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THE JOINT INFLUENCE OF METEOROLOGICAL EVENTS FOR LIGHT-TRAP COLLECTING OF HARMFUL INSECTS

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Összefoglalás - Az Országos Meteorológiai Szolgálat 1967 és 1990 közötti "Időjárási események naptára" adataiból az instabilitási vonal, a konvergencia zóna, a ciklogenezis, az országos eső, a hideg- és a meleg frontok, a tengeri- és szárazföldi mérsékelt, sarkvidéki és szubtrópusi légtömegekkel összefüggésben vizsgáltuk meg a vetési bagolylepke (Scotia segetum Schiff.) repülési aktivitást tükröző fénycsapdás fogási eredményeit. A vizsgált időszakban 64 fénycsapda 3232 éjszaka során 29832 példányt gyűjtött. Mivel egy-egy éjszakán több fénycsapda is működött, 25021 megfigyelési adatot dolgozhattunk fel. Megfigyelési adaton 1 állomás 1 éjszakai fogási adatát értjük. Az időjárási eseményekre vonatkozó adatokat annak megfelelően csoportosítottuk, hogy egy-egy napon melyek fordultak elő önmagukban vagy együttesen. Külön csoportba rendeltük azokat a kombinációkat, amelyek időjárási esemény nélküli napot követtek é s azokat is, amelyeket valamilyen időjárási esemény előzött meg. A fogási adatokból állomásonként, nemzedékenként és naponként relatív fogás értékeket számítottunk. Ezeket hozzárendeltük az időjárási események napjaihoz, valamint az azt megelőző és követő 2-2 naphoz is. Ezután naponként összegeztük és átlagoltuk az értékeket. A naponkénti átlagértékek eltérésének szignifikancia szintjét valamennyi csoporton belül t-próbával ellenőriztük. 95%-nál magasabb szignifikáns eltérést összesen 36 csoportban találtunk. Az egyes események gyűjtésre gyakorolt kedvező vagy kedvezőtlen hatása akkor a legerősebb, ha nem egymagukban, hanem más eseménnyel egyidejűleg, esetleg rövid időn belül egymást követően lépnek fel. Eredményeink egyértelműen azt bizonyítják, hogy az egyes időjárási események fénycsapdás gyűjtést befolyásoló hatását nem elég önmagukban vizsgálni. A csapdázás eredményessége ugyanis az egyes időjárási események különböző kombinációitól függően módosul és csak ritkán egyezik meg az önmagában fellépő eseményhez kapcsolódó fogási eredménnyel.

Summary - The light-trap collecting results - showing its flight activity - of turnip moth (Scotia segetum Schiff.) were examined connected with the instability line, the convergence zone, the cyclogenesis, the country-wide rain, the cold- and warm weather fronts, the maritime- and continental moderate, arctic and subtropical air masses used the data published in "Calendar of weather phenomena" between 1967 and 1990 by National Meteorological Service. There were 29 832 moths caught during 3 232 nights by 64 light-trap stations in the examined period. During one night more light-traps operated, therefore 25 021 observing data were worked up. We mean by observing data the catching data at one night at one observing station. The data of meteorological events were collected into groups according to their occurrence on one day alone or together with other ones. They were collected into separated groups according to arriving after a day without any meteorological events or if there were any of them on the previous day. The values of relative catch (RC) were calculated daily for each observing stations and generations used the catching data. There was made a comparison between the relative catch (RC) values and the meteorological events belonging to the date and also on previous and following 2 - 2 days. After it the relative catch values were summarized and averaged daily. The differences of daily average values of significance levels were controlled by a t-test in all the groups. More than 95% significance levels were found in 36 groups. The favourable and unfavourable influence of each events are the strongest at that time, when they have influence not only alone, but also with other effects simultaneously, or they follow one another in a short time. Our results prove clearly, it is not enough to examine alone the modifying influence of each meteorological events for light-trap collecting. The success of light trapping is modified depending on several combinations of each meteorological events and they are not very often the same as the catching result of event to have an influence alone.

Key words: instability line, convergence zone, cyclogenesis, country-wide rain, weather fronts, air masses, insect, light trapping

INTRODUCTION

The insects' phenomenon of life exerting influence of meteorological events are examined generally with the atmospherical process taking to pieces for elements the authors of publications in literature. It is clear that the joint influence of meteorological events has more importance according to the living creature, but publications dealing with these researches are less known. The influences of air masses and weather fronts for light-trap collecting of insects were studied by *Wéber* (1957, 1959) among Hungarian researchers. *Kádár and Szentkirályi* (1991) showed, the number of light-trapped ground beetles (Coleoptera, Carabidae) are the less on the day of arriving convergence zone and on following day of arriving instability line. We could not find fundamental publications on this theme in the foreign literature. The modifying influence of collecting connected with 22 kinds of air masses and 20 kinds of weather fronts and discontinuity levels determined after Berkes (1961) - were examined in our publications (*Puskás et al.*, 1997; *Örményi et al.*, 1997). These papers will be published in the near future. The air masses, the weather fronts and the discontinuity levels were determined for surrounding of Budapest, and unfortunately they are not valid for the whole territory of Hungary (*Csizsinszky*, 1964). We spread our examinations for the joint influence of meteorological events (weather fronts, air masses, instability line, convergence zone, cyclogenesis and country - wide rain). These pieces of information are part of regular meteorological data and they are simultaneously valid for the whole country, or they pass the territory of Hungary at one night.

MATERIAL

The "Calendar of weather phenomena" - published monthly by National Meteorological Service - contains cold and warm weather fronts and 6 kinds of air masses: arctic continental (Ac), arctic maritime (Am), moderate continental (Mc), moderate maritime

(Mm), subtropical continental (Tc) and subtropical maritime (Tm) ones.

We mean on air masses the wide - spread mass of the air, although physical characteristics (mainly the temperature and degree of humidity) change horizontally continuously, but their changes are very small, and their vertical dispersions are almost the same.

The instability lines, the convergence zones, the point of time and length of time belonging to cyclogenesis and the country-wide rain are found in the above-mentioned "Calendar of weather phenomena".

The instability line (squall line) is a convective activity, which moves in a band or line. The short-term intense strengthening of wind speed is the characteristic of its passing and after it violent tempest and thunderstorm come. The convergence develops if two atmospheric motions come from two different directions in the atmosphere. Generally this process takes place along long line, the air accumulates here and one part of it rises up high. It comes often with weather fronts and cyclons. Cyclogenesis is the developing or strengthening of cyclonic circulation.

The catching results of turnip moth (Scotia segetum Schiff.) were analysed connected with these meteorological events. We used the data of light-trap network in Hungary used uniformly the Jermy type light-traps. The light source is a 100 W normal light bulb at 2 meters above the ground, colour temperature: 2900 K, the killing material is chloroform. The traps of the plant protection worked from 1st April to 31st October, while the forestry ones all the year round, independently of the time of sunrise and sunset, every night from 6 p.m. to 4 a.m. All time data are given in universal time (UT). The insects trapped during one night were stored in one bottle, so the whole catch of one night at one observational site is interpreted as one observational datum.

The collecting data of turnip moth (Scotia segetum Schiff.) were used for examinations getting from 64 observing stations of national agricultural and forestry network operated between 1967 and 1990. During 3 232 nights 29 832 individuals were caught by the traps. We used 25 021 observing data in our examination. We mean by observing data the catching data at one night at one observing station independently of caught moth number.

METHODS

The number of individuals trapped at different observation sites and times cannot be compared to each other even in the case of identical species, as each trap works in different environment factors constantly vary according to time as well. To solve the problem, from the catch data we calculated relative catch (RC) values for observation sites, species and generations. RC is the quotient of the number of individuals caught during the sampling interval (1 night), and the mean values of the number of individuals of one generation counted for the sample interval. In this way, in the case of expected mean number of individuals, the value of relative catch is 1.

The data of meteorological events were collected into groups according to their occurrence on one day alone or together with other ones. They were collected into separated groups according to arriving after a day without any meteorological events or if there were any of them on the previous day. We made a comparison between the relative catch - calculated from the collecting results - and the meteorological events, and also the previous and following 2 - 2 days. Then it the relative catch values were summarized and averaged daily. The differences of daily average values of significance levels were controlled by t-test in all the groups.

RESULTS

The light trapping success of turnip moth (Scotia segetum Schiff.) connected with meteorological events is shown in *Table 1*. The significance level was more than 95% in relative catch values in 36 groups.

If the significant difference of value of relative catch is more than 95% level on two following days it is shown with italic numbers. If the value of relative catch differs more than 95% significance level from the relative catch average of summarized all the other data it is shown with bold numbers. The number of observing data are given in parentheses. No meteorological events are in the table, when there are less than 20 observing data, and probably this is the reason they do not show significant differences neither with the previous day's catching nor the average of summarized all the other data.

CONCLUSIONS

The instability line decreases alone the number of caught specimen only at that case, when it repeats during some days. If cold weather front comes after it still the same day, the unfavourable influence can be shown yet the same day. If it comes with other meteorological events the influence is unfavourable or ineffective for catching result. On the following day the quantity of collecting increases only, if subtropical air mass also arrives. The convergence zone is ineffective alone, but if it comes together with cyclogenesis the number of collected moths decreases on the previous day. There is an unfavourable influence if it comes with moderate maritime air mass from the previous day till following day. The collecting results are low on previous day if cyclogenesis can be found alone. On the day of arriving it is also low when it comes with any other meteorological events. If it comes with country - wide rain the catching is low even on the following day. It is remarkable that the country - wide rain alone is favourable before and after the event for success of catching, but if it comes with any other meteorological events the catching is unfavourable for it. The cold weather front arrived alone is favourable on previous days for collecting, but it is unfavourable on the day of arrival and following one. It is also unfavourable if it arrived together with moderate air mass, and collecting is increased by the coming with arctic air mass, but it is decreased on next day. The warm weather front arrived with subtropical air mass is favourable for catching already on previous day and day of arriving, but it is unfavourable if warm front comes with moderate maritime air mass. The number of caught moths is low on day of arriving and following one at coming of moderate maritime air mass and it is independent of combination with any other meteorological events. The catching is not very high - except if it comes with other meteorological event - on previous day of arriving the moderate continental air mass, but it is high on following days. If the instability line on previous day is followed by moderate continental air mass with cold front on day of arriving, the catching of previous night is high, but it is low on following one. If the instability line on previous day is followed by moderate maritime air mass with cold front on day of arriving, the low collecting can be observed on that day will change for high on following one. The subtropical maritime air masses - arrived alone, with instability line and cold front - are unfavourable, but they are favourable on previous and following days. If these kinds of air masses come with convergence zone and cyclogenesis the collecting is small on previous night. The subtropical maritime air masses - arrived with warm weather front - are favourable for success of collecting on previous day and also on day of arriving. The number of caught moths shows decrease on arriving day of subtropical continental air mass and it is the same on next day. The number of collected moths is lower on arriving and following days of subtropical continental air masses. The catching is high on previous and arriving days belonging to the arctic air mass coming with cold weather front, but there is a decrease on following day.

Our results prove clearly, it is not enough to examine alone the modifying influence of each meteorological events for light-trap collecting. The success of light trapping is modified by several combinations of each meteorological events and they are not very often the same as the catching result of event to have an influence alone. At the time of practical utilization of our results everyone has to pay attention to our hypothesis - expressed in one of our former publications (*Nowinszky* ed., 1994) - as the low values of relative catch mean those weather situations in all cases, when the flight activity of insects decreased, but the meaning of high values are not so equivalent. The significant environmental changes cause physiological changes in the organism of insects. The life of imago is short, unfavourable weather endangers not only the continuance of individual but also the continuance of the total species. According to our supposition the individuals can use two kinds of strategies to prevent the hindering influences of normal function in phenomenon of life. The first is the increased activity. It means the growing intensity in flying, copulation and oviposition. The second strategy is to hide and ride out in passivity the unfavourable situation. Seeing the above-mentioned facts, according to our present knowledge high light trapping results can belong to both favourable and unfavourable situations.

The results of these agrometeorological examinations can give chance to make better plant protection prognosis.

Table 1 Relative catches of turnip moth (Scotia segetum Schiff.) connected with meteorological events used the data of light-trap network in Hungary operated between 1967 and 1990. The explanation of abbreviations is in the text

Name of event						Values of relative catches at the days around events					
Number	Previous days	On the day event				-2	-1	0	→0	1	2
1.	∅	Inst.				1.17 (232)	1.01 (254)	*1.17* (317)	***0.55*** (39)	*0.95* (143)	1.01 (110)
2.	∅	Conv.				1.04 (236)	0.98 (297)	1.05 (391)	1.06 (457)	1.16 (284)	1.02 (189)
3.	∅	C				*1.00* (142)	***0.86*** (166)	*0.99* (395)	***0.86*** (222)	0.93 (367)	0.93 (264)
4.	∅	CF				***1.29*** (81)	***1.36*** (81)	0.89 (279)	***0.56*** (53)	*1.07* (243)	1.09 (180)
5.	∅	CR				**1.76** (52)	***1.78*** (72)	***1.22*** (76)	1.04 (28)	*1.13* (58)	***1.47*** (56)
6.	∅	Mc				*1.05* (91)	***0.66*** (90)	***1.34*** (90)		**1.32** (47)	**1.51** (44)
7.	∅	Mm				0.61 (20)	0.50 (16)	**0.64** (96)		***1.31*** (82)	***0.76*** (71)
8.	∅	Sc				***0.64*** (79)	*1.03* (87)	*0.95* (108)		***0.50*** (39)	***0.56*** (31)
9.	∅	Sm				**1.54** (55)	***1.36*** (68)	*0.97* (99)	***0.80*** (59)	***1.24*** (47)	**1.32** (47)
10.	∅	Inst.				1.11 (148)	1.02 (155)	0.97 (155)		0.96 (43)	0.87 (34)
11.	∅	Inst.	Mm			*1.05* (74)	***1.22*** (79)	***0.94*** (96)	1.10 (28)	1.17 (17)	1.42 (16)
12.	∅	Inst.	CF	Sm		1.11 (148)	***1.53*** (25)	***0.86*** (27)		***1.57*** (30)	***1.35*** (27)
13.	∅	Inst.	CF	Mm		1.02 (209)	1.03 (368)	**0.96** (304)		***0.92*** (306)	***1.14*** (252)

Table 1 continued

Name of event						Values of relative catches at the days around events					
Number	Previous days	On the day event				-2	-1	0	→0	1	2
14.	∅	Inst.	CF	Sm	Am	*1.12* (29)	*0.77* (29)	*0.97* (28)		***1.78*** (29)	*1.24* (27)
15.	∅	Inst.	CF	Mm	Sm	***1.23*** (22)	***1.51*** (51)	*1.03* (50)		***0.74*** (36)	*1.19* (34)
16.	∅	Inst.	CF	Mm	CR	*1.06* (30)	***0.78*** (32)	***0.73*** (35)		***0.59*** (34)	*1.07* (35)
17.	∅	Conv.	C	Sm		***1.43*** (25)	***0.85*** (28)	*1.04* (21)			
18.	∅	Conv.	C	Sm	CR	***1.20*** (22)	***0.81*** (22)	*0.94* (21)			
19.	∅	Conv.	Mm			***1.46*** (35)	***0.82*** (38)	***0.72*** (52)		***0.44*** (29)	***0.93*** (27)
20.	∅	C	CR			*1.05* (94)	***0.93*** (134)	**0.64** (202)	0.98 (75)	*1.01* (180)	***1.35*** (94)
21.	∅	C	Mm			1.07 (62)	*1.04* (69)	***0.79*** (95)	1.03 (14)	*1.03* (103)	1.06 (90)
22.	∅	C	Mm	CR		***1.25*** (49)	***0.66*** (71)	**0.62** (104)		***0.80*** (60)	0.96 (57)
23.	∅	C	Am	CR			1.06 (25)	**0.90** (42)		***0.87*** (38)	***1.49*** (41)
24.	∅	CF	Mc			***0.75*** (218)	*1.05* (245)	*1.09* (318)		*0.97* (266)	***0.76*** (199)
25.	∅	CF	Mm			1.02 (993)	*1.03* (1201)	***0.92*** (1630)	**0.88** (156)	**0.94** (1463)	**0.94** (1392)
26.	∅	CF	Mm	CR		1.02 (34)	*1.07* (56)	**0.75** (72)	**0.71** (21)	**0.83** (73)	**0.66** (58)

Table 1 continued

Name of event						Values of relative catches at the days around events					
Number	Previous days	On the day event				-2	-1	0	→0	1	2
27.	∅	CF	Ac			*0.98* (45)	***1.21*** (59)	***1.16*** (73)		***0.46*** (63)	*0.99* (36)
28.	∅	CF	Am			0.94 (156)	*1.01* (208)	***1.22*** (228)		***0.92*** (203)	0.98 (173)
29.	∅	CF	Am	CR			*0.97* (46)	***0.70*** (48)		***0.90*** (23)	
30.	∅	WF	Sm			**1.38** (50)	**1.54** (60)	**1.66** (73)		1.18 (16)	
31.	∅	WF	Mm			0.96 (33)	***0.81*** (50)	***0.48*** (68)		*0.96* (39)	***1.35*** (30)
32.	∅	WF	Mc			0.91 (22)	***0.42*** (45)	***1.27*** (45)			
33.	Inst.	CF	Mc			1.11 (58)	**1.15** (60)	***1.12*** (62)		***0.95*** (60)	0.97 (33)
34.	Inst.	CF	Mm			0.99 (54)	*1.00* (69)	***0.42*** (68)		*1.00* (51)	**1.30** (46)
35.	Inst.	CF	Mm	CR		*1.11* (44)	***0.83*** (39)	***0.53*** (36)		*1.19* (25)	
36.	Conv.	CF	Mm			0.92 (45)	*1.02* (49)	***1.48*** (54)		*1.08* (33)	1.05 (20)

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