ISSN 1313 - 8820 (print)
ISSN 1314 - 412X (online)
Volume 10, Number 2
June 2018

AGRICULTURAL SCIENCE AND TECHNOLOGY

2018

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

There are no submission / handling / publication charges.

All manuscripts written in English should be submitted as MS-Word file attachments via e-mail to editoffice@agriscitech.eu. Manuscripts must be prepared strictly in accordance with the detailed instructions for authors at the website www.agriscitech.eu 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 on 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 from request from the Technical Assistance or could be downloaded from the website of the journal. Manuscripts submitted to this journal are considered if they have submitted only to it, they have not been published already, nor are they under consideration for publication in press elsewhere. 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.

The journal is committed to respect high standards of ethics in the editing and reviewing process and malpractice statement. Commitments of authors related to authorship are also very important for a high standard of ethics and publishing. We follow closely the Committee on Publication Ethics (COPE), http://publicationethics.org/resources/guidelines

The articles appearing in this journal are indexed and abstracted in: AGRIS (FAO), CABI, EBSCO-host, ROAD and DOAJ. DOI system is used for article indentification

The journal is freely available without charge to the user or his/her institution. Users can read, download, copy, distribute, print, search, or link to the full texts of the articles, or use them for any other lawful purpose, without asking prior permission from the publisher or the author.

This issue is printed with the financial support by Contract No. DNP 06-41/20.12.2017, financed from Fund 'Scientific Research' grant Bulgarian scientific periodicals.

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
www.agriscitech.eu

Technical Assistance:
Nely Tsvetanova
Telephone: +359 42 699446
E-mail: editoffice@agriscitech.eu

ISSN 1313 - 8820 (print)
ISSN 1314 - 412X (online)

Volume 10, Number 2
June 2018

AGRICULTURAL SCIENCE AND TECHNOLOGY

2018

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

AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 10, No 2, pp 140 - 143, 2018
DOI: 10.15547/ast.2018.02.028

Assessment of the yields of essential oil crops in Bulgaria through mathematical approaches

N. Keranova*

Department of Mathematics, Informatics and Physics, Faculty of Economics, Agricultural University-Plovdiv, 4000 Plovdiv, Bulgaria

(Manuscript received 9 April 2018; accepted for publication 23 May 2018)

Abstract. *The present study examines the yields of the following essential-oil crops: oil-yielding rose (Rosa Damascena), peppermint (Mentha piperita), lavender (Lavendula angustifolia Mill.), coriander (Coriandrum sativum L.) and lemon balm (Melissa officinalis) in Bulgaria from 2003 to 2013 based on mathematical approaches. Correlation and regression analyses have been applied using the capabilities of the IBM Statistics SPSS 24 and the MS Excel 2010 software. The study proves the existence of positive correlations between 'year' and 'yield' of the lemon balm (r=0.609*), between oil-yielding rose and lavender (r=0.620*) and between lavender and coriander (r=0.766**) and negative association between 'year' and the peppermint yield (r=-0.700*). Between yields of other crops - oil-yielding rose, coriander and lavender, and between year and the yields from these crops there are no statistically proven relations. Linear regression equations are presented, showing the relation between the year and the quantity of lemon balm and peppermint production.*

Keywords: essential oils, productivity, yields, correlations, regression equations

Introduction

Essential-oil crops are widespread in the vegetation world. Some of them are wild, others are field plants and some are garden plants. Essential oils are widely used. They are used in pharmacy to make medicines because of the bactericidal properties of oils and in food industry in the form of spices or preservatives, and in perfumery and cosmetics - for the production of perfumes, creams, etc.

There are a number of studies related to the production and characteristics of essential oil plants. Much of these are mathematical approaches to the study and analysis of both the average yield of these crops and the interaction of various indicators on the chemical components of the plant. The most commonly applied are correlation, regression and dispersion analyses. Cimanga et al. (2002) examines the relations and influence of various chemical components at *Eucalyptus alba, Eucalyptus citriodora* and *Eucalyptus deglupta* through a correlation analysis. The laboratory experiment has been carried out (Stavovich et al., 2011) by analyzing the essential oil contents in Tansy from two completely different locations - an unpolluted area and a highly contaminated industrial zone. Essential oil constituents are separated and identified using the GC-MS chromatography. Results showed that the plants react on environmental stress by higher production of essential oils.

Zheljazkov et al. (2013) established the effect of the length of time for distillation (DT) on lavender essential oil yield and composition when extracted from dried flowers. Results suggest that lavender essential oil yield may not increase after 60 min DT. The change in essential oil yield and the concentrations of cineole, fenchol and linalool acetate as DT changes were modeled very well by the asymptotic non-linear regression equation. Rezende et al. (2013) found that the environmental factors influence on the chemical composition of leaf essential oils of *Syzygium jambos* are important because they contribute data about its cultivation, harvest and establish parameters for essential oil components. The data are analyzed using stepwise multiple regression and cluster analyses, and the results suggest that the main factor capable to influence the chemical composition of leaf essential oils was the collection period, while the collection site has a minor effect.

Characterization and confirmation of identity as part of the structural interaction perspective of essential oils biostructure from lavender (*Lavandula officinalis*), peppermint (*Mentha piperita*), green Douglas (*Pseudotsuga menziesii*), fir (*Abies alba*) and chicory (*Cichorium intybus*) are addressed by qualitative detection and quantification of specific natural clusters, by infrared absorption spectrophotometry (Samfira et al., 2015). The method allows the identification of structural components that are characteristic to essential oils. Digitized spectra comparison by calculating the correlation coefficient is a convenient way, fast and safe for objective confirmation of the identity of essential oils.

Omer et al. (2013) applied mathematical approaches for study of the morphological parameters, yield and essential oil of Ajwain (*Trachyspermumammi*) growth on saline soil. It was established that plants are tolerant to soil salinity and the maximum productivity of seeds, straw and essential oil are produced at high levels of salinity 9.32-10.48 ds/m, while the minimum is obtained at lower ones 6.72-7.48 ds/m. Hazzoumi et al. (2015) found negative correlation (-0.840**) between irrigation water content and the yield of *Pelargonium* sp., an aromatic essential oil plant widely used in Morocco.

The variety of essential oil crops in Bulgaria is an object of the interest of Bulgarian scientists in this field as well. Stanev and Zheljazkov (2004) conducted a two-year field experiment to study the essential oil and menthol productivity of 19 cultivars and population of peppermint. The authors evaluated the available peppermint material obtained through various breeding methods with respect to further selection and breeding by using two indices: intensity of essential oil synthesis (as the necessary dry herba for obtaining 1g of essential oil), and intensity of menthol synthesis and accumulation (as the necessary dry herba for obtaining 1g of menthol). The highest essential oil content in dry herba was measured in two varieties - Dulgo pole (2.5%) and Bulgarian

* e-mail: nelikeranova@abv.bg

population (2.9%). The highest menthol content was established in the oils from cultivars Zefir, Dulgo pole and Clone.

Zheljazkov et al. (2012) carried out field and laboratory experiments to evaluate the productivity and essential oil composition of lavender (*Lavandula angustifolia* Mill.) and hyssop (*Hyssopus officinalis* L.) as functions of year, harvest time and drying. Lavender essential oil content ranged from 0.71 to 1.3% (overall average of 0.89%) and hyssop oil content ranged from 0.13 to 0.26% (overall average of 0.19%). Lavender and hyssop essential oil yields increased with time. Lavender oil extracted from dry material has higher concentrations of linalyl acetate and caryophyllene but lower concentrations of myrcene than the oil from the fresh material.

Kovacheva (2011) examines the impact of the application of a soil improver on some economic indicators in the oil-yielding rose, using a single-factor analysis of variance and correlation analysis. Correlations show that the weight of a flower is the strongest positive depending on the addition of Terawet proven statistical level at p=0.95. Positive effect, but lower in degree is the correlation between use of Terawet and weight and number of flowers from a shrub (0.609 and 0.545). When creating a new plantation, the highest percentage of 94% claps was observed in variants with dipping roots in a solution of 5g Terawet in 1L of water.

Not many studies have been reported to reflect the changes of yields of essential oil crops over the years, both in Bulgaria and around the world. Even less are those based on different mathematical approaches, which determines the need to analyze the trends in the production of such output through the above-mentioned methods. The present study explores the average yields of oil-yielding rose (*Rosa Damascena*), lavender (*Lavendula angustifolia* Mill.), peppermint (*Mentha piperita*), coriander (*Coriandrum sativum* L.) and lemon balm (*Melissa officinalis*) from 2003 to 2013 based on mathematical approaches.

Material and methods

The present study examines the yields of the following essential-oil crops: oil-yielding rose (*Rosa Damascena*), peppermint (*Mentha piperita*), lavender (*Lavendula angustifolia Mill.*), coriander (*Coriandrum sativum L.*) and lemon balm (*Melissa officinalis*) in Bulgaria for the period 2003-2013. The data are derived from the Agrostatistics bulletin of the Ministry of Agriculture, Food and Forestry of the Republic of Bulgaria. It's well known that the necessary condition for applying a regression analysis on a series of data is their normal distribution.

In order to analyze the information, correlation and regression analyses were applied. The correlation coefficients of Pearson-Brave were determined, giving information about the relation between the year and the average yields of the crops indicated. It is calculated according to the formula:

$$r = \frac{\Sigma^n_{i=1}(Y_i-\overline{Y})(X_i-\overline{X})}{\sqrt{\Sigma^n_{i=1}(Y_i-\overline{Y})^2\Sigma^n_{i=1}(X_i-\overline{X})^2}}$$

Where: $\overline{X}$, $\overline{Y}$ are the arithmetic mean of the two variables.

After applying regression analysis, mathematical equations were constructed, presenting in an analytical form the relation between the year and the yield of the respective crop. There are graphs, visualizing the variation in yields. They enable tracing the change of production over years as well as comparing the yields of the different crops.

The MS Excel 2010 software has been used to create the described graphs. The tools of IBM Statistics SPSS 24 (Field, 2013; Meyers et al., 2013; Weinberg et al., 2016; Wendler and Gröttrup, 2016) were used for the correlation and regression analyses, as well as for establishing the normality of the data distribution.

Results and discussion

The results for the average yields of essential-oil crops in Bulgaria are presented in Figure 1. Sensible differences in the yields of peppermint and the other crops require the introduction of a second (right) coordinate axis. It measures peppermint yields. This gives a realistic picture of the dynamics of production, on the one hand, and easier interpretation, on the other. Between 2003 and 2013, there was a dynamic change in peppermint (*Mentha piperita*) yields. There were strong drops in 2003-2004, 2010-2011 and even stronger in 2006-2007. A significant increase in the output of peppermint was found in 2005-2006 and a slight increase in 2007-2010. None of the increases has been able to compensate the

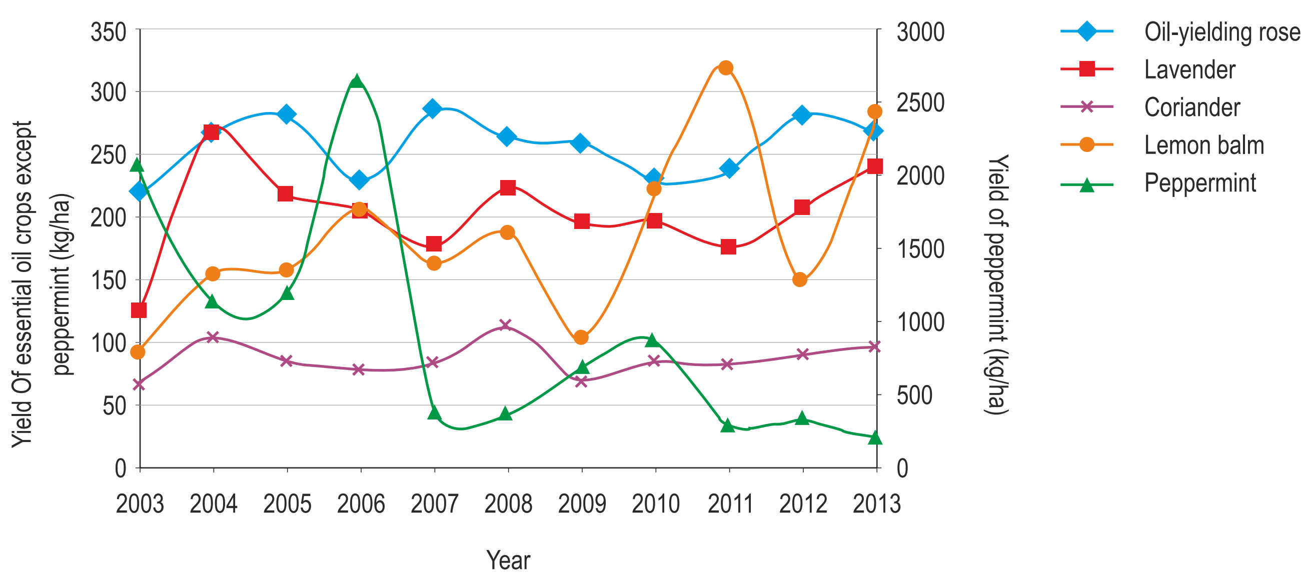

Figure 1. Average yields of essential-oil crops in Bulgaria during the period 2003-2013

decline since 2006. After 2011, we have relative stability of the yields, which is also observed in the other studied essential-oil crops.

The interest of farmers in the production of peppermint in the period 2003-2010 could be explained in several directions. On the one hand, there is a strong interest in Western European markets. On the other hand, the cost per decare in Bulgaria during this period is almost half of the possible income, making this activity attractive.

The graph in Figure 1 shows that the most stable according to the analyzed parameters from 2003 to 2013 is coriander (*Coriandrum sativum* L.). In all the other crops, the yield change is low, with no sharp peaks or drops, with the values of all crops changing in close proximity.

The results of the correlation analysis are shown in Table 1. Both the calculated correlation coefficients and their degree of significance at a significance level of less than 0.05 are given. The study proves the existence of positive correlations between 'year' and 'yield' of the lemon balm (r=0.609*), between oil-yielding rose and lavender (r=0.620*) and between lavender and coriander (r=0.766**), and negative association between 'year' and the peppermint yield (r=-0.700*). If the trend of yield variation for the period 2003-2013 persists, the lemon balm forecasts would be optimistic. On the reverse side are the peppermint forecasts.

Table 1. Pearson's correlation matrix for the analyzed parameters (yields of essential oil crops, year)

	Year	Oil-yielding rose	Lavender	Peppermint	Coriander	Lemon balm
Year	1.00	0.430	0.348	-0.700*	0.253	0.609*
Oil-yielding rose		1.00	0.620*	-0.592	0.426	-0.105
Lavender			1.00	-0.272	0.766**	0.229
Peppermint				1.00	-0.417	-0.351
Coriander					1.00	0.300
Lemon balm						1.00

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)

The fact that the correlation coefficients obtained between the survey year and the average yields of oil-yielding rose, coriander and lavender from 2003 to 2013 are not statistically significant is the reason why the relevant regression equations presenting the links between them are not included in the presentation. The latter would be statistically insignificant. They cannot be the basis for future research and analysis.

As previously indicated, in order to implement a regression analysis, the data must have normal distribution. In the present study this fact was confirmed by the Kolmogorov-Smirnov Test (1974), (One-Sample Kolmogorov-Smirnov Test).

The regression equation representing the dependencies between the average yields of lemon balm and peppermint, respectively, and the year are given in Table 2.

Table 2. Regression equations presenting the relations between year (x) and yield (y) at Lemon balm and Peppermint

Essential oil crops	Regression equation	Sign. of regr. eq. (*)	SS	F	Coeff. of determ	p-value of const	p-value of x-variable
Peppermint	y=335932.4-166.836x	0.02	3061781	8.63	0.49	0.02	0.02
Lemon balm	y=-25442.7+12.76364x	0.04	17920.15	5.31	0.37	0.04	0.04

* the regression equation is statistically significant at p<0.05

Through the regression analysis, it was found that the composite equation and the coefficients involved in it are statistically significant. The obtained relation once again confirms the result of the correlation analysis – the positive correlation between the year and the average yield of lemon balm. As mentioned, there is a negative relation between 'year' and peppermint yield and this is confirmed by the compiled regression equation. Here again it is statistically significant.

Conclusion

As a result of this study, it was found that the most stable, although not the maximum, are the yields of oil-yielding rose. This could be explained by the fact that Bulgaria has long-standing traditions and experience in the production of this crop and has gained worldwide fame with it. The lack of sensitive dynamics in the change of yields and the lack of advantage of a crop over the rest could be attributed to their equal support through European programs and the monotony of domestic markets. The mathematical approaches (graphic images, correlation and regression analysis), applied in this study, provide information on trends in the change of output quantities (from the sign in front of the independent variable in the regression equation) over the years. As a result of the analysis, it has been proved that positive correlations exist between 'year' and 'yield' of the lemon balm (r=0.609*), between oil-yielding rose and lavender (r=0.620*) and between lavender and coriander (r=0.766**), and negative association between 'year' and the peppermint yield (r=-0.700*). When the differences in the values of the dependent variable (yield of the respective crop) for each year are large, then the corresponding mathematical equation will result in a value, which is significantly different from the actual one. For this reason, the differences between the statistical data and the theoretical data would be significant. As for the reasons why the interest of Bulgarian agricultural producers in the oil-based crops is not growing, other explanations should be sought.

References

Agrostatistical reference book 2000-2013. Ministry of Agriculture, Food and Forestry of the Republic of Bulgaria, Sofia (Bg.)

Cimanga K, Kambu K, Apers S, De Bruyne T, Hermans N, Totte J, Pieters L and Vlietinck A, 2002. Correlation between chemical composition and antibacterial activity of essential oils of some aromatic medicinal plants growing in the Democratic Republic of Congo. Journal of Ethnopharmacology, 79, 213-220.

Field A, 2013. Discovering Statistics using IBM SPSS Statistics, Mobile Study, London.

Hazzoumi Z, Moustakime Y and Amrani Joutei K, 2015. Variation in yield and composition of essential oil in Pelargonium sp. during the vegetative stage, International Conference on Chemical, Environmental and Biological Sciences (CEBS-2015), Dubai (UAE), http://iicbe.org/upload/4824C0315104.pdf

Kovacheva N, 2011. Effect of applying a synthetic soil improved on some economic characters of oil-bearing rose. Science & Technologies, I, 165-169.
http://www.sustz.com/journal/VolumeI/Number6/Papers/NatashaKovacheva2.pdf

Meyers L, Gamst G and Guarino A, 2013. Performing Data Analysis Using IBM SPSS, Wiley.

Omer E, Said-Al Ahl H and El Gendy A, 2014. Yield and Essential Oil of Ajwain (*Trachyspermumammi*) Plant Cultivated in Saline Soil of North Sinai in Egypt. Journal of Essential Oil Bearing Plants, 17, 469-477.

Rezende W, Borges L, Alves N, Ferri P and Paula J, 2014. Chemical variability in the essential oils from leaves of Syzygiumjambos. Revista Brasileira de Farmacognosia Brazilian Journal of Pharmacognosy, 23, 433-440.

Samfira I, Rodino S, Petrache P, Cristina R, Butu M and Butnariu M, 2015. Characterization and identity confirmation of essential oils by mid infrared absorption spectrophotometry. Digest journal of nanomaterials and bioctructures, 10, 557-566.

Stanev S and Zheljazkov V, 2004. Study on essential oil and free menthol accumulation in 19 cultivars, populations and clones of peppermint (Mentha x Piperita). Acta Holticulturae, 629, 149-152.

Stavovich S, Calic D and Mikovilovic V, 2011. Correlation Between Environment and Essential Oil Production in Medical Plants. Advanced in Environmental Biology, 5, 465-468.

Weinberg S and Abramowitz S, 2016. Statistics Using IBM SPSS. An Integrative Approach, Cambridge University Press.

Wendler T and Gröttrup S, 2016. Data mining with SPSS modeler: Theory, exercises and solutions, Springer International Publishing, Switzerland, p. 302, DOI 10.1007/978-3-319-28709-0.

Zheljazkov V, Astatkie T and Hristov A, 2012. Lavender and hyssop productivity, oil content, and bioactivity as a function of harvest time and drying. Industrial crops and products, 36, 222-228.

Zheljazkov V, Cantrell C, Astatkie T and Jeliazkova E, 2013. Distillation year effect on lavender essential oil yield and composition. Journal Oleo Sciences, 62, 195-199.

CONTENTS

Review

CONTENTS

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, September 11–14, Berlin, Germany.

Thesis:

Hristova D, 2013. Investigation on genetic diversity in local sheep breeds using DNA markers. Thesis for PhD, Trakia University, Stara Zagora, Bulgaria, (Bg).

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

Animal welfare

Studies performed on experimental animals should be carried out according to internationally recognized guidelines for animal welfare. That should be clearly described in the respective section "Material and methods".

AGRICULTURAL SCIENCE AND TECHNOLOGY

Volume 10, Number 2
June 2018

Journal web site:
www.agriscitech.eu

Publisher:
www.alfamarket.biz