850*	1063	2973	60·6
Total	12	811	926	1439	1754	4942	—
Average	·6	40·5	46·5	79·9	87·7	—	50·4

*Include estimated values component.

ANOVA TABLE

S.V.	d.f.	S.S.	M.S.	F	$F_{5\%}$
Light	4	95414·90	23853·72	8·881	2·47
Sex	1	10285·87	10285·87	3·83	3·94
Light × sex	4	1043·43	260·85	·10	2·427
Error	8	236359·80	2685·91	—	—
Total	97	343104·00	—	—	—

Estimated Total Catches. The expected totals of *Z.qs.* have been obtained from

$$\hat{Y}_{ijk} = \hat{\mu} + \hat{s}_i + \hat{l}_j + (\hat{sl})_{ij} \text{ over all } k.$$

$$\hat{Y}_{11} = 0.40 \qquad \hat{Y}_{21} = 0.79$$
$$\hat{Y}_{12} = 32.4 \qquad \hat{Y}_{22} = 48.69$$
$$\hat{Y}_{13} = 36.03 \qquad \hat{Y}_{23} = 56.42$$
$$\hat{Y}_{14} = 65.45 \qquad \hat{Y}_{24} = 94.44$$
$$\hat{Y}_{15} = 69.1 \qquad \hat{Y}_{25} = 106.29$$

The above values have been given in the Table 3.

In order to grade the intensity of attraction of *Z.qs.* the colours of lights have been ranked in order of the total *Z.qs.* The ranking is done on the basis of mean square error and standard error of differences. These are obtained from the ANOVA Table and are given below:

MSE = 2685.91

SE of mean = σ^2/r
SE of difference between two means = $\sqrt{(2\text{MSE}/r)}$
SE(d) = $\sqrt{(5371.82/10)} = 23.1$

	Red	Green	Yellow	Blue	Ordin-ary
Average	0.6	40.5	46.2	79.9	87.7

At 99% significance level, the red light has the least attraction for *Z.qs.*, whereas there is no difference between other colours for *Z.qs.* All these colours are equally attractive for the insects. At 95% significance level, red light is most resistant as compared to others. *Z.qs.* are equally attractive to green and yellow but are more attractive to blue and ordinary lights. It may be noted here that there were two missing values for the blue that might have effected its final results. There is no significant difference between yellow and blue but yellow is definitely different from the ordinary light. The above results show that most of *Z.qs.* are attracted by blue and ordinary lights. However, it is preferable to make use of ordinary light in attracting leafhopper, for the purpose of estimating their population changes, keeping in view the environmental factors.

TABLE 3. TOTAL CATCHES OF *Z. quyumi* BY SEX AND LIGHT (estimated).

Sex	Red	Green	Yellow	Blue	Or-dinary
Female	4	324	360	655	691
Male	8	487	564	944	1063

Conclusions

The following hypothesis have been tested and the conclusions drawn:

1. There is no significant sex effect on the attraction of *Z. quyumi* towards light.
2. There is highly significant effect of light colours on attracting *Z. quyumi* towards them.
3. The interaction of sex and light colours is in significant.

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