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THE EFFECT OF INTERCEPT® TRAP COLOR ON *IPS TYPOGRAPHUS* CAPTURES (PRELIMINARY RESULTS)

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Abstract: *Most of the previous researches concerning the effect of the trap color on the captures proved that the bark beetles are strongly attracted to dark colored traps. In 2010, a series of experiments with Intercept® traps of different colors were performed, for which in addition to captures, the release rates of pheromones and the temperatures achieved in traps were determined. It was found that in dark colored traps (black and brown) which captured more insects, the dispensers released pheromones with higher rates than in light colored traps (white and yellow), due to higher temperatures inside them. Therefore, the catches may be influenced especially indirectly by the trap color, which influences the release rates of pheromones.*

Key words: *Ips typographus, color pheromonal traps, spruce forest.*

1. Introduction

The spruce bark beetle *Ips typographus* L. (Coleoptera: Curculionidae) is one of the most important spruce forest pest in Europe [9]. The control of the population of this pest by mass trapping the beetles has concerned the forest managers for over 200 years. There were used trap trees, installed during the flight period of insects [5]. This type of control was often very expensive and sometimes difficult to apply.

After highlighting the aggregative pheromone of *Ips typographus* [1], [15] and identification of its components [20], [2], [3] it was possible to develop control measures for this species by using synthetic pheromones to attract and capture insects in different manufactured traps [4], [17], [7].

As types of traps, those for other species of bark beetles were used: tubular traps, slot traps (Theyson), flight barrier traps (Intercept® etc.) or multi-funnel traps etc. [5], [10], [14], [8], [12], [18], [19].

Some of the field experiments carried out so far has tried to establish the role of trap color (dark color versus light color) on catches. Such tests have been performed for most types of traps and for different species of bark beetles: tubular traps - *Ips typographus* [5]; flight barrier traps - *Ips typographus, Trypodendron lineatum, Pityogenes chalcographus* [10], [14], slot traps (Theyson) - *Ips typographus, Ips duplicatus* [8], [12], multi-funnel traps - *Dendroctonus frontalis*, *Dendroctonus brevicomis* [18], [19]. In all cases, regardless of species, the dark colored traps captured more insects than the light colored traps. In

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most situations the catches in dark colored traps (mostly black) were significantly different from those of light colored traps [5], [10], [14], [8]. But there were cases when the dark-brown traps attracted more insects than black or other colored traps, but the differences were not statistically significant [12].

Even if most of the previous researches proved that bark beetles are strongly attracted to dark colored traps, by this research we aimed to analyze whether the response of the bark beetles is visually influenced by the color or is conditioned by the variation of the release rate of pheromones due to the various temperatures that occur in traps depending on the color.

2. Material and Methods

The effect of the Intercept® trap color on *Ips typographus* captures was tested by the intensity of the European spruce bark beetles response to the tested variants. The field tests were carried out on the Tâmpa plot (Braşov County, Romania: 45°37´N; 25°32´E; altitude: 975 m), which was installed on the edge of an artificial spruce stand, aged 105 years. The response of the *Ips typographus* beetles was tested in 2010, both seasonal (May 14 - August 10) and diurnal (May 14-16, respectively July 20-22). There were installed four variants of trap color (black, brown, yellow and white), in three replicates. The traps were placed at a minimum distance of 15 m between them and from the forest edge. The colored Intercept® traps (black as originally manufactured) were obtained by using colored stickers. All traps were baited with synthetic pheromone specific for *Ips typographus* - AtraTYP PLUS (Institute for Research in Chemistry, Cluj-Napoca, Romania).

The traps checking and the beetles collecting were performed every 6 to 10 days in case of seasonal test and hourly between 14 and 16 May (from 10 AM to 6 PM) and between 20 and 22 July (from 8 AM to 8 PM) as well.

During the diurnal tests, the temperature at the level of pheromone for each color of trap was monitored by using the data logger (Hobo® U23-001, USA). The release rate of each dispenser was monitored by weighing the dispensers before placing to traps (on mornings) and the end of the day (on evenings).

The captured beetles were preserved in alcohol until the sorting and counting of *Ips typographus* specimens. Sex determination was done for all insects or for groups of 50 beetles/trap in case of captures larger than 50 beetles, then extrapolating the result to the entire amount. The sexes were identified by dissection, analyzing the genital armature [13], [11], [6].

Data analysis. The evaluation of the differences between catches on the four tested variants of color was achieved by comparing the daily average captures by multifactorial ANOVA, after verification of normality with the Shapiro-Wilk test and homogeneity with Hartley test. In this analysis, daily captures were considered as repetitions. If significant differences between variants were found, the significance of differences between average values was established using the Tukey test [21]. The differences between the release rates of dispensers and the differences between the average hourly temperatures in the four colored traps were tested in the same manner.

3. Results

A total of 34975 *I. typographus* beetles were captured during the experiment (5584 males and 29391 females), from 14 May to 10 August 2010. In case of diurnal tests, 566 bark beetles were captured in 14-16 May (162 males and 404 females) and

2045 bark beetles in 20-22 July (482 males and 1563 females).

For all tests, the response of *Ips typographus* to tested variants was significantly influenced by the trap color and the time (Table 1). The number of males was significantly lower than the number of females. On the other hand, analyzing the interaction between the trap color and the sex of captured beetles there were not significant differences between catches concerning the sex-ratio, regardless of trap color. In the case of seasonal test, the response of European spruce bark beetles to colored trap variants did not vary significantly in time.

Table 1

Effects of different factors on Ips typographus response to different color traps

Statistical value	D.F.	Fisher's F	Pr > F
Diurnal test - May 2010			
Trap color	3	3.477	0.021
Time	2	25.025	< 0.001
Beetle sex	1	7.005	0.010
Trap color x Beetle sex	3	0.223	0.880
Diurnal test - July 2010			
Trap color	3	12.331	< 0.001
Time	2	21.281	< 0.001
Beetle sex	1	155.307	< 0.001
Trap color x Beetle sex	3	2.587	0.061
Seasonal test (May - August) 2010			
Trap color	3	6.011	0.001
Time	8	24.012	< 0.001
Beetle sex	1	52.558	< 0.001
Trap color x Time	23	1.211	0.244
Trap color x Beetle sex	3	2.163	0.095

In the case of diurnal tests, the most of *Ips typographus* beetles were captured by black traps, important captures were also recorded in brown traps which did not significantly differ from those obtained in the other variants, except the test performed in July when captures in brown traps differed significantly from those from white traps. The lowest captures were recorded in yellow and white traps, which were significantly lower than those collected from black traps (Figure 1).

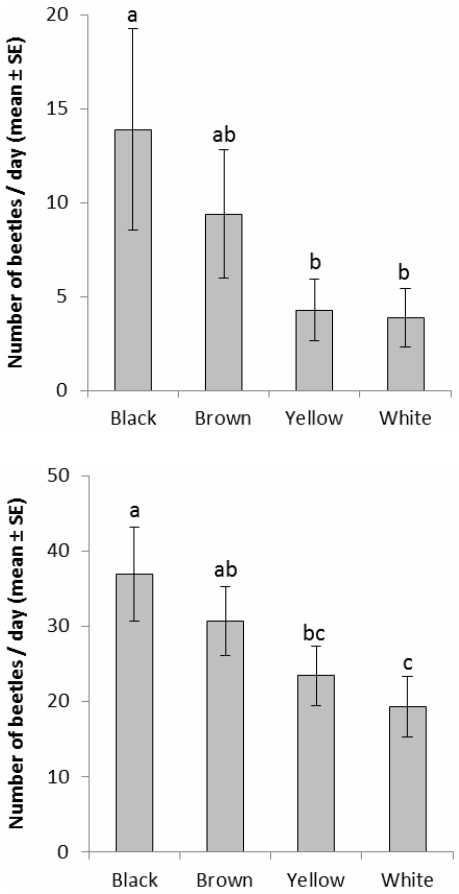

Fig. 1. *Mean number of Ips typographus beetles depending on trap color in May 2010 (up) and July 2010 (down) (Columns with the same letter show that the means are not significantly different from each other for P = 0.05)*

Analyzing the release rates of pheromones during the diurnal tests (Table 2) the highest rates of release were registered by the dispensers from black traps and the lowest rates by those from yellow and white traps. A direct correlation between catches and the release rates for the same tested variant can be also noticed, the captures being higher for higher release rates.

Table 2

Average release rates of dispensers depending on trap color

Analyzed period	Release rate of trap color: … (mean±SE) (mg/day)			
	Black	**Brown**	**Yellow**	**White**
14-17 May	18.65± 4.99[a]	14.67± 1.53[ab]	14.07± 3.95[b]	13.07± 3.85[b]
20-22 July	77.96± 9.62[a]	57.56± 9.90[ab]	47.82± 6.61[b]	45.22± 3.10[b]

Table 3

Average temperature at the level of trap depending on trap color

Analyzed period	Temperature records in the trap: … (mean±SE) (°C)			
	Black	**Brown**	**Yellow**	**White**
14-17 May	17.0± 0.7[ab]	17.8± 0.6[a]	16.1± 0.5[b]	16.4± 0.5[b]
20-22 July	25,4± 0.5[ab]	26,7± 0.7[a]	24,2± 0.4[b]	24,6± 0.6[b]

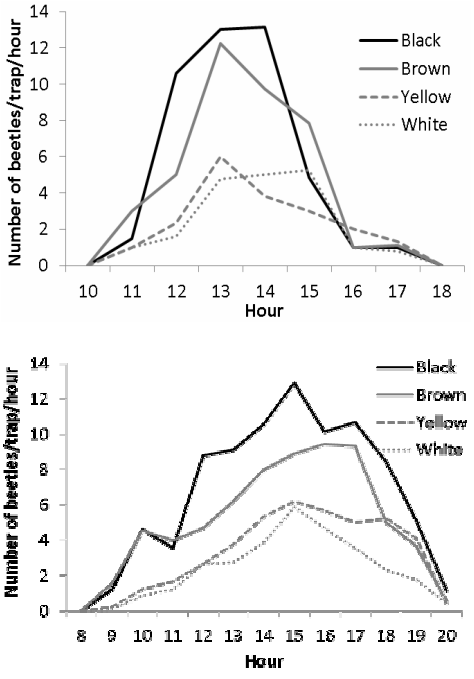

Fig. 2. *Diurnal flight depending on trap color between 14 and 16 May 2010 (up) and between 20 and 22 July 2010 (down)*

Also, the highest average temperatures during the diurnal tests were registered in brown and black traps whereas lower temperatures were recorded in yellow and white traps (Table 3).

During the diurnal tests the response of *Ips typographus* adults was mostly similar to the tested variants, regardless of time of the day (Figure 2). During the diurnal test performed in May the maximum catch was recorded around 13:00 and 14:00, while in July around 15:00.

Concerning the seasonal response of *Ips typographus* to colored trap variants we have found that brown traps captured significantly more insects than yellow and white traps (Figure 3). The black traps captured fewer insects compared to brown traps, but the differences were not statistically significant.

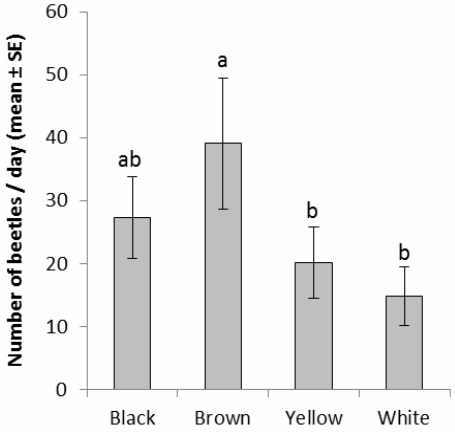

Fig. 3. *Mean number of Ips typographus beetles depending on trap color in seasonal test 2010*

4. Discussions

This research concerning the effect of trap color on the intensity of *Ips typographus* response confirms similar results obtained by other authors [5], [10], [14], [8], [12], [18], [19], according to which the dark colored traps capture more insects than the light colored traps. This is mainly due to the

higher release rates of pheromones achieved in Intercept® traps as a result of higher temperatures recorded in dark colored traps, because according to Schlyter et al. [16] the response of *Ips typographus* beetles to traps baited with synthetic pheromones increases linearly as the release rates of dispensers increase.

Regarding the proportion of males or females from the catches recorded in various colored traps, no significant differences were found, regardless of color, thus confirming the results of Chen et al. [8] for *Ips duplicatus.*

The significantly lower captures recorded in light colored traps (especially in the white traps) may be due to the avoidance of this color by beetles as in the case of the Dubbel et al. [10] research, which showed that the transparent traps captured the same amount of bark beetles as the black traps and significantly more beetles than the white traps. Therefore it seems that the response of bark beetles to the Intercept® traps baited with synthetic pheromones is conditioned both directly by their color and indirectly by the influence of the release rates of pheromones.

5. Conclusions

The dark colored Intercept® traps (black or brown) capture more *Ips typographus* beetles than the light colored traps (white or yellow).

The trap color does not influence the capture of insects predominantly of one sex.

The dark colored traps achieve higher average temperatures than light colored traps and as a result, higher release rates of pheromones.

The higher attractiveness of dark colored traps is largely due to the higher release rates of pheromones which is a consequence of the higher temperatures inside them.

Further researches are needed to determine precisely the visual role of trap color on bark beetles captures.

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