ISSN 1313 - 8820
Volume 5, Number 4
December 2013

AGRICULTURAL SCIENCE AND TECHNOLOGY

2013

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

All manuscripts 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 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 articles appearing in this journal are indexed and abstracted in: EBSCO Publishing, Inc. and AGRIS (FAO).
The journal is accepted to be indexed with the support of a project № BG051PO001-3.3.05-0001 “Science and business” financed by Operational Programme “Human Resources Development” of EU.
The title has been suggested to be included in SCOPUS (Elsevier) and Electronic Journals Submission Form (Thomson Reuters).

Internet Access

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

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/

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

ISSN 1313 - 8820

Volume 5, Number 4
December 2013

AGRICULTURAL SCIENCE AND TECHNOLOGY

2013

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

Evaluation of the combining ability of grain yield of mutant maize lines

M. Ilchovska*

Maize Research Institute, 5835 Knezha, Bulgaria

Abstract. *For the purposes of preliminary evaluation of the combining ability for grain yield of 12 mutant maize lines a top cross method for early testing and the mathematical model of Savchenko(1993) for analysis of the general combining ability and specific combining ability of these lines are used. Mutant lines are tested by three testers that have proven high general combining ability. For the purposes of evaluation of the productive abilities of the received top crosses at the experimental filed of Maize Institute,Knezha three preliminary varietal experiments are carried out by using agro technique accepted for the region. As a result of the committed experimental workand the analysis performed under the method of Savchenkoit is established that the lines XM 42-7-1*-1, XM 34-1-1*-1 and XM 33-4-4-1 have the highest generalcombining ability. They can be used as components for obtaining synthetics with high yields or as testers in analyzing crosses for determining the general combining ability at earlier stages of the selection process. Specified lines with high specific combining ability – XM 4-1-1-1, XM 31-1-3*-1, XM 44-6-2*-1, XM 34-1-1*-1 and XM 3-5-1-1 are appropriate to be included in the combination for obtaining hybrids with high yields. Two mutant lines of the spectrum – XM 33-4-4-1 and XM 42-7-1*-1, have both high general combining ability and specific combiningability. They can be used in both selection directions.*

Keywords: mutant lines, general and specific combining ability, synthetics, grain yield

Introduction

A question of present interest remains the one for creation and improvement of the source material for maize selection. The use of experimental mutagenesis causes mutation of individual genes or a group of genes that have valuable economic qualities and, as a result, it is possible to obtain varieties and lines with new qualities, without affecting the main genotype of the source material that facilitates and accelerates selection (Hristova, 1988).In this aspect, the experimental mutagenesis and the mutant selection may be effectively applied upon creating and selecting lines with high productivity combined with the high general and specific combining ability and a number of other economical qualities(Blyandur, 1974; Morgun, 1983; Genov, 1988; Hristova, 1988; Hristova and Hristov, 1990; Hristova and Hristov 1995; Valkova, 2013).

In the heterosis selection the evaluation of the combining ability of the lines is one of the most important stages in the selection process. For the purposes of evaluation of the combining ability some systems of crosses are used: top crosses, poly crosses, diallelesand setprosses (Yordanov, 2004;Valkova, 2005;Petrovska and Genova, 2007;Petrovska and Genova, 2009; Ivanov and Ivanova, 2010; Petrovska, 2012, etc.). The top cross is used at the initial stages of the selection experiment and allows fast and satisfactory evaluation of the combining ability of the investigated material. The successful application of this method depends to the greatest extent on the selection of the tester, the stage of breeding and the stage of self-pollination of the lines and the number of testers. The combining of valuable forms continues with diallele and setpross crossing for the purposes of investigation of their general combining ability (GCA) and specific combining ability (SCA).

The screening of the newly created and introduced selection material and determining of lines with high GCA and SCA is a precondition for accelerated creation of more productive maize hybrids. In the heterosis selection the evaluation of the combining ability of the lines is one of the most important stages of the selection process.

The purpose of this study is the evaluation of the combining ability for grain yield of mutant maize lines with a view to their more effective use in the selection process.

* e-mail: ilchovska_mima@abv.bg

Material and methods

The studies were performed in the period 2004 – 2012. As an object of the mutagenic treatment are used dry hybrid seeds treated with a NMU solution (n-nitroso, n-methyl urea) at concentration of 10–4%, exposure 24 h.After self-pollination and selection based on valuable economic qualities the mutant lines in M4, M5 generations were tested in isolation by three testers: XM 92 471, XM 4418 and XM 4390.

The hybrid combinations have been tested at field experiments by the method “Latin rectangle”, at three repetitions with a size of the crop area of 5m², under conditions of the agro technique accepted for the region, without irrigation. Statistical processing of the source data from the experiment for grain yield is made by the dispersion analysis method of Shanin (1977). For the analysis of the GCA and SCA the mathematic model of Savchenko (1973) is used.

Results and discussion

Table 1 shows the average data for grain yield of the mutant lines crosses. The dispersion analysis of the data from the field experiments shows reliable differences between them ($F > F_{crit.}$). The yield of the investigated crosses varies between 5747 kg/ha and 10890 kg/ha. Hybrid combinations where the line XM 92 471 participates have the highest yields compared to the ones of the other two testers. Three of them – XM 33-4-4-1 x XM 92 471, XM 42-7-1*-1 x XM 92 471 and XM 34-1-1*-1 x XM 92 471 have the highest

Table 1. Grain yield (kg/ha) of the hybrids with mutant lines maize, 2011

Tester lines	XM 92 471	XM 4418	XM 4390
Mutant lines	Effects of GCA (gi, gj)		Variance of the effects of SCA(σ^2si, σ^2sj)
XM 13-1-1-1-1	7760	7000	7420
XM 3-5-1-1	6064	5748	6148
XM 4-1-1-1	6500	6760	5892
XM 13-1-3-3-1	7368	6358	6686
XM 18-1-1*-1	7468	6480	6616
XM 31-1-3*-1	7440	7480	7960
XM 31-1-1*-1-1	7424	6608	6490
XM 44-6-2*-1	7350	7166	7041
XM 28-2-4-1	7542	6928	6659
XM 33-4-4-1	10890	7090	7220
XM 34-1-1*-1	8580	8640	8560
XM 42-7-1*-1	9791	7093	10020
Mean for the testers	7851	6984	7228
$LSD_{5\%}$ – 516 kg/ha			
$LSD_{1\%}$ – 686 kg/ha			
$LSD_{0,1\%}$ – 888 kg/ha			

yield. From the crosses with line XM 4418, XM 34-1-1*-1 x XM 4418 is with higher yield and where tester XM 4390 participates – XM 34-1-1*-1 x XM 4390 and XM 42-7-1*-1 x XM 4390, respectively. All hybrid combinations with high yield are of interest for the selection and their testing continues with their investigation as a part of competitive and ecological varietals experiments.

By the dispersion analysis of the GCA and SCA for grain yield reliable differences between the lines involved in the crosses ($F > F_{crit.}$) are found, which allows the analysis of the evaluation of their combining ability to continue. As criteria for such evaluation are used the parameters gi,gj for GCA and σ^2si, σ^2sj for SCA (Table 2).Comparison of the effects of GCA with the variances of SCA of a particular line allows to judge the relative importance of the action of the genes. Griffing(1965) andTurbin et al. (1974), established that the GCA is determined by genes with additive effect and the SCA – by genes with dominant and epistate effects. At a later stage this is confirmed by the studies of Hristova(1988), Petrovska (2012),Valkova(2013).Therefore, based on the data shown at Table 2 certain conclusions about the directions of use of mutant lines in the selection process can be drawn.

Table 2. Effects of GCA (gi, gj) and variance of effects SCA (σ^2si, σ^2sj) for grain yield of mutant maizelines, 2011

XM 13-1-1-1-1	3.92	203.99
XM 3-5-1-1	-135.75	1464.17
XM 4-1-1-1	-97.70	4179.59
XM 13-1-3-3-1	-54.89	53.28
XM 18-1-1*-1	-44.66	210.22
XM 31-1-3*-1	27.30	3642.48
XM 31-1-1*1-1	-51.32	387.43
XM 44-6-2*-1	-6.85	2518.68
XM 28-2-4-1	-29.72	667.17
XM 33-4-4-1	104.59	29838.79
XM 3 4-1-1*-1	123.70	2205.22
XM 42-7-1*-1	161.39	18798.90
Standard error	(gi-gj)=±5.28	
	Tester lines	
XM 92 471	49.646	4466.46
XM 4418	-37.012	3619.50
XM 4390	-12.634	2609.03
Standard error	(gi-gj)=±4.72	

If the analyzed line has a high effect of the GCA and a low variance of the effects of the SCA, it shows that all combinations with this line in F_1 shall have the same heterosis effect and almost the same effect for the trait grain yield. Therefore, such line can be used as a component for creating synthetics. On the other hand, the high variance of the effect of the SCA of a particular line indicates that some of the combinations are relatively better and others – worse compared to what could be expected on the basis of the average value of the line. Such line should be included in combinations for obtaining hybrids with high yield (Hristova, 1978).

From the analyzed mutant lines with high GCA is the line XM 42-7-1*-1 followed by the lines XM 34-1-1*-1 and XM 33-4-4-1. In these lines the genes with additive effect dominate and therefore they are appropriate both as a source material for creating synthetics populations with high yield and as testers in earlier stages of the selection process. High variances of the effects of the SCA of these two lines (XM 33-4-4-1 and XM 42-7-1*-1) suppose their successful use also in combinations for obtaining hybrids with higher yield. Other five mutant lines (XM 4-1-1-1, XM 31-1-3*-1, XM 44-6-2*-1, XM 34-1-1*-1 and XM 3-5-1-1) have comparatively high SCA and low GCA. They are also appropriate to be included in the heterosis selection for obtaining hybrids with high yields.The remaining evaluated lines with low GCA and SCA are not appropriate for the obtaining of synthetics and hybrids with high yield; their application is according to the other qualities they have, which shall be analyzed in subsequent studies.

Conclusion

The mutant lines XM 42-7-1*-1, XM 34-1-1*-1 and XM 33-4-4-1 which have high GCA are appropriate for obtaining synthetics with high yield. They can participate also as testers at earlier stages of the selection process. High variances of the SCA in the lines XM 4-1-1-1, XM 31-1-3*-1, XM 44-6-2*-1, XM 34-1-1*-1 and XM 3-5-1-1 allow their use in combinations for obtaining hybrids with high yields. Two of the mutant lines XM 33-4-4-1 and XM 42-7-1*-1 which have high GCA and SCA can be successfully used in both directions.

The obtained hybrid combinations with high yield are included in competitive and ecological field experiments for the purposes of continuing their testing.

References

Blyandur OV, 1974. Chemical mutagenesis of maize lines, Publishing Shtiintsa, Kishinev

Genov M, 1988. Genetic investigation of diploid and tetraploid maize in regard to the heterosis and mutant variability. Thesis for

PhD, Maize Research Institute, Knezha (Bg).
Griffing JB, 1956. Concept of general and specific combining ability in relation to diallel crossing systems.Australian Journal of Biological Sciences, 9; p 463 - 493
Hristov K and Hristova P, 1995.Mutation breeding of maize - methods and achievements. Plant Science, XXXII, 1-2, 40 – 43.
Hristova P, 1978. Assessment of the Combining Ability of Maize Inbred Lines in Diallel Crosses. Genetics and Plant Breeding, 11, 6, 379 – 383.
Hristova P, 1988. Genetic and selection studies in regard to the improvement of some methods of heterosis selection of medium late and late maize hybrids. Thesis for PhD, Maize Research Institute, Knezha (Bg).
Hristova P and Hristov K, 1990.Mutation Breeding in Maize. V. Selection of mutant lines with Enhanced Combining Ability. Genetics and Breeding, 23, 3, 225 - 231
Ivanov SI and Ivanova I, 2010. Effect of the mutant gene Opaque-2 on the combining ability of maize inbred lines for protein content in the grain.Genetics and Breeding, 1-2, 11.
Morgun V, 1983. Experimental mutagenesis and its application in maize breeding, Publishing Naukova ,Kiev
Petrovska N, 2012. Combining ability for grain yield of mid-late maize inbred lines.Agricultural Science Technology, 4, 1, 7 -9.
Petrovska N and Genova I, 2007.Combining ability for grain yield of medium late inbred maize lines, Agricultural University – Plovdiv, Scientific Works, LII, 5, 225 - 228.
Petrovska N and Genova I, 2009.Combining ability of the elements of the crop of medium early maize lines.Scientific studies – Plovdiv, Agricultural Institute, LIV, 99-107.
Savchenko VK, 1973. Methods of genetic selection and genetic experiments.Science and Technic (Ru).
Turbin NV, Hotayleva LV and Tarutina AA, 1974.Diallel analysis in plant breeding.Science and Technic, Minsk (Ru).
Shanin Y, 1977. Methods of the field experiment. Bulgarian Academy of Science, Sofia.
Yordanov G, 2004. Analysis of the general and specific combining ability for grain yield of early inbred lines.Scientific Conference with international participation Stara Zagora 2004, Plant, 2. Genetics and Selection, Weeds, Diseases and Enemies, 108-110.
Valkova V, 2005. Evaluation of the CA for grain yield of inbred maize lines. Agricultural University – Plovdiv, Scientific Works, L, 5, 225 – 228.
Valkova V, 2013Breeding evaluation of newly stabilized lines of maize.AgriculturalScience and Technology, 5, 3, 257 – 260.

CONTENTS

Genetics and Breeding

Nutrition and Physiology

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, 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 muscus duck (Carina moshata, L). Thesis for DSc. Agrarian University, Plovdiv, 314 pp.

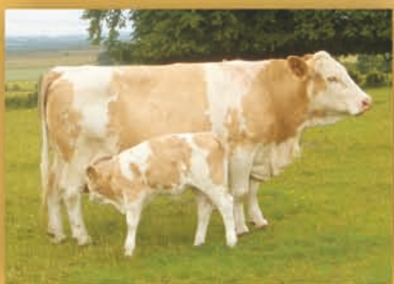
The Editorial Board of the Journal is not responsible for incorrect quotes of reference sources and the relevant violations of copyrights.

Ethics

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 5, Number 4
December 2013



Journal web site:
www.uni-sz.bg/ascitech/

Publisher:
www.alfamarket.biz