



ISSN 1313 - 8820
Volume 2, Number 2
June 2010

AGRICULTURAL SCIENCE AND TECHNOLOGY

2010

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

Editor-in-Chief

Tsanko Yablanski
Faculty of Agriculture
Trakia University, Stara Zagora
Bulgaria

Co-Editor-in-Chief

Radoslav Slavov
Faculty of Agriculture
Trakia University, Stara Zagora
Bulgaria

Editors and Sections

Genetics and Breeding

Atanas Atanasov (Bulgaria)
Ihsan Soysal (Turkey)
Max Rothschild (USA)
Stoitcho Metodiev (Bulgaria)

Nutrition and Physiology

Nikolai Todorov (Bulgaria)
Peter Surai (UK)
Zervas Georgios (Greece)

Production Systems

Dimitar Pavlov (Bulgaria)
Dimitar Panaiotov (Bulgaria)
Jordan Staikov (Bulgaria)
Yuliana Yarkova (Bulgaria)

Agriculture and Environment

Georgi Petkov (Bulgaria)
Ramesh Kanwar (USA)

Product Quality and Safety

Marin Kabakchiev (Bulgaria)
Stefan Denev (Bulgaria)

English Editor

Yanka Ivanova (Bulgaria)

Scope and policy of the journal

Agricultural Science and Technology /AST/ – an International Scientific Journal of Agricultural and Technology Sciences is published in English in one volume of 4 issues per year, as a printed journal and in electronic form. The policy of the journal is to publish original papers, reviews and short communications covering the aspects of agriculture related with life sciences and modern technologies. It will offer opportunities to address the global needs relating to food and environment, health, exploit the technology to provide innovative products and sustainable development. Papers will be considered in aspects of both fundamental and applied science in the areas of Genetics and Breeding, Nutrition and Physiology, Production Systems, Agriculture and Environment and Product Quality and Safety. Other categories closely related to the above topics could be considered by the editors. The detailed information of the journal is available at the website. Proceedings of scientific meetings and conference reports will be considered for special issues.

Submission of Manuscripts

All manuscript written in English should be submitted as MS-Word file attachments via e-mail to ascitech@uni-sz.bg. Manuscripts must be prepared strictly in accordance with the detailed instructions for authors at the website

<http://www.uni-sz.bg/ascitech/index.html> and the instructions on the last page of the journal. For each manuscript the signatures of all authors are needed confirming their consent to publish it and to nominate an author for correspondence. They have to be presented by a submission letter signed by all authors. The form of the submission letter is available upon request from the Technical Assistance or could be downloaded from the website of the journal. All manuscripts are subject to editorial review and the editors reserve the right to improve style and return the paper for rewriting to the authors, if necessary. The editorial board reserves rights to reject manuscripts based on priorities and space availability in the journal.

Subscriptions

Agricultural Science and Technology is published four times a year. The subscription price for institutions is 80 € and for personal subscription 30 € which

include electronic access and delivery. Subscription run for full calendar year. Orders, which must be accompanied by payment may be sent direct to the publisher:

Trakia University
Faculty of Agriculture, Bank account:
UniCredit Bulbank,
Sofia BIC: UNCRBGSF

IBAN: BG29UNCR76303100117681
With UniCredit Bulbank Stara Zagora

Internet Access

This journal is included in the Trakia University Journals online Service which can be found at www.uni-sz.bg.

Copyright

All rights reserved. No part of this publications may be translated into other languages, reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying or any information storage and retrieval system without permission in writing from the publisher.

Address of Editorial office:

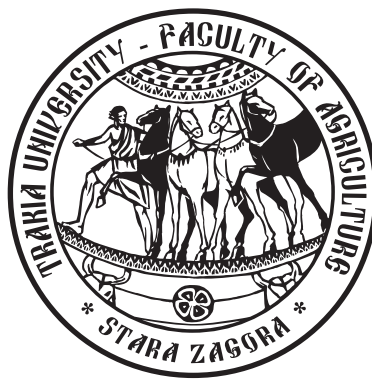
Agricultural Science and Technology
Faculty of Agriculture, Trakia University
Student's campus, 6000 Stara Zagora
Bulgaria
Telephone.: +359 42 699330
+359 42 699446
<http://www.uni-sz.bg/ascitech/index.html>

Technical Assistance:

Nely Tzvetanova
Telephone.: +359 42 699446
E-mail: ascitech@uni-sz.bg

ISSN 1313 - 8820

Volume 2, Number 2
June 2010



AGRICULTURAL SCIENCE AND TECHNOLOGY

2010

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria



— PRODUCTION OF FRESH —
SAUSAGES AND OTHER MEAT PRODUCTS



*KEN...
Everywhere
you go*

KEN LTD
6000 Stara Zagora
www.ken.bg
for contacts:
+359 42 64 11 28
60 24 92
fax: +359 42 60 11 46



An approach for Fusarium infected corn kernels recognition using linear discrete models

P. Daskalov*, V. Mancheva, Ts. Draganova, R. Tsonev

Department of Automatics, Information and Control Engineering, University of Rousse, 8 Studentska, 7017 Rousse, Bulgaria

Abstract. A new approach to identify infected with pink *Fusarium* maize seeds through the spectral features in the near infrared region is proposed in the paper. It is based on analysis of coefficients of linear parametric models of discrete type Autoregression (AR). Seeds identification criterion is based on the boundary of A_{LV} between the class healthy and class infected seeds. The maximum distance between the two classes - ΔA for the 10th order of AR-model is used to determine the boundary. The recognition accuracy achieved 100% for a variety XM87/136 and for varieties 26a, Knezha 436 and Rouse 424 the accuracy range was from 97.50 to 98.75%.

Keywords: near infrared spectral characteristics, linear discrete model of the Autoregression type, corn kernels, Fusarium infections

Introduction

Maize diseases are widely spread in all the regions where it is grown and they are one of the most important factors with negative influence on the maize yields. The infectious diseases caused by viruses, fungi and bacteria are significant for the crops, as well as for the production. Infections due to *Fusarium* spp. are collectively referred to as fusariosis (Denev and Beev, 2002; Beev et al., 2007; Beev, 2009). The pink ear rot is the most popular *Fusarium* infection (Beev, 2004, 2009). It's characterised by the appearance of separate smaller or bigger areas of kernels all over the corn cob with white to pink fungal deposits. Most often, the deposits are on the lower part of the maize shucks, at places damaged by insects or when the kernel endosperm is cracked in its upper or lower part. The cause for the pink ear rot are different *Fusarium* spp. and especially *Fusarium moniliforme* (Tomov and Jordanov, 1984; Beev, 2009). Infection of ears by *Fusarium* species can result in mycotoxin development (Denev, 1999, Beev, 2009). Mycotoxin levels in grain vary from year to year and between regions. The key factors comprising likely risk are: preceding crop, crop residues, variety, agronomy and weather at flowering, harvest and storage (Kirov and Denev, 1990).

When evaluating the quality of agricultural products, not only should certain indicators be controlled, but also the diseased products should be separated from the healthy ones. The quality identification methods could be divided into subjective (organoleptic) and objective (technical, mechanical) methods. The flaws of the subjective methods are mainly the lack of identical perceptions of the different subjects and the instability of perception over time due to tiredness, absent-mindedness, age and other differences. The objective quality identification methods are of physical and chemical nature mainly and they could be defined into the following groups: mechanical, physical, chemical, and electromagnetic (Damyanov, 2006). The methods based on the measuring of electromagnetic radiation (electromagnetic fields, roentgen radiations, radiations in the visible (VIS), ultraviolet (UV) and infrared (IR) areas, laser radiations, etc.) meet the modern requirements of remote and non-destructive quality determination (Damyanov, 2006). Of all of the above methods, the optical ones (UV, VIS, IR) achieve high quality measurement accuracy and

correspond very well to the technology conditions and requirements (Damyanov, 2006).

Delwiche (2003) identifies wheat kernels infected with mould through spectroscopy of a reflection in the near infrared region. High classification accuracy of 95 per cent is achieved and it is established that the best classification model uses a combination of the grain mass and the difference of the reflection coefficients of the wave lengths – 1182 and 1242 nm. It is established that the most informative wavelengths for a wheat grains sorting machine (for separation of healthy grains and *Fusarium* spp. infected grains) are achieved through a linear discriminant analysis. 95 per cent accuracy of separation is achieved with wavelength of 500 and 550 nm for the visible region, and 97 per cent accuracy is achieved for the near infrared region with wavelengths of 1152 and 1248 nm (Delwiche and Ganes, 2005). Loos et al. (2005) study the influence of the *Fusarium* spp. and *Microdochium nivale* moulds and the formation of mycotoxins connected to them on naturally infected grain seed. Fernandez et al. (2009) offer near infrared spectroscopy as a quick and cheap method for discovery of the toxic matter aflatoxin B₁ (AFB₁) in maize and barley. The best predictive model to detect AFB₁ in maize is obtained by using standard normal variate and detrending (SNVD) as scatter correction. In the case of barley, the best predictive model is developed using SNVD on the dispersive NIRS instrument.

There are already algorithms offered for the discovery of Fusariosis infected maize kernels through analysis of their spectral characteristics on the grounds of their description through linear discrete models of the Autoregression type (Draganova et al., 2003; Mancheva et al., 2009a). Based on the achieved results, an algorithm is offered, which discovers the Fusariosis infected maize kernels through an analysis of the model series and its coefficients. It is established that when the model series is lower than the second, then the kernel is healthy, and when the series is higher than the fifth, it is typical for diseased kernels. In the case of the fourth series of the model, the detection of the diseased kernels is made on the grounds of A₂ and A₃ coefficients of the model. As the obtained results concern a small number of kernels, this is a prerequisite for the analysis of a set of maize kernels with bigger volume in order to achieve exact coefficients of the AR model. In the procedure for

* e-mail: daskalov@ru.acad.bg

evaluation of the characteristics of a set of kernels with bigger volume is repeated (Mancheva et al., 2009a). It is established that the best series for both classes is the ninth series, but this is not a determining factor for identification of the kernels. That is why the coefficients of the models for the both classes of kernels are analysed. A_5 coefficient of the model is used as a criterion for identification, and the other coefficients are commensurable for both classes. The achieved identification accuracy for healthy and diseased kernels is 70 and 80 per cent, respectively (Mancheva et al., 2009a).

The aim of the current study is to choose signs and formulate the criteria for identification of *Fusarium* infected maize kernels through the introduction of the spectral characteristics of diffuse reflection from the kernels with linear discrete models and the selection of a suitable classification approach. The influence of the kernel variety on the identification accuracy will also be analysed.

Material and methods

The research subject is the pink pink ear rot infection (*Fusarium moniliforme*) and its occurrence on maize kernels. Seven varieties of

maize kernels were examined – Knezha 308, Knezha 436, Knezha 613, Knezha 620, 26A, XM87/136 and Ruse 424. They have been certified by the Maize Institute in the town of Knezha since year 2008. 700 spectral characteristics of diffuse reflection were taken – 350 of healthy and 350 of diseased maize kernels in the range from 456 to 1140.5 nm. The system for obtaining spectral characteristics of diffuse reflection from the maize kernels is presented in (Mancheva et al., 2009b). USB4000-VIS-NIR spectrophotometer of the Ocean Optics company was used, as well as QR200-7-VIS-NIR probe for measuring the diffuse reflection from the subject surface. The spectral characteristic of each kernel was obtained for its back side and the germ side, pursuant to the methodology described in (Mancheva et al., 2009b). These characteristics show the dependency of the wavelength λ , nm on the intensity of the reflected radiation from the maize kernels $S_{\lambda n}$, in absolute values. The achieved database with spectral characteristics is shown in (Mancheva et al., 2009b).

Results and discussion

The taken spectral characteristics, shown on Figure 1, are normalized through:

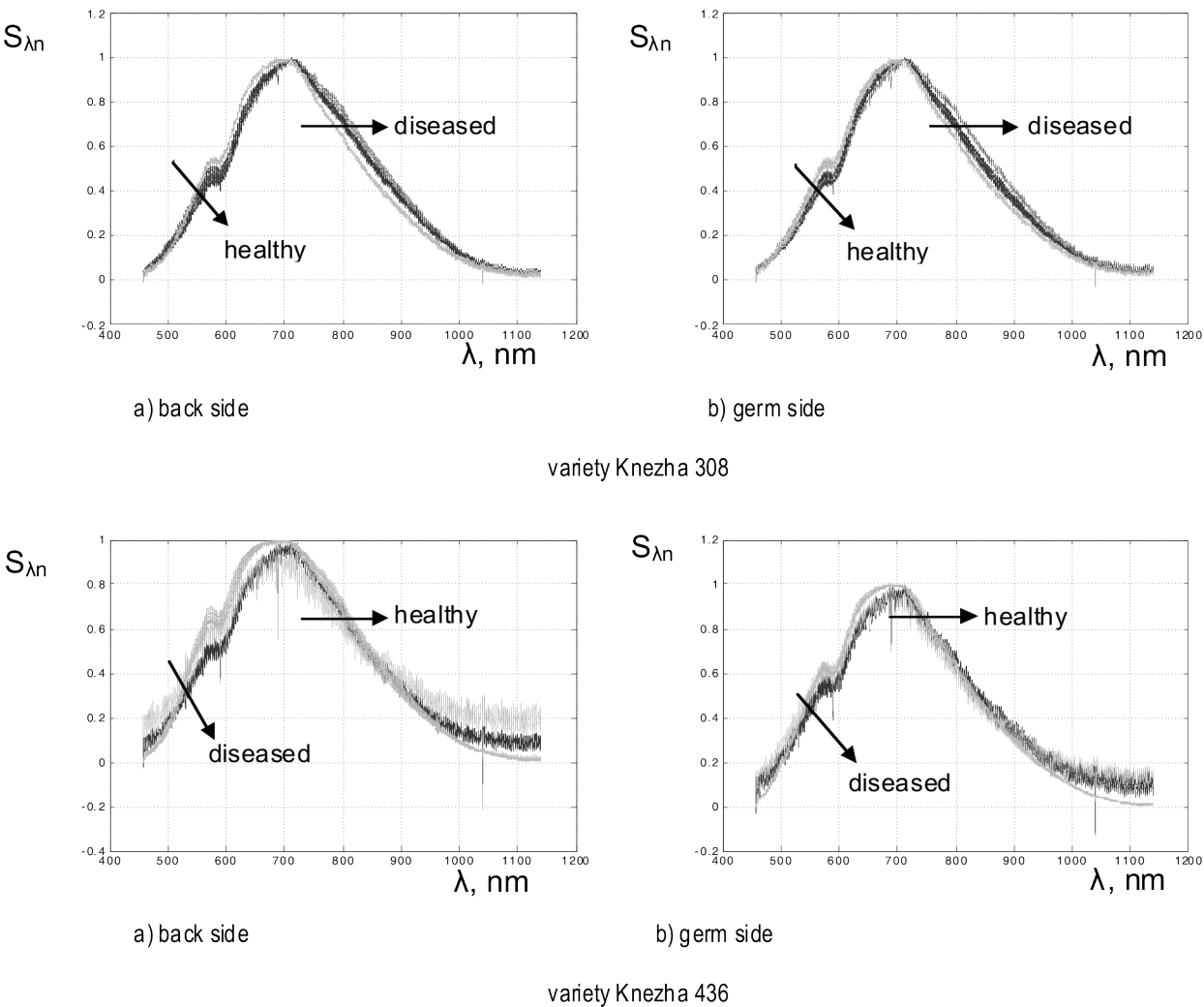


Figure 1. Regulated spectral characteristics of two varieties of maize kernels

$$S_{\lambda n} = \frac{S_{\lambda n}(\lambda_i)}{S_{\lambda \max}} \quad (1)$$

whereas $S_{\lambda}(\lambda_i)$ is the value of the intensity of the reflected radiation with wavelength λ_i , $S_{\lambda \max}$ is the maximum value of the intensity of the reflected radiation for the n^{th} spectral characteristic. The linear discrete model of the Autoregression (AR) type is described through the following equation:

$$S_{\lambda}(k) + A_1 S_{\lambda}(k-1) + \dots + A_n S_{\lambda}(k-n) = e(k) \quad (2)$$

where k is the k -th value of the wavelength λ in nm;

$A_i, i = (1 \div n)$ are the coefficients of the Autoregression model (AR);

$S_{\lambda}(k)$ is the intensity of the radiation reflected from the maize kernels for the k -th value of the wavelength λ in nm;

n is the model series of the Autoregression type;

$e(k)$ is the difference (error) between the modelled and the real characteristics.

The algorithm shown on Figure 2 is offered for the identification of *Fusarium* spp. infected maize kernels. There are numerous methods for formation of training and test sets when there are big databases. In one of the approaches for selection of representative objects, the objects are selected so that they are uniformly distributed over the output database. A well-known representative of

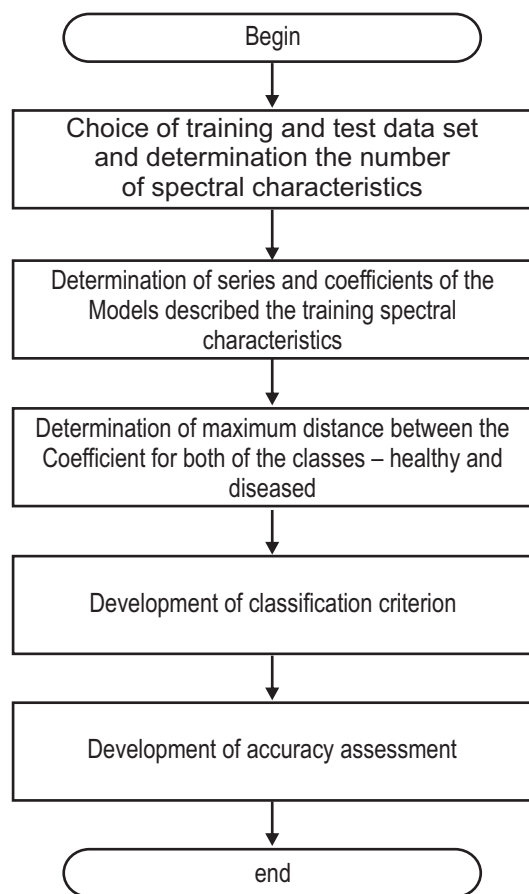


Figure 2. Algorithm for identification of healthy and *Fusarium* infected maize kernels

this approach is the Kennard and Stone Algorithm. In this method, a certain number of objects is defined, which have to be selected from the output ones (Facchin et al. 2005). The obtained spectral characteristics are distributed into two sets. The training set includes 30 spectres of healthy and 30 spectres of diseased maize kernels of each kind or totally 210 spectres of healthy and 210 spectres of diseased kernels for all the seven varieties. The test set includes 20 spectres of healthy and 20 spectres of diseased maize kernels of each variety or totally 140 spectres of healthy and 140 spectres of diseased kernels for the seven varieties.

The n -th series of the linear discrete model, describing the spectral characteristics of the healthy class and diseased class of kernels, is analysed. The obtained series of the discrete model of the Autoregression (AR) type is presented in Table 1. The obtained results show that the model series is not a determining indicator for identification of the kernels. Table 1 show that the 10th series of the model is dominating for the seven varieties of maize kernels. That is why only the 10th series will be used in order to receive the coefficients of the model from the training set. Therefore, ten coefficients should be calculated for each variety. Three cases for the A-coefficients of the AR model are obtained and they are shown on Figure 3. In the first two cases, the a) and b) group of the healthy kernels is clearly distinguishable from the group of the diseased kernels. In the third case – c) – there is an overlapping of the healthy and diseased kernels.

In order to formulate the identification criterion, the boundary of A_{LV} should be determined between the two classes of kernels – healthy and diseased. To this end, the maximum distance ΔA between the class of the healthy and the class of the diseased maize kernels should be calculated for each of the ten calculated coefficients. The next step is to select the biggest distance from the calculated maximum distances ΔA . The distance ΔA is calculated on the grounds of the three variants of the received A-coefficients from Figure 3 in the following way:

$$\Delta A = A_{zdr_min} - A_{zar_max} \quad \text{- for variant a)}$$

$$\Delta A = A_{zar_min} - A_{zdr_max} \quad \text{- for variant b)}$$

$$\Delta A = \frac{A_{zdr_mean} + A_{zar_mean}}{2} \quad \text{- for variant c)}$$

whereas A_{zdr_min} and A_{zar_max} are the minimum and maximum value, respectively, of the coefficient $A_i, i = (1 \div 10)$ for the both classes of maize kernels should be determined.

The biggest distance from the calculated distances for the ten coefficients is chosen and it corresponds to the A_i coefficient. The boundary A_{LV} between the healthy kernels class and the diseased kernels class is determined (Table 2), and based on the received coefficient variants, shown on Figure 3, the conditions for identification of healthy and diseased maize kernels from the test set are formulated (Table 3).

In order to evaluate the accuracy of identification, the test sets of spectral characteristics, determined through the Kennard and Stone method, are used. The spectral characteristics of the healthy and diseased kernels from the test set are taken from the back side and from the germ side. The calculated coefficients for each spectral characteristic are checked pursuant to the criteria formulated above and after one of the conditions is met, the final result concerning the type of the maize kernel is worked out. The results from the evaluation of the accuracy of identification of maize kernels from the

Table 1. AR model series describing the normalized spectral characteristics of healthy and diseased kernels

Model series <i>n</i> Corn kernels variety	Back side		Germ side	
	healthy	diseased	healthy	diseased
Knezha 308	8	6	8	6
Knezha 436	10	10	8	10
Knezha 613	8	10	10	8
Knezha 620	10	10	10	10
26 A	10	10	8	10
XM 87/136	10	10	10	10
Ruse 424	10	10	10	10

Table 2. The limits A_{1LV} of the model coefficient A_1 between the healthy kernels class and the diseased kernels class

variety	Limit A_{1LV} for back side	Limit A_{1LV} for germ side
Knezha 308	- 0.2696	- 0.2788
Knezha 436	- 0.2168	- 0.2296
Knezha 613	- 0.2786	- 0.2987
Knezha 620	- 0.3792	- 0.3915
26 A	- 0.2895	- 0.3317
XM 87/136	- 0.2925	- 0.2743
Ruse 424	- 0.2812	- 0.3038

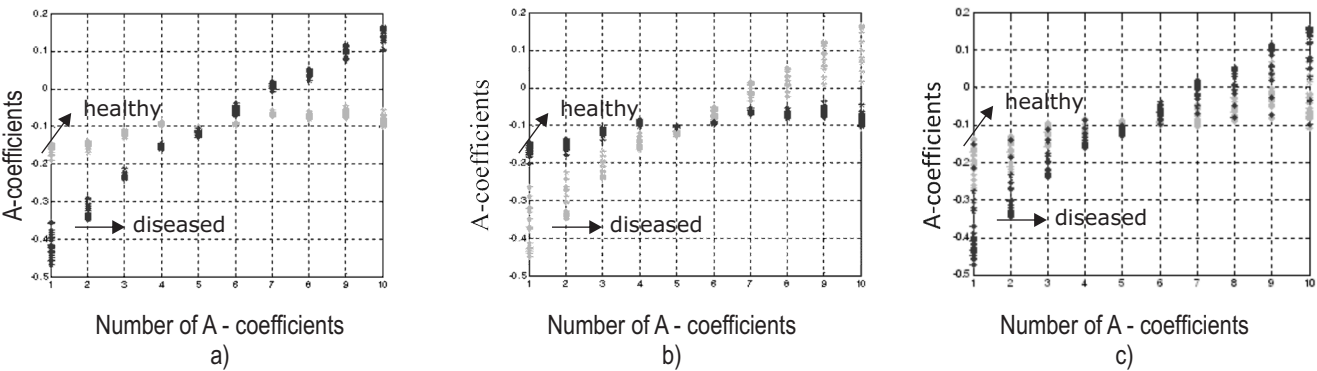


Figure 3. Three cases for the A-coefficients of the AR model

Table 3. Conditions for classification of maize kernels through the A-coefficients of linear discrete models

Variant	Rules	Result
Variant a)	If $A_{ij} > A_{1LV}$, then	corn kernel is healthy
	If $A_{ij} < A_{1LV}$, then	corn kernel is diseased
Variant b)	If $A_{ij} > A_{1LV}$, then	corn kernel is diseased
	If $A_{ij} < A_{1LV}$, then	corn kernel is healthy
Variant c)	If $A_{ij} > A_{1LV}$, then	corn kernel is healthy
	If $A_{ij} < A_{1LV}$, then	corn kernel is diseased

test set through the use of the coefficients of the linear discrete models are shown in Table 4.

The obtained results show that the accuracy of identification of diseased kernels of XM87/136 variety is 100 per cent. High accuracy

of identification is achieved with the following varieties: Ruse 424 (98.75%), Knezha 436 (97.5%) and 26A (97.5%). The percentage of identification for the other three varieties is lower: for Knezha 620 – 78.75%, for Knezha 308 – 52.5% and for Knezha 613 – 51.25%.

Table 4. Results from the verification of the accuracy of identification of maize kernels compared to the test set through A-coefficients of the linear discrete models

Corn kernels variety		Coefficients variant	Number of correctly classified corn kernels	% Correctly classified corn kernels	Number of non-classified corn kernels	% non-classified corn kernels
Knezha 308	Healthy – back side	c	12	60	8	40
	Healthy – germ side	c	10	50	10	50
	Diseased - back side	c	12	60	8	40
	Diseased - germ side	c	8	40	12	60
Knezha 436	Healthy – back side	b	19	95	1	5
	Healthy – germ side	b	19	95	1	5
	Diseased - back side	b	20	100	0	0
	Diseased - germ side	b	20	100	0	0
Knezha 613	Healthy – back side	c	8	40	12	60
	Healthy – germ side	c	13	65	7	35
	Diseased - back side	c	8	40	12	60
	Diseased - germ side	c	12	60	8	40
Knezha 620	Healthy – back side	c	16	80	4	20
	Healthy – germ side	c	17	85	3	15
	Diseased - back side	c	19	95	1	5
	Diseased - germ side	c	11	55	9	45
26 A	Healthy – back side	a	20	100	0	0
	Healthy – germ side	a	18	90	2	10
	Diseased - back side	a	20	100	0	0
	Diseased - germ side	a	20	100	0	0
XM 87/136	Healthy – back side	a	20	100	0	0
	Healthy – germ side	a	20	100	0	0
	Diseased - back side	a	20	100	0	0
	Diseased - germ side	a	20	100	0	0
Ruse 424	Healthy – back side	b	20	100	0	0
	Healthy – germ side	b	20	100	0	0
	Diseased - back side	b	19	95	1	5
	Diseased - germ side	b	20	100	0	0

Conclusion

A classifier of the linear discrete model type could be used for identification of healthy and *Fusarium* infected maize kernels for the following varieties: 26A, Knezha 436, XM87/136 and Ruse 424. The accuracy of identification for the Knezha 308, Knezha 613, Knezha 620 varieties is lower. Other classification procedures should be used for them, in order to obtain higher accuracy of identification. The obtained results show that the variety influences the identification accuracy.

Acknowledgement

The study was supported by contract № BG051PO001-3.3.04/28, "Support for the scientific staff development in the field of engineering research and innovation". The project is funded with support from the Operational Program "Human Resources Development" 2007-2013, financed by the European Social Fund of the European Union.

References

- Beev G**, 2004. Fungal species from the genus *Fusarium* in Bulgarian cereals. *Animal Sciences*, 5, 90-93, (Bg).
- Beev G, Denev SA, Lalev T and Pavlov D**, 2007. Comparison of Different Commercial Wheat Cultivars and New Selection Lines Durum and Soft Wheat to *Fusarium* Infection in the Region of Stara Zagora. *Ecology and Future*, 3, 29-34.
- Beev G**, 2009. Mycotoxological evaluation of pollution in cereals by microscopic fungi of the genus *Fusarium* and their mycotoxins. PhD Thesis, Trakia University, Stara Zagora, Bulgaria.
- Damyanov C**, 2006. Non-destructive identification of the quality in food products automatic sorting systems. Academic publisher of the UFT – Plovdiv, Bulgaria.
- Delwiche SR**, 2003. Classification of Scab- and other mold-damaged wheat kernels by near-infrared reflectance spectroscopy. *Transactions of the ASAE*, 46, (3), 731–738.
- Delwiche SR and Ganes CS**, 2005. Wavelength selection for monochromatic and bichromatic sorting of *Fusarium*-damaged wheat. *Applied Engineering in Agriculture*, 21, (4), 681–688.
- Denev SA**, 1999. The Problem of Mycotoxins in the Feed industry and Animal Husbandry. *Proceedings of the 3rd Alltech's Research Seminar*, 4th March, Sofia, Bulgaria, 71-79.
- Denev SA and Beev GG**, 2002. *Fusarium* Fungi and Mycotoxins in Foods and Feeds – A Review. *Proceedings of Tenth Congress of the Bulgarian Microbiologists with International Participation*, Stefan Angelov Institute of Microbiology, Bulgarian Academy of Sciences, October 9-12, 2002, Plovdiv, Bulgaria, (Abstract of Poster Presented), pp.111-112.
- Draganova T, Daskalov P and Tsonev R**, 2003. An algorithm for *Fusarium* disease maize grains recognition by analyzing the spectral characteristics. *Proceedings of Angel Kanchev University of Rousse*, 40, 1, 33-38.
- Facchin S, Trierwieler J and Konz V**, 2005. Soft sensor design: A new approach for variable selection. 2nd Mercosur Congress on Chemical Engineering.
- Fernandez-Ibacez V**, 2009. Application of near infrared spectroscopy for rapid detection of aflatoxin B1 in maize and barley as analytical quality assessment. *Food Chemistry*, 113, 629-634.
- Ioos R, Belhadj A, Menez M and Faure A**, 2005. The effects of fungicides on *Fusarium* spp. and *Microdochium nivale* and their associated trichothecene mycotoxins in French naturally-infected cereal grains. *Crop Protection*, 24, 894–902.
- Kirov N and Denev SA**, 1990. The Problem of Mycotoxins in the Animal Husbandry and Food Industry. *Agricultural Academy*, Sofia, Bulgaria, pp 86.
- Mancheva V, Daskalov P, Tsonev R and Draganova T**, 2009a. Investigation the Possibility of Modeling the Spectral Data of Sound and *Fusarium* damaged Corn Kernels by Linear Discrete Models. *Proceedings of the Student Scientific Session, Angel Kanchev University of Rousse*, 46-50.
- Mancheva V, Daskalov P, Tsonev R and Draganova T**, 2009b. Creation of spectral characteristics database for *Fusarium* diseased corn seeds recognition. *Proceedings of the Angel Kanchev University of Rousse*, 48, 3.1, 150-157.
- Tomov N and Jordanov J**, 1984. Maize in Bulgaria. *Zemizdat*, Sofia, Bulgaria, (Bg).

Instruction for authors

Preparation of papers

Papers shall be submitted at the editorial office typed on standard typing pages (A4, 30 lines per page, 62 characters per line). The editors recommend up to 15 pages for full research paper (including abstract references, tables, figures and other appendices)

The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods, Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

The title needs to be as concise and informative about the nature of research. It should be written with small letter /bold, 14/ without any abbreviations.

Names and affiliation of authors

The names of the authors should be presented from the initials of first names followed by the family names. The complete address and name of the institution should be stated next. The affiliation of authors are designated by different signs. For the author who is going to be corresponding by the editorial board and readers, an E-mail address and telephone number should be presented as footnote on the first page. Corresponding author is indicated with *.

Abstract should be not more than 350 words. It should be clearly stated what new findings have been made in the course of research. Abbreviations and references to authors are inadmissible in the summary. It should be understandable without having read the paper and should be in one paragraph.

Keywords: Up to maximum of 5 keywords should be selected not repeating the title but giving the essence of study.

The introduction must answer the following questions: What is known and what is new on the studied issue? What necessitated the research problem, described in the paper? What is your hypothesis and goal?

Material and methods: The objects of research, organization of experiments, chemical analyses, statistical and other methods and conditions applied for the experiments should be described in detail. A criterion of sufficient information is to be

possible for others to repeat the experiment in order to verify results.

Results are presented in understandable tables and figures, accompanied by the statistical parameters needed for the evaluation. Data from tables and figures should not be repeated in the text.

Tables should be as simple and as few as possible. Each table should have its own explanatory title and to be typed on a separate page. They should be outside the main body of the text and an indication should be given where it should be inserted.

Figures should be sharp with good contrast and rendition. Graphic materials should be preferred. Photographs to be appropriate for printing. Illustrations are supplied in colour as an exception after special agreement with the editorial board and possible payment of extra costs. The figures are to be each in a single file and their location should be given within the text.

Discussion: The objective of this section is to indicate the scientific significance of the study. By comparing the results and conclusions of other scientists the contribution of the study for expanding or modifying existing knowledge is pointed out clearly and convincingly to the reader.

Conclusion: The most important consequences for the science and practice resulting from the conducted research should be summarized in a few sentences. The conclusions shouldn't be numbered and no new paragraphs be used. Contributions are the core of conclusions.

References:

In the text, references should be cited as follows: single author: Sandberg (2002); two authors: Andersson and Georges (2004); more than two authors: Andersson et al. (2003). When several references are cited simultaneously, they should be ranked by chronological order e.g.: (Sandberg, 2002; Andersson et al., 2003; Andersson and Georges, 2004). References are arranged alphabetically by the name of the first author. If an author is cited more than once, first his individual publications are given ranked by year, then come publications with one co-author, two co-authors, etc. The names of authors, article and journal titles in the Cyrillic or alphabet different from Latin, should be transliterated into Latin and article titles should be translated into English. The original language of articles and books translated into English is indicated in

parenthesis after the bibliographic reference (Bulgarian = Bg, Russian = Ru, Serbian = Sr, if in the Cyrillic, Mongolian = Mo, Greek = Gr, Georgian = Geor., Japanese = Ja, Chinese = Ch, Arabic = Ar, etc.)

The following order in the reference list is recommended:

Journal articles: Author(s) surname and initials, year. Title. Full title of the journal, volume, pages. Example:

Simm G, Lewis RM, Grundy B and Dingwall WS, 2002. Responses to selection for lean growth in sheep. *Animal Science*, 74, 39-50

Books: Author(s) surname and initials, year. Title. Edition, name of publisher, place of publication. Example: **Oldenbroek JK**, 1999. Genebanks and the conservation of farm animal genetic resources, Second edition. DLO Institute for Animal Science and Health, Netherlands.

Book chapter or conference proceedings: Author(s) surname and initials, year. Title. In: Title of the book or of the proceedings followed by the editor(s), volume, pages. Name of publisher, place of publication. Example:

Mauff G, Pulverer G, Operkuch W, Hummel K and Hidden C, 1995. C3-variants and diverse phenotypes of unconverted and converted C3. In: Provides of the Biological Fluids (ed. H. Peters), vol. 22, 143-165, Pergamon Press. Oxford, UK.

Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows, IXth International Conference on Production Diseases in Farm Animals, Sept. 11 – 14, Berlin, Germany, p. 302 (Abstr.).

Thesis:

Penkov D, 2008. Estimation of metabolic energy and true digestibility of amino acids of some feeds in experiments with muscovy duck (*Carina moschata*, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

The Editorial Board of the Journal is not responsible for incorrect quotes of reference sources and the relevant violations of copyrights.



CONTENTS

Genetics and Breeding

- Influence of various cryoprotectants on the sperm mobility of Muscovy semen before and after cryopreservation** 57
V. Gerzilov

61

Adaptive possibility and yield stability of varieties of oil-bearing roses

N. Kovatcheva, K. Rusanov, I. Atanasov

Nutrition and Physiology

Shelter policies in the management of canine aggression

A. Arnaudova, I. Varlyakov

64

Production Systems

Daily dynamics of the essential oils of *Rosa damascena* Mill. and *Rosa alba* L.

A. Dobрева, N. Kovacheva

71

Effectiveness of the insecticide "Mido 20 SL" in the fight with the green rose aphid populations (*Macrosiphum Rosae* L)

H. Lambev

75

Potassium fertilization on cotton

G. Panayotova, N. Valkova

78

Agriculture and Environment

Microbial communities in areas affected by formation of calcrete in the Thracian plane

S. Bratkova, K. Nikolova, K. Gesheva

84

An approach for Fusarium infected corn kernels recognition using linear discrete models

P. Daskalov, V. Mancheva, Ts. Draganova, R. Tsonev

90

Mechanism-based category formation of aldehydes for acute aquatic toxicity and mutagenicity

Y. Koleva

96

Quality and Safety

Gas-chromatography and organoleptic analysis of the essential oil of *Agastache foeniculum* (Pursh.) Kuntze

G. Zhekova, A. Dzhurmanski, A. Dobрева

102

Comparative studies on the fatty acid composition of White brined cheese, marketed in the town of Stara Zagora

N. Naydenova, K. Davidova, T. Iliev, G. Mihaylova

105