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THE TOURISM IMPORTANCE IN THE SURROUNDING OF THE HÉVÍZ-BALATON AIRPORT REGION

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Abstract

Tourism and aviation is connected by numerous factors, out of which weather and climate plays a very important role. These factors determine together the activities the tourists can make and the accessible services as well, such as aviation. The effects of climate change are advantageous concerning tourism in the Hévíz and Keszthely districts, which was always famous for its distinguished and unique microclimate. From an economic point of view the Western Transdanubian Region is the second most developed region in Hungary where in the life of the region the spas have a very important role. Due to the raising of tourist interest in the area, it is of primary importance to operate a regional airport as well.

Key-words: tourism, aviation, climate change, regional meteorological observations

Összefoglalás

Hagyományos értelemben egy kistérség turisztikai potenciálját a gazdaságtudományban szokás vizsgálni. Napjainkban egyre elterjedtebbé válik azonban az igény, hogy e gy kérdéskört, több szakterületet közösen érintő megközelítéssel elemezzünk. Írásunkban arra vállalkoztunk, hogy a Hévíz-Balaton Airport repülőtérről készítsünk egy tanulmányt, melyben figyelmet szentelünk a természetes környezetnek, ezen belül a meteorológiának és a geográfiának, konkrétan kitérve a közlekedésföldrajzra, valamint a turizmusra egyaránt.

A turizmust és a repülést sok tényező kapcsolja össze, ezek közül az időjárás és a klíma nagyon fontos szerepet tölt be. Ezek a tényezők együttesen határozzák meg a turisták által végezhető tevékenységeket és az elérhető szolgáltatásokat, így a repülést is. A klímaváltozás hatása talán véleményünk szerint kedvező a turizmusra nézve a hévízi- és keszthelyi térségekben, amely mindig is híres volt kiváló és különleges mikroklímájáról.

Az éghajlatváltozás különböző szcenárióiban leggyakrabban a léghőmérséklet és csapadék várható változásai szerepelnek, mely mutatók a Kárpát-medencére nem túl optimista előrejelzéseket tartalmaznak. A melegedés szárazodással társul, mely ugyan a nemzetgazdaság több területén negatív következményekkel jár

(mezőgazdaság), viszont van kivétel is, a turizmus, aminek estében a felvázolt változások akár kedvező módosulásként is felfoghatók.

A változásokból valószínűsíthető, hogy a térségbe látogató vendégek a jövőben kicsit korábbi, tavaszi időpontban is kellemesebb időjárási körülmények közé érkezhetnek, valamint az ősszel emiatt tovább itt tartózkodhatnak. Ezzel tovább növelhető a lehetséges vendégéjszakák- és vendégek száma, valamint a repülési időszakok kitolása is. A több fogadható repülőjárat a térség gazdaságát erősítő nagyobb forgalmat generálhat. A Hévíz-Balaton Airportnak komolyabb szerep juthat a jövőben a régió fejlesztésében.

Véleményünk szerint a turizmus, a közlekedés és a meteorológia közötti összetett kapcsolat összefüggéseinek vizsgálata fontos terület. Különösen a turisztikai célú tervezéseknél – lévén a klímamódosulás szélsőségeket hoz időjárásunkban– mindinkább szükséges ezeknek tudományterületek vizsgálati eredményeire figyelmet fordítani.

Introduction

From a traditional point of view the tourism potential of a micro region is analysed from the point of view of economic sciences. However in our days the necessity becomes more and more widespread to analyse a research area with an approach from numerous disciplines. In our study we aimed to prepare a paper about the Hévíz-Balaton Airport in which we focus on the physical environment, within this meteorology and geography, specifically dealing with issues of geography of transport and tourism as well.

On the whole, the climate of Hungary is warming up, becomes more dry and the annual number of sunshine hours is increasing. Winters become warmer and a bit rainier than at present. We also have to consider a warming process in the summertime period while at the same time the precipitation will decrease. In the last third of the 20th century the strengthening of the daily precipitation intensity was noticeable as well (ANDA – KOCSIS, 2010).

Climate change as a phenomenon is more or less known by anybody. However, only a few people focus on its details and on the fact that when the weather conditions change in an area they will affect the local population and the local economic activities as well.

Material and Methods

During the analysis of the Hévíz-Balaton Airport we used personal interviews with the manager of the airport and ordered also other published secondary statistics and data as well. The air passenger traffic statistics were analysed by Microsoft Office Excel 2007.

Measurement location of the sunshine duration data were collected at the Agrometeorological Research Station of Keszthely (46°45 'N, 17°14' E, 102 m above sea level). We got the data set from the University of Pannonia, Georgikon Faculty, Department of Meteorology and Water Management Department. The measurements

were made by a Campbell-Stokes sunshine recorder. Available data was collected by simple descriptive statistical characteristics and time series analysis technique, and was characterized by a linear trend calculation with Microsoft Office Excel 2007. We received the data from the measurements of the Keszthely Observatory, recorded with the same instrument, measured at the same measurement location. Therefore, the data set inhomogeneity is negligible.

Discussion

Tourism and aviation in the examined region

The medical tourism industry is relatively a new part of health tourism and is one of the fastest growing industries of tourism globally (YEAH ET AL, 2013.). Medical baths and settlements providing medical holidays always played a highlighted role in the tourism sector of the Western Transdanubian Region. Besides the most important spas of the region, Bükfürdő, Sárvár, Kehidakustány, Zalakaros, (without listing all of the spas) Hévíz realises the decisive majority – 1050000 nights in 2011 (BENKŐ, 2012) – of such tourism income.

Besides serving and attending the guests suffering from musculoskeletal problems, which mainly affects the elderly population, the different forms of hospitality units take care of the visitors and patients all year long well prepared.

Taking into consideration the accessibility of the region, terrestrial transport – first rate and second rate main roads and the M7 highway – possesses a primary role nevertheless in the future the fastest and comfortable mode of transportation, aviation could achieve an accentuated role as well. Regional airports which mean a new quality for the region in terms of accessibility (ERDŐSI, 2000) function as a business venture. It is widely known that the profit coming from the functioning of the regional airports is realised only years after. Besides the potential state support, the financial contribution of the local enterprises, tourism accommodations and local governments is needed as well, without which the functioning of the regional airports has no real chance.

Out of the five regional airports of Hungary two is functioning in the Western Transdanubian Region, out of which the turnover of the Győr-Pér Airport primarily serves commerce and business tourism. In this paper we are not dealing with the issues of this airport.

The *Hévíz-Balaton Airport* – earlier known as Fly-Balaton Airport – operates in Zala county, between the settlements of Sármellék and Zalavár. The airport was built in 1953. The airport which was owned by Hungarians and later by the Soviets serves civilian aviation since 1991. The width of the 2500 m long, excellent quality basalt-concrete airstrip is 60 m, which is excellent for the manoeuvers of airplanes with 150-200 passengers. Between 1995-2005 there was only a slow development during the operation of the airport (*Figure 1*). Its primary reason was first of all due to the fact that lacking run lighting and modern air navigation devices flying was

only possible in daylight and at well visibility circumstances (PINTÉR, 2009). In addition the investors were lacking as well who could make adequate profit from the operation of the airport (ZÓKA, 2006). After the turn of the Millennium the proprietary were settled in the airport and a real great scale development was experienced in 2004, when the place was took in the hand by the Irish-Hungarian Corporation, the Cape Clear Aviation (ZÓKA, 2006).

The new operator immediately started the necessary development constructions. A new, modern terminal, parking lot and hospitality services were built complemented with a travel bureau, ATM and transfer services. Besides the already functioning airlines taking flights to Sármellék new one appeared, the Ryanair low cost airline. Out of the new flights the number of passengers from Sármellék to London-Stansted and Frankfurt-Hahn was outstanding. From the point of view of passenger flow besides the mentioned destinations the relations with Düsseldorf, Berlin, Hamburg, Cologne, Zürich and Amsterdam should be mentioned, resulting in the significant traffic growth between 2006 and 2008 in the region (*Figure 1*).

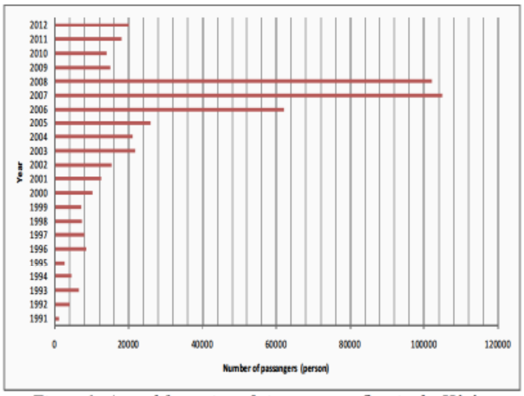

Figure 1: Annual formation of air passenger flow in the Hévíz-Balaton (Sármellék) Airport

To be able to cover the high costs – mainly the costs of air management and the passenger safety system – of functioning, the operator of the airport entered into marketing contracts in 2007 and in 2008 with the most significant commercial accommodations, so hotels of Hévíz, Keszthely, Zalakaros, Kehidakustány and Tapolca, of the tourism region. It is interesting that in these years only Lufthansa took 3000 German guests annually who arrived with holiday and medical treatment purposes to Hévíz and spent 50000 nights in the settlement (LUKÁCS, 2009). The majority of the tourists coming to medical treatment are from the elderly population today as well, they are the ones more willing to take the long trip by the faster and more

comfortable airplane than by the much more time-consuming coach, or perhaps due to transfer accommodation besides the increased costs they would arrive really tired to the destination.

However the realisation of the attractive future plans – entertaining centre, hotel, establishment of a CARGO base and the construction of the Balatonring, a MOTO GP race course near Sávoly – was cancelled. Regrettably the economic crisis took its effects as well, the discount airline operating the low cost flights left Hungary by 2008 and in the winter period the airport had to be closed as well. Since then to be able to operate the airport a significant financial cooperation of the region's tourism generating settlements, primarily Hévíz and Zalakaros, was needed. As a consequence of this by 2009 the turnover of the airport dropped back to one tenth of its earlier data, which is equivalent to the statistics collected in 2000 (BENKŐ, 2012).

Since that time the airport was functioning only with seasonally operating charter flights primarily taking the passengers to the earlier mentioned medical spas. The demand for the flights is well demonstrated by which region the airport was receiving passengers from. In 2011 passengers came on a weekly and biweekly basis primarily from German cities – Berlin, Hamburg, Düsseldorf, Frankfurt am Main, Leipzig, Dresden, Erfurt – and in the summertime period regularly from Moscow. Thanks to the spa town of Hévíz – which city senses perspectives in the economical operation of the airport in the future – in April, 2012 the airport was opened again under a new name, Hévíz-Balaton Airport. The weekly based connection with the mentioned German cities remained in 2012 and the schedule can be broadened with a new destination, Riga.

The Mutsch Ungarn Reisen travel agency has a primarily role in attracting mainly the representatives of the elderly population to the region basically from German cities with a purpose of medical treatment and holidays (www.mutsch-reisen.de, www.mein-weg-nach-ungarn.de, www.hevizairport.com). The research and work of FEKETE (2008) proves that the majority of the turnover of the airport expels such foreign inbound tourists who spend their free time in the agglomeration of the airport. Out of them approximately 75% spend their time in Hévíz. Taking into consideration the tourism based spending in relation the German guest generate less and the eastern, decisively Russian guests generate more income to the tourism industry of the region.

As long as we take into consideration the 100 km or even greater attraction zone of the Hévíz-Balaton airport in the latter period we can see the following number of nights (Table1).

Settlement	Number of guest nights (2011)
Hévíz	1.050.000
Bükfürdő	665.000
Balatonfüred	458.000
Siófok	453.000
Zalakaros	413.000
Sárvár	387.000

Table 1: Number of guest nights in the most important tourism settlements in the catchment area of the airport (BENKŐ, 2012)

A great proportion of the tourism of these settlements is guests coming from Germany with medical purposes staying an average of 10 days in the region (BENKŐ, 2012). The foreign guest flow of the airport's surrounding areas further increases in the summer period since the primarily German tourists coming to Lake Balaton seasonally generate further more significant turnover. In this respect aviation could be a favourable choice for them as well. Taking into consideration only the two most important holiday resorts in 2011 they generated 453000 nights in Siófok and 458000 nights in Balatonfüred. If we take into consideration the nights realised in the area and the region of Lake Balaton out of the passengers of the German charter flights we can observe an increasing proportion – in 2009: 68000, 2010: 81400, 2011: 96000 persons (BENKŐ, 2012) – in the latter years. Examining the nights realised in the area of Lake Balaton we can see on the top Germany in 2011, although compared with 2010 we can experience a decrease of 13% (BENKŐ, 2012).

Summarizing the tourism importance of Lake Balaton and the medical spa towns of Western Hungary we get a turnover exceeding the annual guest flow of Budapest, a significant part of which aviation is a necessity (BENKŐ, 2012). For the mentioned elderly age group the accessibility of the medical holiday resort is of vital importance within 1-2 hours otherwise they will visit other, more easily accessible regions, and spend their holidays strengthening the economy with their spending there.

Despite the obvious dependence of many forms of tourism on favorable weather conditions, the potential impacts of climate change remain underdiscussed in both research and policy settings (NICHOLLS, 2004). All tourism destinations and operators are climate-sensitive to a degree and climate is a key influence on travel planning and the travel experience (SCOTT-LEMIEUX, 2010).

The positive impact of climate change on tourism in Keszthely region, in the sunlight duration increases

One of the most important application areas of meteorology is aviation meteorology since the safety of flying is strongly influenced by the punctuality of the observations and forecasts (CAESAR, 2007). In Sármellék the Hungarian Meteorological Service maintains an Aviation Meteorology office. Here measured and observed data are monitored as well. The observations are recorded in every 10 minutes, its parameters are: temperature; dew point, blow, wind direction, wind velocity, direction and velocity of mean wind, air pressure. In the airport regular observations are made in every 30 minutes. The published observations are forwarded in METAR (Meteorological Actual Report) telegrams to the centre. Apart from this forecasts are prepared in altering regularity which are called TAF (Terminal Aerodrome Forecast) telegrams. The telegrams are coded which is carried out under the regulations of Annex 3 of the ICAO (International Civil Aviation Organization) (WANTUCH-POTOR, 2012).

Most frequently we find the changes of air temperature and precipitation in the different scenarios of climate change, which indicators do not contain optimist forecasts to the Carpathian Basin.

(MIKA 2001, 2002) Warming is associated with drying which has negative impacts in many areas of economy (agriculture), but there are some exceptions as well, such as tourism, in which case the mentioned changes might be conceived as a positive change Based on the simple climate statistical analysis of long-term air temperature data of Keszthely (*Figure 2*) from 1968 to present, the annual mean temperature showed an increasing trend significant at 5% probability level. The annual increment was 0.018°C, which means a 1.8°C increase concerning the mean air temperature on a 100 year scale.

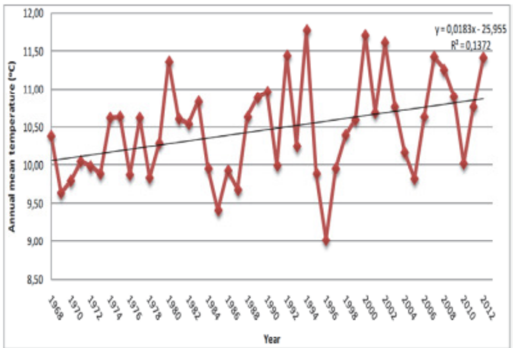

Figure 2: Annual mean temperature average in Keszthely (°C)

The long-term average air temperature for Keszthely was 10.44°C (from 1871 until our days, data excluded). When besides constant environmental conditions, this direction of temperature change will produce 11.11°C to 2050. Analysing the precipitation data series at the same time, the annual precipitation sums show a decreasing tendency from 1968 to present (*Figure 3*). The measure of this reduction is 2.19 mm/year, performing the significance analysis with F test, it turns out that the data are not correlating with each other, so the change should be considered as a tendency. In the studied period the mean annual precipitation sum was 638 mm and if we escalated this forecasted decreasing tendency to the future, than the expected mean annual precipitation will decrease to 556 mm by 2050. This shows a nearly 84 m m precipitation decrease compared to present day precipitation level.

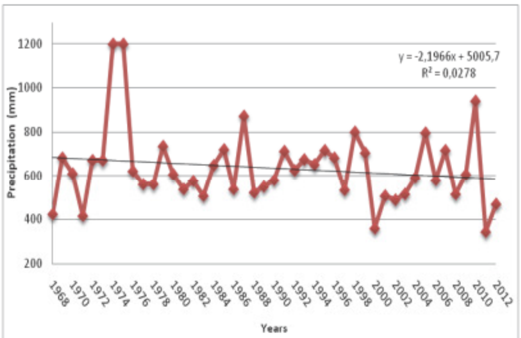

Figure 3: Annual mean precipitation amounts (mm) in Keszthely from 1968 to present

Probably the warmer and dryer summer characteristic to the Mediterranean areas, which also appeared in our region's projected scenario by 2050, c ould definitely create more favourable circumstances for the tourists visiting our lakes. The data of the sunshine hours modulating the holiday experience are analysed more rarely, however its potential change could not only influence the holiday conditions for the visitors but aviation as well. In the Meteorological Station of Keszthely, sunshine hour observations were carried out for more than 30 ye ars (until 2000). This database is appropriate to extend the possible changes of the recent past to the near future as well. It is important to notice that the measurements of the station are resolved at 2000.

Based on the monitoring of the latter years concentrating on our analysed region (KOCSIS ET AL. 2012) the received data determined the amount of seasonal change in Keszthely. They demonstrated a growth of 3.98 hours in winter, 0.93 hours in spring and 2.68 hours in summer, besides which they did not receive significant linear change for the autumn period. The linear trend analysis of the amounts of annual sunshine duration showed an increase of 7.35 hours/year increase per year. Between 1968 and 1999 the mean annual sunshine hour was 2043. When we extend the results of the trend analysis to the future, the duration of sunshine hours will be around 2400 hours/year by 2050, which is 357 hours more than the average of the analysed 30 years period. As we mentioned earlier it is important to note that the sunshine duration measurements ceased in 2000 in Keszthely. Current data are not available, but the quality and length of the data set was appropriate to calculate estimates of the future. It would be interesting to update the sunshine duration, but this is only a feasible option for some calculation.

Based on model simulations, the Carpathian Basin belongs to the zone of the most climate sensible regions (BARTHOLY ET AL. 2010). When researching the effects of climate change in Hungary it is an essential aspect that the Carpathian Basin is allocated on the fringe upon the humid oceanic, the dry continental and the mediterranean climate which is dry in summer and humid in winter. In this border zone even a smaller dislocation of the climate zones could lead our country under the complete influence of one of the three climatic impacts (ANDA – KOCSIS, 2010).

Summary

Tourism and aviation is connected by numerous factors, out of which weather and climate plays a very important role. These factors determine together the activities the tourists can make and the accessible services as well, such as aviation. The effects of climate change can be advantageous concerning tourism in the examined area, which was always famous for its distinguished and unique micro climate. Due to the raising of tourist interest in the area, it is important to operate a regional airport in the region as well. The changes would make likely that the guests visiting the region can arrive in the future in an earlier spring period to more favourable weather conditions, and in autumn they can stay further due to the same reasons. With this the possible number of nights and guests can be increased and the periods of the aviation as well, decreasing seasonality in the researched area. The more received air flights could generate a greater turnover of the region strengthening its economy. The Hévíz-Balaton Airport could fulfil a more serious role in the future concerning regional development as well.

In our estimate we managed to find a relationship between tourism, transport and meteorology. In the tourism purposed developments – since we are living in the era of climate change – it is increasingly necessary to attend to the results of these disciplines.

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HEAVY METAL POISONED WILD BIRDS AT HORTOBÁGYI MADÁRPARK BETWEEN 2004-2011

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Abstract

Between February 2004 and November 2011, 37 birds with a suspicion of poisoning were transported to Hortobágyi Madárpark. Based on the clinical signs heavy metal poisonings, particularly lead and mercury, were suspected in 20 cases. Generally, the diagnosis of heavy metal poisoning is relatively difficult in the lack of exact source of the toxicosis. Besides, other agents can cause more or less similar symptoms. Among the poisoned birds Common Buzzard (*Buteo buteo*) was the most frequently affected species (12 out of the 20 poisoned birds). All investigated birds are protected in Hungary. Ten out of the 20 poisoned birds were healed. 7 of them were released in the nature, other 3 were placed in an aviary. Unfortunately, 8 birds were died and there was no information about the fate of 2 others. The clinical signs observed in the Hortobágyi Madárpark were coincided with those in the scientific literature. Based on our results, the lead and the mercury were the most frequent causative agents among the heavy metals and the Common Buzzard felt victim to metal poisonings in relatively high proportion (60%) at this area.

Keywords: heavy metal poisoning, wild birds, lead, mercury, Hortobágy

Összefoglalás

A Hortobágyi Madárparkba 2004. február és 2011. november között 37 madarat szállítottak be mérgezési gyanúval. A tünetek alapján 20 esetben merült fel valamilyen nehézfém-mérgezés, elsősorban ólom és higany. A nehézfém-mérgezések felismerése a mérgezési forrás hiányában általában nehéz feladat, mivel más anyagok hatására is kialakulhatnak hasonló tünetek. Az összegyűjtött 20 mérgezett madárból 10 gyógyult - ebből 7 állatot visszaengedtek a természetbe, 3 valamelyik röpdébe került -, 8 elpusztult és 2-ről nem volt információ. A leggyakrabban mérgezéssel beszállított faj a Magyarországon védett egerészölyv (*Buteo buteo*) volt, 12 egyedet érintett. A Madárkórházba szállított eseteknél megfigyelt tünetek és a szakirodalomban leírtak egybe estek. Ezen eredmények alapján a leggyakoribb mérgezést okozó nehézfém az ólom és a higany volt, és

relative nagy számban (az esetek 60%-ában) az egerészölyv esett áldozatul ezen a területen.

Kulcsszavak: nehézfém mérgezések, vadmadarak, ólom, higany, Hortobágy

Introduction

In the last century, mercury and other heavy metal containing substances were used extensively. Wild animals have been poisoned due to the consumption of seed grain treated with mercurial antifungal compound and others until 1970's when the adverse health effects of them have been recognized and their use was banned (ATSDR 1999). Large proportion of heavy metals has been used for hundreds of years but the harmful effects of them have been revealed still after a long period of time. During this period the environment was contaminated due to the industrial and agricultural use (crop protection, fertilizers, steel manufacturing, mining, and dyes additives etc.) (Cabrera et al. 1984; Csathó 1994; Hahn et al. 1993; Pál, 1999; Rubin et al. 2010).

Thus recently, the environmental aspects of heavy metal pollution have come into the limelight. Birds may ingest toxic or sub-toxic amounts of them if they drink polluted water or ingest contaminated plants or other feed due to the previous anthropogenic activities. The majority of heavy metals can accumulate in the organism after ingestion and can show biomagnification in the food-chain which raises lots of risk. It can be observed that the pollutants can enter the food chain in the aquatic environment due to their property of bioaccumulation, which also has an effect on people (Burger and Gochfeld, 2001). The bioaccumulative properties of the heavy metals have been defined by the way of life of the birds and by the fact that the pollutants can be metabolized in a low potency (Fossi et al. 1995; Walker, 1990). Once heavy metals get into the body of birds, they can be eliminated by different routes or can accumulate in their tissues. The metals can be excreted via urine or faeces, sequestered into feathers (Boncompagni et al. 2003; Burger & Gochfeld 1993, 2001; Furness et al. 1986, 1990; Henny et al. 2002; Muralidharan et al 2004; Ortego et al. 2006) or eliminated into eggs (Cifuentes et al. 2003; Goodale et al. 2008; Goutner et al. 2001; Heinz et al. 2009; Maedgen et al. 1982; Mason et al. 1997). The aquatic birds accumulate relatively high concentrations of metals (e.g. mercury) in liver, kidney and other organs and tissues (Burger & Gochfeld 2000; Honda et al. 1990; Jayakumar 1999; Lehel et al. 2013; Lock et al. 1992; Muralidharan 1995; Thompson & Furness 1989). Certainly, the metal burden of the body i s not only determined by the diet, other parameters, such as age, gender, date of collection and the geographical location influence it as well (Kim et al., 1998).

Different bird species as cormorants (*Phalacrocorax* spp.), mallards (*Anas* spp.), gulls (*Larus* spp.), terns (*Sterna* spp.), shearwaters (*Puffinus* spp.) grebes (*Podiceps* spp.) are frequently used as bioindicators to monitor heavy metal concentration in the environment (Bearhop et al., 2000; Braune, 2007; Monteiro and Furness, 1995; Thompson et al., 1990, 1998).

Based on the survey of the Hungarian Ornithological and Nature Conservation Society 977 protected and highly protected birds have been poisoned between 1998 and 2010 in Hungary. In this period 45 Eastern Imperial Eagles *(Aquila heliaca)*, 65 White-tailed Eagles *(Haliaeetus albicilla)*, 12 Saker Falcons *(Falco cherrug)* and 271 Common Buzzards have been found (http1).
The aim of our study was to investigate the frequency of heavy metal poisonings based on ve terinary medicinal diagnosis in wild birds transported to Hortobágyi Madárpark from several regions of the country, mostly from the Great Hungarian Plaine.

Materials and methods

Heavy metal poisonings of wild birds were evaluated by restrospective analysis during the study. The poisoning cases were collected in Hortobágyi Madárpark between 2004 and 2011. The birds were investigated individually by veterinarians at the transport to the Madárpark and they were treated based on the clinical signs. The survey was based on the information found in the case-sheet including species, time and location, birds' age, sex, observed symptoms, cause of the heavy metal poisoning, treatment and the subsequent fate of the birds. The detailed data are presented in Table 1.

Table 1

Detailed information about the heavy metal poisoning of different bird species from the case-sheet (listed according to sampling date)

Species	Date	Location	Status, condition	Clinical signs
Common Buzzard	25. 02. 2004	Near Hortobágy-Szásztelek, in a forest	Unable to move	Incoordination, visual disturbance
Common Buzzard	18. 03. 2004	Szarvas, at main road	Unable to move	Incoordination
Common Buzzard	26. 06. 2005	Near Vámospércs, in a vineyard	Unable to move, bad condition	Incoordination
Eurasian Collared Dove	29. 09. 2005	Debrecen	Ataxia, good condition	Incoordination
Barn Owl	29. 11. 2005	Berettyóújfalu	Unable to move, good condition	Incoordination
White-tailed Eagle	12. 03. 2009	Near Tomajmonostora, in a forest	Unable to move, good condition	Incoordination, visual disturbance, greenish diarrhoea, nause
Common Buzzard	22. 03. 2009	Kunhegyes	Ataxia, good condition	Moderately wide, light-rigid pupil, diarrhoea, closed wings, recumbency, keeping his legs under him, sticking out tongue to left
Common Buzzard	21. 06. 2009	Near Hatvan	Unable to move, good condition	Visual disturbance, possible cerebral contusion
Ural Owl	09. 10. 2009.	Between Putnok and Kelemér, in a forest	Ataxia	Intact reflexes, muscle weakness
Common Buzzard	15. 12. 2009.	Létavértes, next to the road	Ataxia, good condition	Stiff fingers
Common Buzzard	28. 12. 2009	Between Szolnok and Törökszentmiklós, next to the road		Stiff fingers, head winding, mydriasis, ruffling head feather, diarrhoea
Barn Owl	17. 01. 2010	Tiszaszentimre	Moribund	no data
Common Buzzard	04. 02. 2010	Tiszapüspöki, on the road	Ataxai, recumbency on the back	Ruffling head feather, head winding, neck torsion
Rough-legged Buzzard	08. 02. 2010	Monor	Ataxia	Head winding, stiff fingers, cahectic, diarrhoea, exsiccosis
Common Buzzard	26. 02. 2010	Nagyhegyes	Ataxia	Incoordination, paralytic leg, recumbency
Common Buzzard	26. 05. 2010	Hortobágy-Máta	Ataxia	incoordination, diarrhoea
Common Buzzard	28. 06. 2010	no data	Unable to move, poor condition	Diarrhoea, cahectic, exsiccosis
Rook	03. 09. 2010	Hajdúnánás	poor condition	no data

White-tailed Eagle	14. 08. 2010	Nagyhegyes	no data	Incoordination, weakness, head winding, convulsion, cahectic, visual disturbance
Common Buzzard	12.2011.	Hajdúböszörmény	poor condition	no data

Detection of any heavy metal poisoning was completed according to their symptoms. Indication of the acute lead poisoning is as follow: greenish or bloody diarrhoea, scare, bowed head, cramp, tremor, nystagmus, hypersalivation, thirst and constipation. The clinical signs of chronic lead toxicosis may be wasting, reduced production, similar neurological disorders with acute poisoning, muscular dystrophy, kidney and liver damage (Lehel and Laczay, 2011).

The acute symptoms of mercury poisonings are vomiting, black or greenish diarrhoea, hypersalivation, polyuria, albuminuria, oliguria, hyposthenuria, anuria, uraemia, neurological symptoms, stiff movements, visual disturbances, lethargy and convulsions. Death may occur within 6-8 days. The clinical signs may be diarrhoea and albuminuria in sub-acute and chronic toxicosis (Koltai, 1972; Lehel and Laczay, 2011).

Results

Thirty seven birds were transported to the Hortobágyi Madárpark with suspicion of poisoning between February 2004 and November 2011. The cause of the poisoning has been determined as carbofuran or

phosphine in 17 cases. Suspicion of heavy metal poisonings were diagnosed in 20 c ases based on the clinical signs observed by veterinarians because of the lacking of the poisonous source and the analytical results.

The majority of the poisoned birds were found in Jász-Nagykun-Szolnok and Hajdú-Bihar County, and 1 animal was transported from Pest, Békés and Heves County (Figure 1, Table 1). The reason of this incidence is that these counties have large agricultural lands, which can serve suitable hunting area for birds.

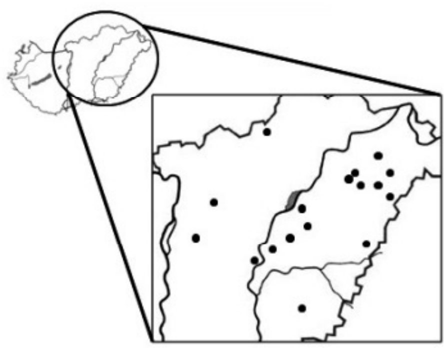

Figure 1. Geographical distribution of the poisonings

Species distribution of the poisoned birds was as follows: 12 Common Buzzards (*Buteo buteo*), 2 White-tailed Eagles (*Haliaeetus albicilla),* 2 Barn Owls (*Tyto alba*), 1 Rough-legged Buzzard (*Buteo lagopus*), 1 Ural Owl (*Strix uralensis*), 1 Eurasian Collared Dove (*Streptopelia decaocto*) and 1 Rook (*Corvus frugilegus*).

The birds which were taken to the Madárpark were unable to move, but mostly they were in a good condition. Until the adequate cause of poisoning has not been defined, a standard treatment was given by the suspected cause.

A Common Buzzard and a Barn Owl were taken to the Madárpark because of lead poisoning. Based on the clinical signs the buzzard had lead poisoning but not due to ingestion of a shot since they do not need grit for crushing food. Both birds were died;, the owl on the way to the Madárpark, the buzzard in 3 months later. The observed symptoms of the buzzard were incoordination, visual disturbance but it was in a good condition. Pathological investigation has been performed on the owl on the next day after dying. During the necropsy abscess in the left part of the lung, gout, enteritis, degeneration of the liver and the kidney, and dark cecal contents has been observed.

Four birds were taken to the Madárpark with the suspicion of mercury poisoning (two Common buzzards, one White-tailed eagles and the Rough-legged buzzard). Incoordination, greenish diarrhoea, moderately wide, light-rigid pupil, sticking tongue out to the left, ruffling head feather, stiff fingers, and exsiccosis were the most common observed symptoms.

Seven of 10 recovered birds were released into the nature (five Common buzzards, one White-tailed eagle and the Eurasian Collared dove) and 3 have been kept in one of the aviaries (two Common

buzzards and the Ural owl), 8 died (three Common buzzards, two Barn owls, one White-tailed egale, the rook and the Rough-legged buzzard) and there was no sufficient information about 2 bi rds (Common buzzards). Among the 20 poisoning events, heavy metal toxicosis – including lead and mercury - were specifically described and diagnosed in 6 cases (Mercury poisoning: two Common buzzards, the Rough-legged buzzard and one White-tailed eagle; Lead poisoning: a Common buzzard and one Barn owl). The suspicion was confirmed by toxicological analysis in the case of the mercury poisoned White-tailed eagle.

The sex and the age were not found to be determinative among the reasons of poisoning in our survey.

Discussion

Most heavy metal poisoned bird species was the Common Buzzard. This finding corresponds to that in the survey of the Hungarian Ornithological and Nature Conservation Society (http1).

Lead poisoning symptoms were observed by Barnett et al. (1989) in a feeding experiments of Mallards *(Anas platyrhynchos)* and the American Black Ducks *(Anas rubripes)*, where lead pellets were given to the ducks. At the first week of the experiment wasting, green laxity, hanging the tail or wings were observed but there was no mortality. These symptoms are in accordance with our surveillances. The ingestion of lead pellets, the occurring disorders and behavioural changes were studied by Rodriguez et al. (2010) on Mallards. The described symptoms were similar to those mentioned above, such as wasting, laxity, abnormal posture, and different motor dysfunctions, decreased response to external influences (human presence, light, and sound effects). The postmortem findings were anaemia, degeneration of gizzard, oesophagus and liver, and hemorrhagic enteritis. Our results correspond completely to these findings.

The other most common cause of poisoning was the mercury. The possibility of secondary methyl mercury poisoning was examined on the Goshawk (*Accipiter G. ge ntillis L.*) by Borg et al. (1970). The birds were fed with the muscles and livers of chickens which were in turn fed with methyl mercury-dressed wheat. The first symptoms (anorexia, ataxia, wasting, and muscle weakness) were observed after 2 weeks. Muscle atrophy and neuronal damage were found during the necropsy. Reduced feed consumption was occurred in the case of mercury toxicosis, which induced weight loss, limb weakness, and incoordination (Scheuhammer, 1987). The described symptoms in the literature and the clinical signs observed in the Madárpark were to be found the same as those of mercury poisoning.

Today, lead and mercury is to be found as contaminants in the environment due to the previous wide spread use in different chemicals. Birds can take them up f rom environmental sources contaminated by industrial and agricultural activities (mining, waste dumps, sludge, sewage) during feeding (Fisher et al., 2006). However, wild birds (terrestrial and water birds) can be frequently poisoned by lead and can die due to direct ingestion of lead shot, bullet fragment or sinker, or even when predator and scavanger bird species consume

game birds or mammals that have been shot with lead ammunition (Fisher et al., 2006; Lahner and Franson, 2009).

It has to point out that the diagnosis of a heavy metal poisoning is relatively difficult, because of lacking information about the exact source of toxicosis. Data of the heavy metal analyses are also rarely available. Usually when a bird arrives to the Madárpark there is no time for detailed toxicological studies or analytical testing. Therefore, the poisoned bird is treated with a standard manner in order to heal it as soon as possible. The most likely suspected poisoning is documented. Even if the adequate treatment was given, the bird may die because of different reasons such as the treatment was done too late or large amount of poison was ingested etc. Altogether 7 birds were recovered from heavy metal poisoning and released thereafter.

Acknowledgement

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KINETICS OF FISH SPERM ACTIVATION – APPLICATION OF FLOW CYTOMETRY AND TIME PARAMETER ANALYSIS NOTES ON TECHNIC / SHORT COMMUNICATION

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Abstract

Sperm quality has an important role in the successful outcome of fertilization. Flow cytometry is a promising and emerging tool for spermatology studies due to its speed and the extremely high number of cells analyzed per sample, moreover, flow cytometry offers time parameter analysis to study kinetic changes over time. The aim of the present pilot study was to test the applicability of time parameter analysis for analyzing of kinetic changes of fish spermatozoa

immediately following activation with a simple assay that measures the integrity of the plasma membrane to illustrate the kinetic approach.

Keywords: fish, sperm, flow cytometry

Összefoglalás

A sikeres termékenyülés alapfeltétele a jó minőségű sperma. Az áramlási sejtanalízis – flow citometria – a spermatológiai vizsgálatok ígéretes és egyre gyakrabban alkalmazott technikája, amely rendkívül gyors és precíz méréseket tesz lehetővé, továbbá alkalmas időbeni változások kinetikai értékelésére is. A jelen előkísérlet célja a flow citométerrel végzett időparaméteres vizsgálatok alkalmazhatóságának tesztelése volt, halspermiumok aktivációt követő membránváltozásainak értékelésére.

Introduction

Reproductive success is of crucial importance in fish culture. Sperm (milt) quality has an important role in the successful outcome of fertilization. Recently knowledge about fish spermatology has grown considerably (Alavi et al., 2007). Although freshwater fish has a drastically different fertilization strategy from most domestic animals (either mammals or avian species), up to date approaches of sperm quality control – originally developed for mammalian species –

have been successfully applied for fish sperm evaluation (Fauvel et al., 2010). Automatized approaches like Computer-Assisted Semen Analysis (CASA, Wilson-Leedy and Ingermann, 2007) or Automatized Sperm Morphology Analysis (ASMA, Butts et al., 2011) are useful tools to study basic fish sperm biology as well as to do routine semen evaluation in fisheries, since a rather inexpensive equipment is needed and freeware software options are available.

Flow cytometry is a promising and emerging tool for spermatology studies (Hossain et al., 2011). Due to its speed and the extremely high number of cells analyzed per sample, flow cytometry offers a quick and highly accurate analysis. Although it requires a rather expensive instrument and some training to set up and interpret measurements correctly, this method gets more and more available even to animal reproduction practitioners. There are commercially available instruments with specific settings and protocols for routine semen analysis at artificial insemination centers.

Although flow cytometry has been used to study fish sperm (for ex. Guthrie et al., 2008, 2011), there is a relatively unknown analysis approach available in most commercial instruments: time parameter analysis to study kinetic changes over time (Martin and Swartzendruber, 1980; Kaposi et al., 2012). Correlating different parameters like scatter or fluorescence values with time can provide useful insight into the dynamics of cellular changes.

Externally fertilizing fish species release sperm into the water resulting in a series of dramatic biochemical changes at cellular level, leading to the activation of motility required for fertilization

(Hagedorn et al., 2009; Wilson-Leedy et al., 2009). Kinetic changes were studied with flow cytometry from the points of view of plasma membrane integrity, mitochondrial membrane potential, intracellular calcium levels (Guthrie et al., 2008, 2011), however, these studies applied repeated measurements of the same samples over time, not time parameter analysis.

The aim of the present pilot study was to test the applicability of time parameter analysis for the analysis of kinetic changes of fish spermatozoa immediately following activation. We chose a relatively simple assay that measures the integrity of the plasma membrane to illustrate the kinetic approach.

Materials and Methods

Sperm was collected from two randomly selected carp (Cyprinus carpio) males via abdominal massage after induction of spermiation with carp hypophysis solution and anesthesia with clove oil.

Sperm was transferred to the laboratory and pooled immediately after stripping. After an initial 100x dilution with phosphate-buffered saline (PBS, P4417, Sigma-Aldrich, St. Louis, MO, USA) motility was assessed visually with a phase-contrast microscope (Nikon Eclipse E600) at 400 x magnification. To check the motility changes after activation, equal drops of sperm in PBS and distilled water were mixed on a microscope slide and motility was assessed as described above.

Plasma membrane integrity was assessed with dual fluorescent labelling with SYBR 14 and propidium iodide (PI) commercially available as LIVE/DEAD Sperm Viability Kit (L-7011, Life Technologies, USA) as described by Garner and Johnson (1995). Briefly, 100 µl of diluted sperm was suspended further in 450 µl PBS in a 5-ml polypropylene tube, then 100nM SYBR 14 working solution (Component A of LIVE/DEAD Sperm Viability Kit, diluted 10-fold in DMSO) and 12 µM PI stock solution (undiluted Component B of LIVE/DEAD Sperm Viability Kit) were added to the cell suspension. After 10 min incubation at ambient temperature in the dark, activation was induced with the addition of 450 µl distilled water to the cell suspension immediately before flow cytometric analysis, resulting in an approximately 150 m Osm/kg activating solution, which was previously found to be optimal for carp sperm activation (Morisawa and Suzuki, 1980). A control tube was prepared simultaneously as described above, but in this case instead of distilled water, 450 µl PBS was added to the suspension immediately before flow cytometric data acquisition.

Flow cytometric measurements were done on a Beckman Coulter FC500 flow cytometer with CXP software. Both fluorochromes were excited with a 488 nm Ar ion laser at 20 mW. Forward (FSC) and side (SSC) scatter were collected on linear scale. SYBR 14 (green) and PI (red) fluorescence were collected on logarithmic scale on detectors FL1 (525 nm BP) and FL3 (620 nm SP), respectively. Acquisitions were running continuously for 300 sec. and time parameter was added to the acquisition parameter list. Acquisition data were stored as list mode files and analyzed with Cyflogic software (version 1.1.1). Sperm events were identified on FSC/SSC 2D plots and subsequently used as gates for further analyses. FL3 vs. time kinetic plots were drawn to study the changes in plasma membrane integrity over time as indicated by t he increase of PI fluorescence. The time axis was divided into 10, 3 0-sec intervals and the mean fluorescence intensity (MFI) of each interval was recorded as described by Schepers et al. (2009).

Results

Visual motility checking indicated that spermatozoa suspended in PBS did not activate, while further suspending in distilled water resulted in >90% motility which completely stopped after 5 min (data not shown). The initial percentage of spermatozoa with intact plasma membrane was >99%.

Hypoosmotic effects of the activation resulted in lowered FSC and SSC; mean FSC channel values were 234.5 and 180.45; mean SSC channel values were 191.54 a nd 112.45 f or the control and the activated samples, respectively (Figure 1.).

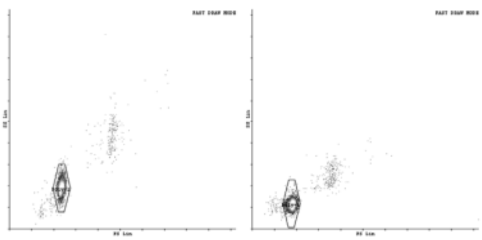

Figure 1. FSC/SSC plots of control (left) and activated (right) samples. Spermatozoa are within regions Poly-1.

There was no detectable shift from low to high PI fluorescence during the 300 sec period (Figure 2.), moreover, Mean Fluorescence Intensities (MFI) did not change during the kinetic analysis (Figure 3.).

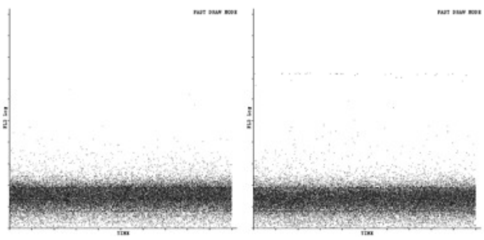

Figure 2. Time kinetic plots of control (left) and activated (right) samples.

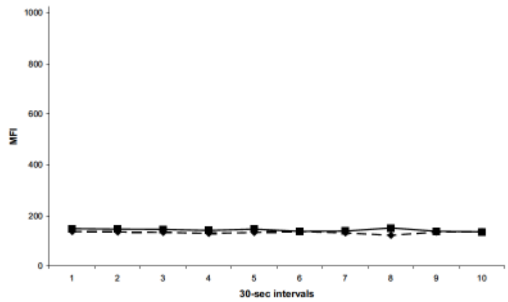

Figure 3. Mean Fluorescence Intensity (MFI) values as measured at 30-sec intervals for control (continuous line) and activated (dashed line) samples.

Discussion

The lowered scatter values of hypoosmotically challenged cells are due to the water influx into the cells – although such cells are larger when seen under the microscope, the higher water content will make the cells dimmer, with less light scattering. Similar effect can be seen when studying necrotically swollen cells (Givan, 2001). This phenomenon indicates that flow cytometric scatter values should not

be interpreted as cell size measurements, like coulter volume measurements.

The lack of detectable effect of hypoosmotic activation on plasma membrane integrity is not surprising as it is known that the decline of motility after activation is due to the depletion of intracellular ATP stores (Guthrie et al., 2008); and fish spermatozoa can be reactivated after the cessation of motility (Dzyuba et al., 2013). However, as species-specific differences in sperm physiology may exist, we are currently setting up experiments to study such kinetic changes in plasma membrane integrity, mitochondrial membrane potential and intracellular calcium level of several economically important freshwater fish species like common carp (*Cyprinus carpio*), wels (*Silurus glanis*) and pike-perch (*Sander lucioperca*). These measurements may provide basic information for other projects like sperm cryopreservation experiments, where the kinetic response of frozen-thawed spermatozoa can be compared to the physiological response of the freshly collected sperm. In conclusion, we think the flow cytometric time parameter analysis offers a useful tool to study sperm physiology.

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ENTROPY AND FRACTAL STRUCTURE BASED ANALYSIS IN IMPACT ASSESSEMENT OF BLACK CARBON POLLUTIONS

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Abstract

Nowadays remote sensing has become a widely used technology collecting information about our environment. Aerial and satellite images are the basic data source in researches where one of the main aims is to detect environmental damaging phenomena, spatial distribution, determine affected areas, identify propagation direction. While assessing the toxicity of heavy metals in many cases, the biological acute toxicity tests are used to determine the effects on remote sensing of heavy metal pollution may also be relevant.

From 2010 researches of plant-soil-atmosphere system have been carried out at the University of Pannonia, Georgikon Faculty. One of the main objectives is to study and detect the effects of environmental

pollution. Impacts of black carbon originated from road traffic on maize growth and development were investigated under field experiment at the Meteorology and Water Department. Exhaust containing black carbon deposits on the leaf surface modifying plant parameters such as radiation and water supply. As a result the radiation balance of the Earth changes thus black carbon soot contributes to global warming. From the growing season of 2010 parallel with field measurements we took aerial images with the purpose of testing and studying the potentials of different spectral range (visible, near infrared, far infrared) aerial imaging techniques. Subsequently we expanded our research on the examination of information content of time-series images (intensity based, entropy based, spectral fractal based). These tests were to analyse the applicability and to find the best data analysing methodology in the research processes managing road traffic pollutants.

Keywords: environmental pollution, multispectral aerial photography, image processing, entropy, spectral fractal dimension

Összefoglalás

Jelenleg a távérzékelési módszerek egyre szélesebb körben alkalmazott technológiák a környezetünkről gyűjtött információk megszerzésében. A légi- és űrfelvételek nélkülözhetetlen adatforrásként jelennek meg olyan kutatási területeken, ahol a környezetkárosító jelenségek felderítése, térbeli eloszlása, a hatásterületek meghatározása, a terjedési irányok beazonosítása kulcsfontosságú cél. Bár a nehézfémek toxikus hatásának megítélése sok esetben biológiai akut toxikológiai tesztek alapján történik a nehézfém-szennyezés hatásainak távérzékeléssel történő meghatározása is releváns lehet.

A Pannon Egyetem Georgikon Karán 2010 óta folynak növény-talaj-légkör rendszerhez kapcsolódó tudományos kutatások, melyek egyik célja a nehézfém szennyezések várható károsító hatásainak detektálása. A Meteorológiai és Vízgazdálkodás Tanszék szabadföldi kísérletei során a közlekedés okozta környezet-szennyezések közül a korom-szennyezés kukorica növényállományra gyakorolt eredményét vizsgálják. Kiválasztásának fő oka, hogy a kipufogókból származó korom lerakódik a növények felületére, megváltoztatva ezzel annak sugárzási, vízháztartási és egyéb paramétereit. Mindez hatással van a Föld sugárzási egyensúlyára, melynek következtében a korom bizonyos fokig hozzájárul a globális felmelegedéshez is. A 2010. évi tenyészidőszaktól kezdődően a földi mérésekkel párhuzamosan légifelvételezésekre is sor került, melynek elsődleges célja a különböző spektrális tartományú (látható-, közeli infravörös-, távoli infravörös tartományok) légifelvételezési technikák által kínált lehetőségek tesztelése, tanulmányozása volt. Ezt követően a vizsgálatok kiterjedtek az idősoros felvételek információtartalmú elemzéseire is (intenzitás alapú, entrópia alapú, spektrális fraktáldimenzió alapú), amelyek a kutatásaink szempontjából a legmegbízhatóbb adatkiértékelési eljárások alkalmazhatóságát vizsgálták a közlekedés eredetű szennyezőanyagok kutatásai során.

Introdution

The 21th century developments in information technology have opened new horizons for the processes and phenomena detection of our planet and the surrounding universe. These developments left their mark on the field of remote sensing science, so nowadays the remote sensing technologies are becoming more widely used applications to understand our environment more comprehensive. The database of the aerial and satellite images are extremely important in prevention, detection and monitoring of the problems caused by the pollution. Thanks to technological developments of the last decade are increasingly used the sensors with high spectral and spatial resolution (Nagy 2005) that allow more accurate results in investigation of the effect of environmental pollutions.

There are many examples of literature shows that remote sensing images taken in different spectral ranges further contribute to understand more exact the processes and phenomena our environment. In remote sensing after the appearance of multichannel satellite sensor (e.g. AVIRIS, LANDSAT, SPOT, Quickbird, ASTER, MODIS etc.) the development of airborne detector started (APEX, ARES AISA, DAIS etc.). As a consequence, increased the diversity of applications in industry, geology, meteorology, agriculture, forestry, environmental protection, defence and remediation activities etc. (Sabins 1987). These advanced information technology solution make it possible to solve many practical environmental task for example spread of plat diseases, ragweed detection, prediction of biomass and forest fires, investigation of water quality, air pollution, soil

contamination, waste management, effect of remediation, urban ecological changes, habitat mapping etc. (Borengasser et al. 2008). The technical development of the sensors is followed by the significant delay of the processing methods and applications (Nixon and Aguado 2008, Young and Fu 1986). Therefore it is reasonable to develop new methods, in order to get more useful information from measured data.

Materials and Methods

Research area

The testing area was situated at Agro-meteorological Research Station in Keszthely (Hungary), where maize crops were polluted by heavy metals (Kozma-Bognar and Berke 2012). Our test area was located north of the station (the centre of the test area N: 46°44'08.55", E: 17°14'19.76", H:114 m) where six plots were established: BC = Black Carbon, polluted, BC-W = Black carbon polluted and irrigated, Cont = Control, Cont-W = Control irrigated, Cd = Cadmium polluted, Cd-W = Cadmium polluted irrigated (Figure 1.). In our study we simulated the effects of black carbon pollution. We applied maize hybrid Sperlona (FAO 340) as test plant with short growing season. The black carbon was dispensed by a motorised sprayer of SP 415 type. During the research we used chemically "pure" black carbon, which was free any contaminants. We sprayed black carbon 3 gm^{-2}/week doses onto the leaf surface to see the effect of the growth of plants.

Figure 1. Aerial image of 2012 in VIS

Research activities also focused on the examination of the potential negative or positive influence of the irrigation to. The irrigated plots received over the natural precipitation additional water supply. The dropping irrigation method was performed, 4-6 mm/hour intensity, depending on the weather (Anda and Illes 2012).

Research Tools

During three growing seasons (2010, 2011, 2012) was collected remote sensing data in different spectral ranges parallel with the field measurements. We used digital sensors in the visible (VIS), Near InfraRed (NIR) and Far InfraRed (FIR) spectral ranges to get more information about the effect of the black carbon pollution. In the growing season we took aerial images in each phonological phases, to follow the changes of the maize plant. During each aerial flight were

mapped the plots more tracks (3-5 track logs) to get enough data to the statistical analysis. The spatial resolution of these images was under 10x10 c m in VIS, NIR spectral range, and 30x30cm in FIR spectral range, which allowed using an accurate plot-level evaluation (Kozma-Bognar et al. 2012). High intensity and spatial resolution data was an important part of the multitemporal imagine sensing. The parameters of the major collection tools were used for mapping can be seen in Table 1. Time-series analyses were carried out based on the remote sensing data. To perform the analysis we used various image processing techniques. With these pre-processing methods were selected the optimal images for our research. After data pre-processing intensity, entropy and spectral fractal dimension measurement evaluation methods were applied to examine black carbon polluted and control maize canopy.

Parameters	Visible data (VIS)	Near Infrared data (NIR)	Far Infrared data (FIR)
Type of sensor	Canon 30D	Canon 30DIR	HX-IDS-M 110
Height of flight	400 m	400 m	400 m
Spectral band	400 - 700 nm	720 - 1150 nm	8000 - 14000 nm
Geometrical resolution	0.1 m	0.1 m	0.3 m
Data recording	14 bit/pixel	14 bit/pixel	14 bit/pixel

Table 1. The main parameters of remote sensing data collection

Research methods

Entropy

Information-theoretic concept of entropy is used today in 1948, Claude E. Shannon (Shannon 1948a, 1948b) respectively, and illustrated through a practical example (Shannon 1951), which was called the proposal by John von Neumann entropy function. Accordingly, the average information content of the message (in the case of independent messages) - entropy can be defined as follows:

$$H = \sum_{i=1}^{m} p_i \, ld\left(\frac{1}{p_i}\right) \qquad (1)$$

Where H - the information-theoretic entropy

p_i - the ith message occurrence probability

General definition of entropy mathematical sense by Alfred Rényi (Rényi 1961) that the

$$H_{\propto}(X) = \frac{1}{1-\propto}\log\left(\sum_{i=1}^{n} p_i^{\propto}\right) \qquad (2)$$

Where $\propto \geq 0$ and $\propto \neq 1$

Should also take into account the following when calculating the entropy in many practical situations:

1. A closed system can be the following values for the entropy of information theory (1) as:

$$0 \leq H \leq \log_2 n$$

Where n is the number of possible messages.

2. The entropy (1) is a minimum (H_{min}=0) if the source is still sending the same message.
3. The entropy (1) is taken to be the maximum value H_{max}=$\log_2 n$, if all the messages with equal probability ($p_i = -\log_2 n$).

Spectral Fractal Structure

The SFD is a general fractional dimension derived from the structure of the processing (Mandelbrot 1983), which is a novel application of fractals. The spatial dimensional structure of the SFD outside of the spectral bands is also suitable for measuring the colour structure (Berke 2006) and provides sufficient information to colours, shades and other fractal properties as well. Calculating the values of the SFD (two or more band images), the defined fractal dimension is applied to the measured data as a function simple mathematical averages are calculated as follows (Berke 2007):

$$SFD_{measured} = \frac{n \times \sum_{j=1}^{S-1} \frac{\log(BM_j)}{\log(BT_j)}}{S-1} \qquad (3)$$

Where,

n – the number of image layers or image channels

S – the spectral resolution (in bits)

BM_j - valued spectral pixel boxes containing j number of bits

BT_j – all possible spectral boxes for the number of j-bits

The possible number of boxes spectral j bits is calculated as follows:

$$BT_j = (2^S)^n \qquad (4)$$

The formula (3) metric (Berke 2007), the evaluations of both hyper- and multispectral images can be used for exact measurements.

Results

The 2010th, 2011th and 2012th based on th e year is near and thermal infrared aerial photographs of multi-temporal analyses were performed with carbon black and cadmium contaminated and control for stocks. Our research included the analysis of the possible positive or negative effects of the irrigation in a way that also examined the differences between the irrigated and non-irrigated stocks.

The multispectral images and the typical starting reference data began to entropy-based and SFD-based different plant populations measurements. All this was done, as most mathematical evaluation methods for average information content (mean, standard deviation, etc.) or structure (PCA, ICA, SFD, etc.) work on the basis based data. During the evaluation of test shots with masked areas of crops were analysed and measured entropy and SFD values only in respect of these. The results are summarized became possible to determine which method results mainly reflect the impact of plants on the carbon and cadmium, as well as the application of which parameters are to be distinguished from the most unpolluted and heavy metal polluted plots. The six-parameter studies were included: typical recordings spectral range (λ), treatment types (p), temporal variations in the vegetation period (t), changes in the yearly analyses (T), geometric resolution (r), water supply (w). The final goal was to determine the dependence for each parameter of the entropy and SFD based data structure. According to the values in the table 3nd clearly establish that the average information content (entropy) based NIR range data show no significant difference between the carbon black, cadmium, and the control data. However, data obtained from the SFD structural studies were significant differences that are capable of detecting differences between the treatments (Table 2.).

Parameters	Treatments	Date of aerial photography in 2012						
		02/04	29/05	10/06	21/06	23/07	14/08	07/09
Entropy values	Black carbon	13.2877	13.2877	13.1397	13.1397	13.2877	13.2877	13.2877
	Control	13.2877	13.2877	13.1396	13.1397	13.2876	13.2877	13.2877
SFD values	Black carbon	1.0407	1.1771	1.2627	1.2591	1.3048	1.3971	1.3692
	Control	1.0648	1.1705	1.2545	1.2339	1.2618	1.3802	1.3693

Table 2. An examination of the differences between the black carbon and the control sample from entropy and SFD NIR range 2012th year's growing season

In our view, the 07/09/2012 nearly the same SFD values can be explained by the complete cessation of photosynthesis, the plants withered state. During our research we aimed to develop a method that allows for multiband aircraft images, which selects maximum information to be considered in the production of optimal images. Another consideration is that when different methods are used together sensors produced high spectral resolution images and high spatial resolution data, which is workable and useable (Kozma-Bognár and Berke 2012).

The starting point of the multispectral images, using the characteristics of the data reference, began when the different plant populations, spectral fractal dimension measurements were taken. The measurement program developed by SFD Information Technology Ltd (Internet site of SFD). Was considered optimal for spectral bands used to select and validate the fractal dimension (SFD) values. A review of the images containing the tested crop areas were analysed, and those values only measured SFD. We have developed the channel selection procedure based on the SFD values of the multispectral images used to optimize the selection of images. In investigation, the SFD values were deduced from the size of the actual information content of images. Airborne imaging of one workflow (e.g. flight track) recording usually occurs in the Keszthely sample area where they were looking to provide the best and most reliable information for the object-finding study. The multispectral images of the pre-processing, post-processing only recorded SFD maximum purchasing values per sensor and per flight, as further investigations of these images gave the most reliable results (hit accuracy as well as other measured parameters and correlation studies).

In our research the professional digital photography is the practice of using trade-specific software, including widespread noise reduction and image enhancement features, the camera type and the optics are aligned corrective actions (chromatic aberration, vignetting, geometric distortion, noise by sensors, etc.).

	3 bands visible image		3 bands near infrared image	
Number of the flight track	**Basic data**	**After DxO v8.0 correction**	**Basic data**	**After DxO v8.0 correction**
Flight track 1	2,1361	2,1610	1,9418	1,9412
Flight track 2	2,1416	2,1733	1,9187	1,9471
Flight track 3	2,1398	2,1665	1,9400	1,9470
Flight track 4	2,1328	2,1648	1,9215	1,9328
Flight track 5	2,1273	2,1716	1,8406	1,8973
Average	**2,1355**	**2,1674**	**1,9125**	**1,9331**

Table 3. The multispectral images SFD values before and after correction, flight per track

These were performed in order to examine what influence the operation of the fractal structure correction in the spectral images of the human visual system is adapted (Internet site of DxO Optics Pro 8 software).The results unambiguously confirmed by an increase in the fractal dimension of the structure (diversity) after the corrections. For the near-infrared range, however, it is more random images, no systematic basis of the measured data (Table 3). The fourth image can be seen from the offset correction about the structural value of the original image data. We were able to isolate four major groups based on the combined (PCA) test data measured on t he ground and extracted on the basis of aerial photographs (Table 4).

	Component			
	1	2	3	4
Land average temperature	,965	,026	-,045	-,237
Micro climate	,926	-,082	-,255	-,110
SFD FIR	,914	,099	-,003	-,081
FIR temperature	,900	,271	,093	,310
Albedo	,083	,973	-,002	-,201
NIR Reflectance	-,229	,863	,123	-,403
VIS Reflectance	,387	,851	,060	,342
Relative humidity	-,591	-,601	-,442	,294
Chlorophyll A	-,024	,225	,964	,126
Chlorophyll B	-,188	-,076	,945	-,106
Leaf Area Index	,095	,095	,817	-,537
SFD VIS	-,109	-,122	-,082	,982
SFD NIR	-,165	-,630	-,183	,730

Table 4. The measured on the ground and in aerial photos taken from the PCA Rotated Component Matrix of parameters

The four parameters show a temperature, reflectance, Chlorophyll and structure-based grouping.

Conclusions

As conclusion it could be determined which examination methods represent the real information content of aerial images. The entropy values of the images of traffic pollutant plants showed a significant difference only in part by spectral range, yearly analyses and water supply. From the entropy values of treatments types are there any differences, so that in our view, the entropy-based analysis does not work in this case. The average information content gives appropriate results in the investigation of vegetation period and geometric resolution. If we evaluate the fractal structure of the black carbon and control plant images we get positive results for each of the six different types. Consequently, it can be said that the spectral fractal dimension parameter is well used to determine the actual information content of the aerial images in the spectral range, treatment types, vegetation period, yearly analyses, geometric resolution, water supply examinations.

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CORTICOSTERONE RESPONSE OF ONE-DAY-OLD BROILER CHICKS TO DEPRIVATION OF FEED AND WATER

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Abstract

Delay in feed and water access for 24 and 48 hours after hatching of broler chicks is a standard practice and may impair performance traits and health status of birds. Adverse physiological effects of starvation activate the hypothalamic-pituitary-adrenal (HPA) axis and corticosterone participates in the control of stress response. Therefore, the aim of the present study was to to investigate the effect of feed and water deprivation on plasma corticosterone of one-day-old broiler chicks. Deprivation of feed and water for 24 and 48 hours after hatching led to a significantly decreased body weight and an elevated concentration of plasma corticosterone of chicks compared to the control birds receiving feed and water *ad libitum*. Our results show that the hyporesponsive period of the HPA axis in the neonatal stage of chicks needs further investigations using different environmental stressors and physiological stress indicators.

Keywords: broiler chick, stress response, starvation, corticosterone

Összefoglalás

A napos brojler csibék a kelés után általános gyakorlatként 24-48 óráig nem jutnak takarmányhoz és ivóvízhez, ami hátrányosan érinti mind a hizlalási teljesítményt, mind az állatok egészségi állapotát. Az éhezés kedvezőtlen élettani hatásai aktiválják a hipotalamusz-hipofízis – mellékvesekéreg (HHM) tengelyt és a kortikoszteron hormon részt vesz a stresszválasz szabályozásában. A jelen kutatás célja mindezek alapján a takarmány- és vízmegvonásnak a napos brojlercsibék kortikoszteron szintjére kifejtett hatásának vizsgálata volt. A kelés után 24 és 48 óráig tartó takarmány és vízmegvonás szignifikánsan csökkentette a csibék testtömegét és növelte a plazma kortikoszteron koncentrációját a takarmányt és vizet *ad libitum* módon fogyasztó kontroll állatokhoz képest. Eredményeink alapján a HHM tengely viszonylagos gyenge válaszképessége közvetlenül a kelés utáni

időszakban további vizsgálatokat igényel különböző környezeti stresszorok és élettani stressz indikátorok felhasználásával.

Introduction

In a commercial hatchery, hatching of chicks can last for a period of 24-48 hours. Hatchery treatments and transport to the farm involve a further holding period of up to 72 hours. During this period, birds normally receive neither feed nor water. Literature on feed deprivation after hatching clearly demonstrates the detrimental effects of any delay in feed access on performance of chicks with respect to growth, immune system activation, digestive enzyme stimulation and muscle development. Delayed feeding in the first few days of life can reduce final body weight and it probably affects immunological capacities (Noy and Sklan, 1999a; Dibner et al., 1998). Extended posthatch holding time has been reported to dehydrate chicks, reduce broiler performance, and depress immune response (Casteel et al., 1994). Uni et al. (1998) also reported adverse effects of delayed feeding on the morphology of the intestine and the secretion of vital digestive enzymes. Posthatching starvation delayed pectoral muscle weight gain and the weight increase occurred only after chicks had access to feed (Bigot et al., 2003).

Adverse physiological effects of starvation activate the hypothalamic-pituitary-adrenal (HPA) axis and glucocorticoids participate in the control of stress response. The elevated baseline level of plasma corticosterone has been frequently used for the assessment of acute stress in broilers and broiler breeders (Thaxton and Puvadolpirod, 2000; Hocking et al., 1993). It is well documented, that in the first 24-48 hours of fasting increased plasma levels of thyroxin, growth hormone, corticosterone, and decreased plasma concentrations of insulin, insulin-like growth factor-I, 3,5,3'-triiodothyronine can be observed in poultry (Buyse et al., 2001). Corticosterone stimulates feed intake in numerous bird species (Gray et al., 1990) and adrenals of chicken respond with increased corticosterone secretion to a protein deficient diet in chicken (Carsia et al., 1988). However, the first 48 hours after hatch appears to be a stress ''nonresponsive" period in chicken and the majority of results originate from studies with older birds (Wise and Frye, 1973; Freeman, 1982). Therefore, the aim of the present study was to investigate the effect of feed and water deprivation on the plasma corticosterone of one-day-old broiler chicks.

Materials and Methods

The experiment was carried out on the experimental farm of the Department of Animal Science, Georgikon Faculty, University of Pannonia. A total of 50 Ross 308 male broiler chickens were purchased from a local hatchery (Gallus Ltd., Devecser, Hungary). The chicks hatched in a period of one hour, between 8:30 and 9:30, 12 December 2012. The chicks arrived at the farm at 14:00 and the body weight of birds were measured individually. After measurement of body weight, ten birds were decapitated and blood samples were

collected and centrifuged (4,000 rpm, 10 min). Plasma was removed after centrifugation and stored at minus 20 °C for later determinations of corticosterone. The remaining forty chicks were randomly assigned into two groups (20 chicks per pen) as follows: a control group received feed and water *ad libitum* (control) from the age of 6 hours and the other group was deprived of feed and water. The individual body weight of chicks was measured and blood sampling was repeated at the age of 24 hours and 48 hours in both groups. Plasma corticosterone concentration was measured by radioimmunoassay method according to the modified method of Gaszner et al. (2004). The data were analyzed as a completely randomized design by two way analysis of variance with feeding (control group with feed and water access and a group without feed and water) and holding time (6, 24 and 48 hours) as main effects using the software package Statistica 5.0 (Statsoft, USA). Significant differences between groups were tested by the Tukey post hoc test. Statistical significance is declared at $p<0.05$. Results are presented as mean ± standard error (SEM).

Results

Body weight of experimental birds

The body weight of experimental birds is presented in Figure 1. The body weight of chicks in the control group increased significantly after the start of feeding at the age of 6 hours ($p<0.05$). However, the body weight of birds deprived of feed and water did not show significant changes during the sampling period. The body weight of control chicks was significantly higher than the body weight of birds without feed and water at the age of 24 and 48 hours ($p<0.05$).

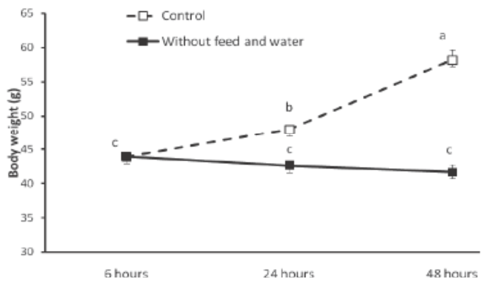

Figure 1. Body weight of experimental birds.

[a-c] Means with no common superscripts differ significantly ($p<0.05$).

Plasma concentration of corticosterone

The plasma concentration of corticosterone is shown in Figure 2. The feed and water deprivation of chicks after hatching resulted in a significant increase of plasma corticosterone at the age of 24 and 48 hours compared to the control birds receiving feed and water ($p<0.05$). The concentration of corticosterone did not show significant changes during the sampling period neither in the fasted nor in the control group.

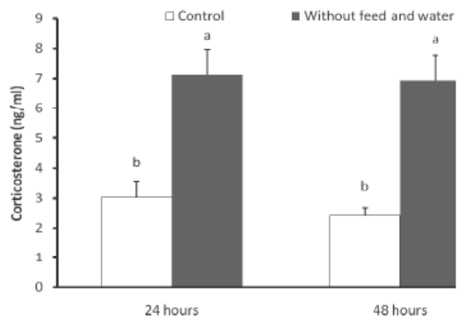

Figure 2. Plasma concentration of corticosterone.

[a-c] Means with no common superscripts differ significantly ($p<0.05$).

Discussion

The newly hatched chick contains residual nutrients in the yolk sac weighing almost 20% of chick body weight and provides a source of energy during the first few days post hatch (Romanoff, 1960). Despite the contribution of residual yolk to the birds' energy balance, the newly hatched chicks have only a limited ability to assimilate food and water (Moran, 1990; Nitsan et al., 1991). It has been shown that broiler chicks can lose weight during the first 24 h post hatch, even with free access to feed and water (Pinchasov, 1991). The chick weight loss during holding period is mainly due to dehydration and yolk consumption (Vieira and Moran, 1999). The results of present experiment support our previous observation when the body weight of chicks deprived of feed and water for 48 hours were 18-21 g lower than the birds receiving feed and water from the age of 12 or 24 hours (Pál et al., 2011; Németh, 2012). According to literature, it seems that the effect of a feed and water deprivation lasted for 24 hours or shorter period can be more effectively compensated by the chicks compared to a 48 hour-long time interval without feed and water. In the study of Juul-Madsen et al. (2004), the broiler chicks without feed for 24 hours after hatching compensated their lower body weight by the 8th day while the chicks starved for 48 hours posthatch showed a 6.1% lower body weight than control animals receiving feed immediately after hatching. Also, the 48 hour-long starvation had significant negative effects on cellular and humoral immune response of chickens but the immune system of birds could compensate the effects of feed deprivation for 24 hours. However, the compensatory growth rate is the highest in these chicks without feed for 30-48 hours post hatch but this ability is limited and does not ensure the full compensation of body weight loss after hatching (Gonzales et al., 2003).

Corticosterone is the major adrenal glucocorticoid hormone in birds (Carsia and Harvey, 2000) and participates in whole body homeostasis and the stress response of organism. In chickens, corticosterone can inhibit growth (Davison et al., 1980), increase heterophil/lymphocyte ratio and reduce antibody response to an antigen (Gross et al., 1980). Basal concentrations are subject to cyclic variation (Broom, 1988) and its concentration increases to acute stressors like immobilisation (Beuving and Vonder, 1978).

This experiment focused on measuring the effect of neonatal feed and water deprivation on plasma corticosterone concentration. Gonzales et al. (2003) observed that basal plasma levels of corticosterone increased during the first days of broilers, from 2.34 to 3.54 ng/ml, and an age-dependent decrease was measured and reached 1.8 ng/ml at day 21 and 0.6 ng/ ml at day 42. The peak mean corticosterone concentrations after an acute handling stressor can reach about 4 to 8 (Littin and Cockrem, 2001) or 4 to 16 ng/ml (Beuving and Vonder, 1978). In our study, the plasma corticosterone concentrations measured in the control group at the age of 24 and 48 hours can be considered as basal levels. The feed and water deprivation for 24 and 48 hours used in the present experiment acted as a stressor for the chicks which resulted in elevated plasma corticosterone showing similar levels like after an acute stressor. Similarly, a 24 hour of fasting significantly increased plasma corticosterone concentration above initial concentrations in immature chcikens (Harvey et al., 1983). The activation of HPA axis during starvation depends on age and body weight of birds as well. Freeman et al. (1983) observed that the plasma corticosterone level of 16 week-old-birds weighing 1.0 to 1.5 kg did not change significantly after a feed deprivation of 24 hours. However, the chickens at the age of 3 weeks weighing 0.15 to 0.20 kg body weight showed a significant increase in the concentration of the hormone after 4 hours feed deprivation and this level of corticosterone remained above the basal level until the end of starvation period.

The experiments focusing on the posthatch changes in adrenocortical function of chicken demonstrated that the stress response of newly hatched chicks is hyporesponsive in the first 48 hours post hatch due to transient hypothalamo-hypophyseal deficiency (Wise and Frye, 1973; Freeman, 1982). The exact reason of this phenomenon is unknown and elevated plasma levels of glucocorticoids around hatching may contribute to this condition. Furthermore, it can be assumed that the lack of feed or water may have different effects on the HPA axis during stress response. The concentration of corticosterone during the period of 48 hours after hatching in the plasma of chicks deprived of feed only did not differ from the chicks with free access to feed and water (Richards et al., 2010). Also, Gonzales et al. (2003) could not find significant increase of plasma corticosterone in chicks deprived of feed but with free water intake for 48 hours post hatch. In contrast, the chicks in our study did not have access to water during starvation so dehydration could contribute to the increase of plasma cosrticosterone. Dehydration in birds stimulates the secretion of the antidiuretic hormone arginine vasotocin (AVT) from the posterior pituitary into the bloodstream. Beside corticotropin releasing factor, AVT is an adrenocorticotropic hormone secretagog in chicken and some other avian species (Westerhof et al., 1992; Cornett et al., 2013). Thus, AVT could play a role in the corticosterone response after feed and water deprivation in the present experiment as well.

In conclusion, day-old broiler chicks after hatch can respond with a significantly elevated cosrticosterone concentration to deprivation of feed and water for 24 and 48 hours. Further examinations including other indicators of stress like plasma biochemical variables, leukocyte profile and heat stress proteins may help to understand the neonatal stress response and activation of HPA axis of broiler chicks.

Acknowledgements

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EXAMINATION OF SPRAY LOSSES AND RECOVERY RATE IN VINE PLANTATIONS

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Abstract

As regard relations between developmental condition of an orchard, and of efficacy of plant protection sprayings very few scientific work can be found in the literature of the last ten years. Using air-carrier sprayers new application technics like ultra sound sensors or tunnel spraying tests as well as data comparisons are necessary to get informations on chemical losses. The proper choice of operating characteristics of an orchard spraying as well as the conformity of orchard geometry is a much more difficult task in a vine plantation, than in a field crop. The most important geometrical features of an orchard are greatly influenced by the developmental condition of the stocks. The main reason of our investigation is however, that most of the farmers still use traditional air-carrier sprayers to protect their vine plantations, since they can not afford buying the more environment-saving, but expensive sprayers. An important task of my investigation was to cunduct the measurement *in situ*, that is during the practical

work to get reliable scientific data to the common practice in vine plantation.

Keywords: plant protection, spraying, air-carrier sprayers, spray losses, efficiency

Összefoglalás

A növényállomány fejlettségi állapota és a permetezés hatékonysága közötti összefüggések keresésére az utóbbi évtized áttekintett szakirodalmában nagyon kevés tudományos mű született. Az ültetvény-permetezésnél az üzemeltetési jellemzők helyes megválasztása, valamint az állomány geometriájához való alkalmazkodás sokkal nehezebb feladat, mint szántóföldi környezetben, a lényegesebb geometriai jellemzőket pedig befolyásolja az ültetvény fejlődési állapota. A problémafelvetésnél további indok volt, hogy a hazai gyakorlatban a gazdák többsége hagyományos szállítólevegős géppel végzi a szőlőállományok növényvédelmét, nincsenek abban az anyagi helyzetben, hogy környezetkímélő, de drága konstrukciókat vásároljanak. A vizsgálatok elvégzésénél további fontos feltétel volt, hogy a zok „ élesben", a védekezéssel együtt történjenek, minél jobban megközelítve ezzel a gyakorlatban tapasztalható körülményeket.

Introduction

As regard relations between developmental condition of an orchard, and of efficacy of plant protection sprayings very few scientific work

can be found in the literature. Using air-carrier sprayers new application technics like ultra sound sensors or tunnel spraying tests as well as data comparisons are necessary to get informations on chemical losses.

The proper choice of operating characteristics of an orchard spraying as well as the conformity of orchard geometry is a much more difficult task in a vine plantation, than in a field crop. The most important geometrical features of an orchard are greatly influenced by the developmental condition of the stocks. The main reason of our investigation is however, that most of the farmers still use traditional air-carrier sprayers to protect their vine plantations, since they can not afford buying the more environment-saving, but expensive sprayers. An important task of our investigation was to conduct the measurement *in situ*, that is during the practical work to get reliable scientific data to the common practice in vine plantation.

Materials and methods

A vine plantation sheltered from the wind were chosen for the measurements located in south-west direction in its lengths at the village Monostorapáti, West-Hungary. The orchard is bordered with skirts on its northern and eastern side, having Chardonnay vine stocks in curtain-like cultivation. Its main characteristics: Row di stance 3.5 m, plant distance 1.2 m, the height of the plants in full development stage was 240-250 cm, with the lowest leaves being 50-60 cm from the soil surface. The constant provisions chosen for the measurements were:

- Movement speed of the tractor :7 km/h
- Dosis of spray solution: 300-500 l/ha (depending on plant development)
- Pump pressure: 20 bar
- A nozzle set of type ALBUZ ATR-80 (orange colored)
- A determined carry-air stream
- Wind speed : <2 m/s
- Maximal deviation of wind direction from row direction: 30º

To determine the degree of chemical deposition, leaf samples were taken using a leaf-hole-maker from each of 5 vine stocks („A” - „E”) of two tested rows at different levels of the plants from 60, 100, 140 and 180 cm (*Figure 1a.*). Three leaf samples were taken, with 2 cm of diameter, the summarized area of upper and lower surface samples was $6 \times 2^2 \times \pi/4 = 18{,}84\ cm^2$. When no leaf occurred at the lowest sampling level during the early vegetations state, artificial holding surface of 18.85 cm^2 were used to replace it. All of the measuring points were placed in the central vertical plane of the rows. Its material was a rough-surface plastic sheet. Further leaf samples were taken prior to each treatment to determine amount of chemical residues remaining from former treatments. To measure the chemical's deposition on the upper and lower surfaces of the leaves, water-sensitive test papers were placed onto assigned leaves at each level. They were evaluated using a computerized image analysis. To measure the solution drift by wind and airflow, further samples were taken at the border of the orchard from two rows similar to the other samples. To measure deposition rate on the soil, three test lines were

created crossing the rows with a distance of 5 m from each other. 8 plastic petri-dishes were located on each test lines between the rows with a total of 224.88 cm^2 active surface (*Figure 1b.*). Summarized number of collected leaf samples of one measuring was 80, the placed petri-dishes were 24, and the placed water sensitiv papers were 80. To determine of drift area as a basis we took the measurement results by Fox et al.(1990). According to them at least 75 % of full amount liquid sprayed out will be deposited on the sprayed area as well as within 6 m beside the border row. As a marker material Pyranin-solution in a concentration of 0.01 % were used during the first three measurements, later on diluted to 0.0033 % when the application rate of spraying solution were increased. The amount of deposited active substance of leaf samples and artificial holding surfaces were determined in a laboratory using a Turner type fluorometer.

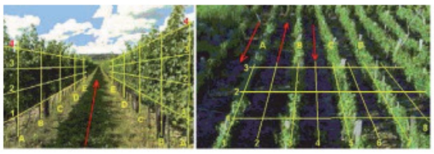

Figure 1. Arrangement of sampling places on the plants(a) and on the soil(b)

For the determination of leaf area index (LAI) and of active substance recovery average sized intact leaves were collected. They were pressed down and their size measured by image analysis. The following meteorological data were continuously recorded during the investigations: wind direction, wind speed, air temperature, relative humidity, clouds.

Results

To determine the actual value of spraying dosis first we measured the moving speed of Fendt Farmer 209 F engine. In the L/2 gear at 1250 RPM rotation speed of engine, the calculated speed was 6.96 km/h. The rotation speed of cardan-shaft was 345 RPM, this drove the driving mechanism of the axial flow fan of the spraying machine Berthoud BX 1500 Arbo type in its first gear. Albuz ATR 80 type nozzles were mounted onto the holding arch of sprayer machine.

During the end of April to mid August 6 measurements were taken depending on the vegetations state of vine stocks, when 280 l/ha was the application rate in the first three treatments, and 481 l/ha was at the other three treatments.

At the time of the first treatment, on 29th April, the average leaf area was only 7.57 cm^2, the leaf area index (LAI) was 0.23. 6.91 % of the liquid arrived to the target surface, that is onto the leaves, while 12.88 % onto the soil below and between the rows. A minimal amount, 0.08 % got the leaves of the neighbouring rows, and 8.43 % arrived to the soil of neighbouring rows, mainly between the rows. The rest, which amounted to 71.7 %, of the total liquid amount, covered the non-controlled surface, evaporated, or were drifted out of the sprayed area. By using the water-sensitive test papers it proved, that leaf covering was uniform, and similar on the upper and lower side of the leaves, at the 100 cm level, its average covering rate was 13.9 – 40.2

%, while at the higher level (140-180 cm) the upper surface has got higher amount, being covered 33.7 – 98.0 %, and the lower surface 1.7 – 31.6 %. The lower side of some sample became less covered, below the desired minimum rate of 10 %. At the time of the second treatment (18th May) the LAI was still low, 0.427, consequently the average rate of recovery was 12.92 %, similar value was measured in soil covering to the first measurings, (8.63 % at the sprayed row and 8.23 % at the neighbouring rows. The non-controlled loss still was too high, 69.39 %. The average leaf size amounted to 31.8 cm^2, the leaf covering rate on the upper and lower surface was at the 100 cm and 140 cm level nearly the same, 10, and 46.8 %, and on the highest level the covering of the upper leaf surface again much higher (52.8 -. 81.8 %), than that of the lower surface. At the time of the third measurement (2nd June) the amount of active substance on the leaf surface (target surface) became much more. The average leaf size was now 90.7 cm^2, the LAI 1.413. The value of recovery was 27.53, which is still below the expected value of a traditional air-carrier axial-fan sprayer. Active substance loss by soil covering below and beside the rows decreased to 6.72 %, while it increased a bit on the neighbouring rows and their soil (1.53 and 6.53 %). The amount of non-controlled loss is still high, 57.7 %.

The data from water-sensitive test papers show, that the upper surface of leaves had higher covering rates (44.4 – 99.7 %) at all leaf levels, than the lower surface (1.2 – 47.0 %. This higher difference is probably due to the fact, that the air doesn't stir enough the bigger-sized leaves, the moving air pushed the leaves together. This phenomenon is observable also on the dispersion, since traces of smeared liquid can be seen on the leaves (*Figure 2.*).

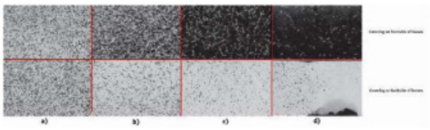

Figure 2. Water-sensitive papers from measuring a) 29th April, A/1 plant, 100 cm height, b) 29th April, A/3 plant, 180 cm height, c) 2nd June, A/3 plant, 100 cm height, d) 2nd June, A/3 plant, 180 cm height

The following measurement continued when the farmer increased the liquid volume per hectare. In contrast to the earlier amount of 289 l/ha, the calculated amount became 481 l/ha. This higher value could be achieved by mounting two other nozzles, therefore the other earlier operating factors (like pump pressure, fan RPM, moving speed) remained constant.At the time of fourth measurements (18th June) the LAI increased to 1.658, which was not much more than in the case of the previous treatment. The recovery became nearly 40 %, but also the rate of active substance on the soil also increased to 12 % in the sprayed row, and to 9.27 % out of the row. The amount of active substance on the neighbouring two rows was 2.2 % in relation to the full liquid amount discharged. From these data it can be concluded, that the bigger foliage had a breaking effect on the carry-air, a part of the non-controlled loss appeared at the neighbouring rows, mainly on

the soil. Still, 36.66 % of the liquid moved onto non-controlled surface, out of the field of measurements, or e vaporated. The test, using water-sensitive papers showed, that the covering rate on the upper surface of leaves was practically 100 %. At the 100 cm and 140 cm level often excess liquid could be observed, and because sticking together of leaves the covering rate on the lower surface can not be estimated, therefore during the next measurements this part were abandoned. Just before the next measurements of 15th July, excess green parts of plants were removed („green cutting") the sprouts growing too high, too low or growing into the space of the two rows were cut down. Despite of this the foliage had a bigger amount and became more closed, than in the time of previous measurements, its LAI value was 1.898. Nearly 51 % of the sprayed liquid got on the target surface, but also somewhat bigger amount came to the soil surface, 13.46 % and out of the sprayed row it decreased to 7.37 %. Also the deposition at the next rows by the sprayed area increased to 6.84 %. The value of non-controlled loss decreased to 21.39 %. At the time of the last measurements (13th August) the value of recovery was 56.3 %, which in case of a traditional axial-fan sprayer is a relatively good value. Because of a bigger amount and of closer foliage (LAI = 2.331) the biggest part of the liquid losses got the soil between the rows, amounting to 16.82 %. The rate of non-controlled loss was 10.56 % only. Losses measured on t he two neighbouring rows increased to 10.54 %, while below them on the soil 6.02 % of the chemical could be found. Prior to the beginning of the measurements samples were collected from all the rows and levels to establish the amount of tracing material remaining from the previous treatments. The data evaluations showed, that the remnants from the earlier treatments did not altered the measured values, being its values below 1.0 ng/cm^2, which is two orders lower, than the values measured just following the sprayings.

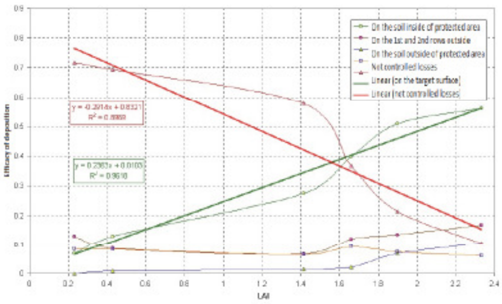

Figure 3. Recovery rates and spraying losses depending from leaf area-index (LAI)

This was influenced also by the weather, since between the measuring at least one rainfall occurred washing down the tracing material, and because there was two weeks between the measures. From the data it can be concluded, that the increasing LAI had a favourable effect on the deposition values, (including also at the different height levels) but at the same time also the losses increases, since more liquid fall onto the soil (*Figure 3.*). Well observable is the effect of higher liquid amount per hectare. We could not find a relation between test paper

covering rates and measured tracer amounts of the leaf samples taken from the same point. This is because the same amount liquid dispersed into bigger droplets causes lower covering, than dispersed into smaller droplets.

Conclusions

The evaluation of relations between vegetations state and efficacy of sprayings showed, that the amount of liquid sprayed onto the target surface (that is the foliage) as well as the value of recovery, will mainly be determined by the LAI, which shows the development of the foliage. The efficacy of spraying is very much connected with the value of LAI, their relation is a linear one. The investigations using water-sensitive test papers proved that the increasing LAI causes a change in covering rates of upper and lower leaf surfaces, more liquid will be absorbed on the upper surface and less on the lower surface. It can be stated, that the use of fluorescent marking and of water-sensitive paper tests well complete each other, since using the former one the covering rate can be determined on the upper and lower surface of the leaves, while with the other method the exact amount of recovery can be measured. However the two methods can not be substituted for each other. In case of large sized and dense foliage the application of water-sensitive paper is restricted or even impossible because of the intensive leaf movement, caused by the carry-air. The recovery values of 55-60 % is considered in the literature as a basis for comparisons, and is in case of traditional axial fan sprayers only acceptable and true, if the foliage is very well developed. According to the revealing investigations on relations between vegetations state of the orchard plants and of efficacy of spraying, the vine plant in its initial stage don't has such a large foliage, which would need the work of the fan. At this stage a good covering rate can only be achieved by using the hydraulic pulverization. Because of disconnection of fan the amount of the liquid falling to the soil will be higher, and the covering rate of lower leaf surface will also be lower, which may cause problem at using contact type chemicals. To lower the drift of very small droplets lower pump pressure can be proposed, and bigger nozzle opening at the same liquid dose. The determination of spraying time length using sprayer without carry-air greatly depends on the vine stock variety, on its age, on the producing area, the weather, and also on the sprayer and on its working parameters, therefore to determine of time intervals the actual LAI has to be taken into consideration. Based on the test results of using water-sensitive test papers it is proposed to spray without fan operation up to LAI <0.5. At larger foliage a higher dose may result in a better utilization rate, but it may increase the amount of liquid falling onto the soil. The determination of the moment, when will be necessary to increase the dose of the protecting liquid, depends also on a number of factors, however also in this case the LAI value should be a basis, according to our investigations at LAI of 1.7 – 1.8.

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