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Vegetable Leaves Colour in the Aspect of Entomology

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Abstract: Survey the colour aspects of causing damage by insects on vegetables. The question is, why they choose the plant parts to feed and where they lay their eggs

Keywords: Thrips, colour vision, insects, fecundity

Introduction

There is a huge damage caused by insects in the agriculture. We can use chemicals to kill insects or to keep them away. Another possibility is to learn how they find the leaves of vegetables and how they can find the best place where to lay their eggs. We can catch insects using light trap or colour trap, yellow, blue and white traps are used. Can we choose discoloured plant to save damage? There are different aspects to explain the phenomenon. The insect can not see the trap because this colour is invisible for her. The insect prefers the colour of the trap. The insect hates the colour of the trap. The insect can not see anything because of dazzling light (contrast)

Theoretical aspects

There are insects of dichromatic vision or trichromatic like human. They can see light and colour in the ultra violet range. Any of them have more than three colour sensor (or rhodopsin type, up to eleven) but this field of life science is undiscovered. There are insects that can sense light in the infrared range. It has not been proved that is picture vision or light vision only. Their visual organ is facetted eye and three point eyes (lateral and dorsal). The insects can sense polarised light that is different from the human vision. The colour vision of more of the insect species can be described by the spectral maxima, one in the UV range and two in the human vision range: greenish-blue and yellowish-green. They are colour blind in the range that is known as the human red colour. It is supposed that their dorsal three point eyes are sensitive for the infrared light.

The colour vision of insects has been surveyed in many different ways, e.g. recording electroretinogram from the eye or chemically testing the light absorbance of the rhodopsin.

Materials and Methods

The animal: the onion thrips, Thrips tabaci LINDEMAN (Thysanoptera: Thripidae). In the aspect of colour vision we have to tell that these insects can prefer the flower or the leaf, dependent on the season.

The plant: white cabbage (*Brassica oleracea* L. convar. *capitata* provar. *capitata* Duch.) The tested varieties were thrips resistant 'Balashi', 'Bloktor' or unresistant ones 'Riana' and 'Green gem', 'Hurricane' and 'Quisto'. The flower of this vegetable is greyish white and the leaf is bluish green.We did colorimetric tests on vegetable leaves, on their face and their back side, from the inside and outside leaves of the cabbage head. The colorimeter applied was a Hunterlab Ultrascan 8009, all the trichromatic and the spectral data were evaluated. The measurable spectrum includes the range between 380 and 750 nm in 10 nm steps.

The vegetable leaves were observed under a stereo microscope. The number of adult thrips on both sides was counted, and the offspring forms were also counted as first and larval stage, in prepupa and in pupal stage. The fecundity was calculated dividing the count of offspring forms by the count of the adult form. As the count is a discrete variable, it was converted into continuous form to compute more statistics.

RESULTS

The count of adults and the fecundity were evaluated against the colorimetric data using statistical methods. First of all, the multivariate analysis of variances was used to test the effect of variety, the harvesting time, the count of adults and the fecundity. The second test was a multivariate regression, surveying the effect of the wavelength of the reflected light. The raw colorimetric data can be seen in the following tables.

Table 1. CIE tristimulous properties of cabbage leaves

CIE	minimum	average	maximum
1931 Y	10.18	20.37	35.22
x	0.2975	0.3244	0.3613
y	0.3168	0.3671	0.437
CIELAB a*	38.17	51.6	65.92
b*	-16.94	-9.83	-4.45
C*	4.55	16.31	36.94

Table 2. Colorimetric properties of cabbage leaves

COLOROID A (hue)	73.35
T (saturation)	5.89
V (Value)	44.56
Munsell Hue	7.5GY
Chroma	5,0
Value	4,0

The wide range of tristimulous values can be observed in the tables. It is caused by the ripening process. The CIE x and y chromaticity coordinates and the CIELAB a* colour coordinate are growing with the harvesting time. In reverse, the lightness (CIE Y and CIELAB L*) of the samples decreases according the harvest date. The saturation-type values (CIELAB C*, COLOROID T and Munsell chroma) are increased in the time. We show in Table 3 the results of counting the adult forms and the fecundity of insects.

Table 3. Insect count and fecundity at different varieties

Cultivar	Adult	Fecundity
Balashi	0.51	0
Bloktor	4.02	5.77
Green Gem	7.978	1.76
Hurricane	21.02	26.86
Quisto	7.978	7.63
Riana	0.808	0.333

The results of tests can be described on graphs: Figure 1 and 2

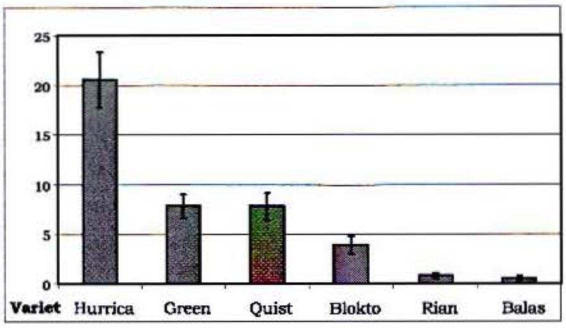

Fig. 1 Count of adults at different vegetable varieties

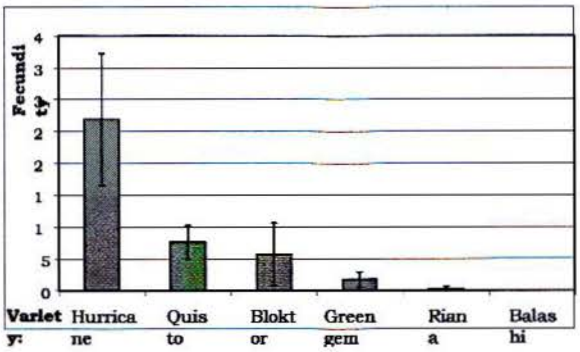

Fig. 2 Fecundity at different vegetable varieties

Upon the collected data we calculated the tables of the multifactor analysis of variances, as can be seen in the Table 3. It describes the connection between the colorimetric data and the count of adults. The strongest effect is the harvesting time, of course. There are more effect, according to the F-test value, of the x and y chromaticity coordinates, the CIELAB b* and the COLOROID hue (A). The probability level of misjudge (P-value) is very small.

Table 3. Analysis of variances for adult count

Source	Sum of Squares	DF	Mean Sq.	F-Ratio	P-value
Y	301.3188	1	301.319	5.65	0.0177
x	3129.9491	1	3129.949	58.65	0.0000
y	6203.0256	1	6203.026	116.23	0.0000
L*	567.0055	1	567.006	10.62	0.0011
a*	7.9897	1	7.990	0.15	0.7030
b*	5948.0283	1	5948.028	111.45	0.0000
C*	265.8521	1	265.852	4.98	0.0258
A	1193.4223	1	1193.422	22.36	0.0000
T	230.2375	1	230.238	4.31	0.0380
V	196.3063	1	196.306	3.68	0.0554
harvest time	20419.1755	1	20419.175	382.61	0.0000
Model	38462.3107	11			

We can see the connection between the fecundity and the CIELAB b* colour coordinate on the Figure 3. The calculated interval is expressed as the least significant difference.

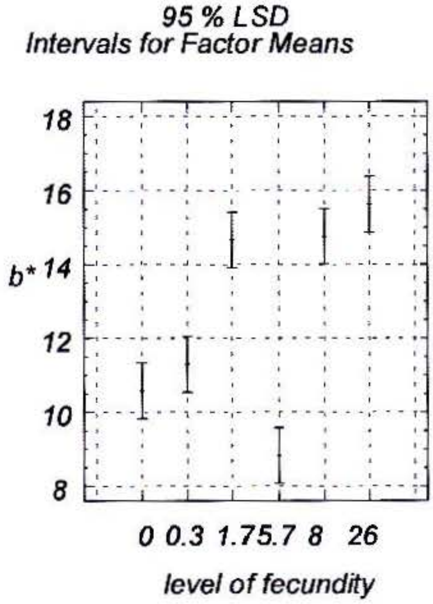

Fig. 3 The effect of CIELAB b on fecundity*

The next step was to fit a multivariable linear regression on the measured data (Table 4). The bonus of regression is, that we can see if the fecundity increases or decreases on the tested variable. The decrease is expressed as negative regression coefficient. The data are not normalised, so a usually less factor results a greater coefficient, e.g. the coefficient for CIE x chromaticity coordinate.

Table 4. Multivariate regression fitted on colorimetric data

Independent variable	coefficient	std. error	t-value	sig.level
Constant	781.8309	116.7372	6.6974	0.0000
Y	4.862042	8.094817	0.6006	0.5481
x	-3955.313	1028.0838	-3.8473	0.0001
y	1376.622	656.24787	2.0977	0.0359
L*	20.02789	20.669986	0.9689	0.3326
a*	7.984716	3.364943	2.3729	0.0176
b*	17.326	3.085935	5.6147	0.0000
C*	-11.1218	3.240557	-3.4321	0.0006
A	-1.7818	1.159538	-1.5367	0.1244
T	0.49055	1.000672	0.4902	0.6240
V	-24.5354	28.2306	-0.8691	0.3848
harvest	2.838257	0.145102	19.5604	0.0000

We tested the adult count and the fecundity as a function of the reflection at a measured wavelength (Table 5). As it is supposed previously, they have a colour sensor in the greenish-yellow range of light. Our table proves this theory as the analysis of variance can be found at higher level for 540-550 nm wavelengths. The sign of the regression means that the adult count decreases and the fecundity increases with the reflectance of the surface.

Table 5. Connection between the wavelength vs. adult count and fecundity

wavelength	ANOVA	regression	ANOVA	regression
	adult count		fecundity	
520 nm	3.884	-0.5934	1.813	0.4492
530 nm	3.417	-0.6093	2.148	0.4817
540 nm	2.802	-0.5911	2.310	0.4643
550 nm	2.612	-0.5509	2.311	0.4241
560 nm	2.98	-0.5431	2.179	0.4240
570 nm	3.627	-0.5694	2.055	0.4581

CONCLUSION

The insect count and their fecundity can be tested measuring the colour of the leaves. The insects' life is influenced by the light and the colour of vegetable leaves. It is supposed that this phenomenon depends on their way of feeding and their way of laying their eggs. The effect of harvesting time is stronger than the visual circumstances \ as colour and illumination.

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