ISSN 1313 - 8820
Volume 8, Number 1
March 2016

AGRICULTURAL SCIENCE AND TECHNOLOGY

2016

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 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: DOI, 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).

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

Volume 8, Number 1
March 2016

AGRICULTURAL SCIENCE AND TECHNOLOGY

2016

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

AGRICULTURAL SCIENCE AND TECHNOLOGY, VOL. 8, No 1, pp 19 - 23, 2016
DOI: 10.15547/ast.2016.01.003

Genotype-environment interaction and stability analysis for grain yield of winter barley in the conditions of North-East and South Bulgaria

M. Dimitrova-Doneva[1]*, D. Valcheva[1], G. Mihova[2], B. Dyulgerova[1]

[1]Institute of Agriculture, 8400 Karnobat, Bulgaria
[2]Dobrudzha Agricultural Institute, 9520 General Toshevo, Bulgaria

(Manuscript received 30 October 2015; accepted for publication 8 February 2016)

Abstract. *The aim of this study was to evaluate the grain yield of winter varieties of feed barley in different environments and to determine their stabilities. Grain yield performances were evaluated for three years (2008/2009, 2009/2010, 2010/2011) at three locations (Karnobat, General Toshevo and Sredets) in Bulgaria. The combined analysis of variance indicated that environmental factors were the most important sources affecting yield variation and these factors significantly explained 90.58% (4.40, 59.20 and 26.98% for year, location and their interactions) of the total sum of squares due to G + E + GE interaction. The average grain yield of the studied varieties of winter feed barley ranged from 5.16 t/ha (Veslets) to 5.46 t/ha (Radul). The genotypic responses to environmental changes were assessed using a linear regression coefficient (bi), the variance of the regression deviations (SDi), Lin and Binns cultivar superiority index (Pi) and GGE biplot analysis. The variety Radul was the best at combining yield stability and high mean grain yield based on most stability statistics. Variety Veslets was the most stable, but lower yielding than other studied varieties.*

Keywords: barley, grain yield, genotype-environment interaction, stability

Introduction

In the breeding programs study of the amount of adaptability of crops in relation to different environmental conditions has special importance. Genotype by environment interactions (GEI) are extremely important in the development and evaluation of plant varieties because they reduce the genotypic-stability values under diverse environments (Hebert et al.,1995). In most cases breeders look for a variety that has good mean performance over a wide array of environments and years and the concept of stability is overlooked. Such approach is reasonable if there is no GEI, but in most cases there is interaction. Some genotypes can have high yield in some environments and very low yield in other environments, showing better mean performance across environments. But few genotypes may have average yield that is stable over wider environments. Therefore, knowledge of the pattern and magnitude of GEI and stability analysis is important for understanding the response of different genotypes to varying environments and for identification of stable and widely adapted and unstable but specifically adapted genotypes. Stability of the yield of a cultivar across a range of production environments is very important for variety recommendation. The cultivars must have the genetic potential for superior performance under ideal growing conditions, and must also produce acceptable yields under less favourable environments. Therefore, a stable genotype can be referred to as the one that is capable of utilizing the resources available in high yielding environments and has a mean performance that is above average in all environments (Allard and Bradshaw, 1964; Eberhart and Russell, 1966). The concept of stability has been defined in several ways and several biometrical methods including univariate and multivariate ones have been developed to assess stability (Finlay and Wilkinson,1963; Lin et al., 1986; Becker and Leon, 1988; Crossa, 1990; Yan and Kang, 2003).Only a few studies of genotype by environment interactions (GxE) and stability have been reported on barley in Bulgaria (Valcheva et al., 2007; Valcheva et al., 2009; Valcheva et al., 2012).

The objectives of this study were to evaluate the grain yield of winter varieties of feed barley in different environments and to determine their stabilities.

Material and methods

Five varieties of winter feed barley were used in this study. The varieties Veslets, Aheloy 2, Panagon and Hemus were developed at the Institute of Agriculture, Karnobat and the variety Radul was developed at the Dobrudzha Agricultural Institute, General Toshevo.

The research was performed at three test locations Karnobat (the Institute of Agriculture), General Toshevo (Dobrudzha Agricultural Institute) and Sredets (Agricultural Experimental Station) and during three years from 2008/2009 to 2010/2011 growing period.

The average temperature and precipitation during the experimental period is shown in Tables 1 and 2. The lowest monthly winter temperature was reported for location General Toshevo (-1.4°C in 2009/2010) and location Sredets (-1.4°C in 2008/2009) (Table 1). For the locations, long-term average total precipitation varied from 387.9 mm to 528.9 mm per growing season (Table 2). Precipitation during the experiments growing period for 2008/2009, 2009/2010 and 2010/2011 was 332.2 mm, 801.5 mm and 444.8 mm location Sredets, 274.9 mm, 773.3 mm and 344.4 mm in location Karnobat and 279.3 mm, 634.3 mm and 457.0 mm in location General Toshevo.

In each location and each year, the trial was sown in the optimal

* e-mail: md_doneva@abv.bg

Table 1. Temperature data, °C of 2008/2009 – 2010/2011 for the three locations

Months	Location Sredets						Location Karnobat						Location General Toshevo					
	2008 / 2009	2009 / 2010	2010 / 2011	Average temperature, °C	Long-term mean, °C	Deviation from the long-term mean, °C	2008 / 2009	2009 / 2010	2010 / 2011	Average temperature, °C	Long-term mean, °C	Deviation from the long-term mean, °C	2008 / 2009	2009 / 2010	2010 / 2011	Average temperature, °C	Long-term mean, °C	Deviation from the long-term mean, °C
X	13.5	14.4	11.7	13.2	13.7	-0.5	13.0	13.6	10.8	12.5	12.4	+0.1	12.2	12.7	12.7	12.5	11.5	+1.0
XI	9.6	11.4	13.4	11.5	9.1	+2.4	8.2	8.6	12.4	9.7	7.1	+2.6	7.1	8.8	8.8	8.2	6.3	+1.9
XII	5.7	4.2	4.2	4.7	4.4	+0.3	5.1	4.2	3.2	4.2	2.6	+1.6	4.3	2.8	2.8	3.3	1.8	+1.4
I	-1.4	0.7	1.9	0.4	1.8	-1.4	1.1	0.1	1.5	0.9	0.6	+0.3	1.0	-1.4	0.1	-0.1	-0.4	-0.3
II	4.8	4.6	1.6	3.6	3.6	0	3.6	4.1	1.3	3.0	2.2	+0.8	2.2	2.7	-0.1	1.3	0.8	+0.5
III	7.1	6.4	6.5	6.7	6.5	+0.2	6.2	6.1	6.1	6.1	5.3	+0.8	5.2	4.6	4.5	4.8	4.1	+0.7
IV	11.0	12.1	10.0	11.0	11.6	-0.6	10.6	11.2	9.2	10.3	10.5	-0.2	9.3	10.3	8.0	9.2	9.8	-0.3
V	17.6	17.7	16.0	17.1	16.8	+0.3	16.8	16.7	15.8	16.4	15.6	+0.8	15.5	15.6	14.7	15.3	15.0	+0.3
VI	22.3	21.6	22.3	22.1	20.8	+1.3	21.4	20.3	20.0	20.6	19.6	+1.0	20.7	19.2	19.3	19.7	19.0	+0.7

Table 2. Precipitation data, mm of 2008/2009 – 2010/2011 for the three locations

Months	Location Sredets						Location Karnobat						Location General Toshevo					
	2008 / 2009	2009 / 2010	2010 / 2011	Average Precipitation, mm	Long-term average, mm	Deviation from the long-term mean, mm	2008 / 2009	2009 / 2010	2010 / 2011	Average Precipitation, mm	Long-term average, mm	Deviation from the long-term mean, mm	2008 / 2009	2009 / 2010	2010 / 2011	Average Precipitation, mm	Long-term average, mm	Deviation from the long-term mean, mm
X	13.2	156.4	77.2	82.3	64.0	+18.3	41.2	122.8	70.5	78.2	44.3	+33.9	11.0	72.7	72.7	52.1	38.3	+13.8
XI	57.2	44.8	31.5	44.5	70.1	-25.6	25.2	43.2	15.3	27.9	53.7	-25.8	22.0	26.1	26.1	24.7	47.0	-22.3
XII	26.5	156.1	64.5	82.4	67.2	+15.2	46.6	152.8	55.9	85.1	51.2	+33.9	42.9	121.7	121.7	95.4	40.2	+55.2
I	61.9	112.5	54.4	72.3	60.2	+12.1	45.4	52.2	37.1	44.9	36.5	+8.4	36.7	66.5	35.9	46.4	33.0	+6.5
II	70.7	135.7	34.6	80.3	47.0	+33.3	50.7	136.7	24.6	70.7	35.8	+34.9	45.7	64.7	15.3	41.9	39.5	+4.2
III	41.8	90.0	31.0	54.3	45.3	+9.0	27.8	40.4	18.1	28.8	34.1	-5.3	18.3	64.5	20.6	34.5	34.5	+9.5
IV	7.2	21.0	89.1	39.1	48.7	-9.6	12.8	43.1	51.5	35.8	45.3	-9.5	34.6	22.2	49.2	35.3	42.7	+3.0
V	18.3	12.6	32.0	21.0	60.1	-48.7	12.9	66.0	50.1	43.0	58.5	-15.5	34.8	119.5	80.4	78.2	50.7	+12.5
VI	35.3	72.4	30.5	46.1	66.3	-20.2	12.3	116.1	21.4	49.9	65.2	-15.3	33.3	76.5	35.1	48.3	62.0	+15.2
∑	332.2	801.5	444.8	526.2	528.9	-2.7	274.9	773.3	344.4	464.3	424.6	+39.7	279.3	634.3	457.0	456.8	387.9	+68.9

sowing time for barley. The experimental design used at each test location was a Latin rectangle design with four replications. The varieties were planted with a planting rate of 450 grains for m^2. Plot size was 10 m^2. Appropriate pesticides were used to control insects, weeds and diseases, and appropriate fertilizers were applied at recommended rates for the location and year. The plot grain yield was converted to t/ha.

Combined analysis of variance was done for grain yield data to determine the effects of genotype (G), environment (E) and GEI using the SPSS 19.0 (SPSS Inc, 2010). The genotypic responses to environmental changes were assessed using a linear regression coefficient (bi) and the variance of the regression deviations (SDi) (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966).

Lin and Binns cultivar superiority index (Pi) was estimated by the square of differences between a genotype's and the maximum genotype mean at location, summed and divided by twice the number of locations (Lin and Binns, 1988).

The GGE biplot methodology, which is composed of two concepts, the biplot concept (Gabriel, 1971) and GGE concept (Yan et al., 2000) was also used to visually analyze and identify the genotypic stability of barley varieties. The GenStat 12.0 (GenStat, 2009) was used to compute stability parameters and for GGE biplot analysis.

Results and discussion

The grain yields of the varieties and locations in three growing seasons are presented in Table 3. The environment mean yield ranged from 3.94t/ha (Sredets, 2009/2010) to 7.79 t/ha (General Toshevo, 2008/2009) indicating differences among the test environments. In location General Toshevo the highest mean yield

Table 3. Grain yield (t/ha) of 5 winter feed barley varieties in three locations and in three growing seasons (2008/2009 – 2010/2011)

Varieties	Location Sredets				Location Karnobat				Location General Toshevo			
	2008 / 2009	2009 / 2010	2010 / 2011	Mean	2008 / 2009	2008 / 2009	2010 / 2011	Mean	2008 / 2009	2009 / 2010	2010 / 2011	Mean
Veslets	4.78	4.02	5.00	4.60	4.36	3.30	6.07	4.58	6.79	6.88	5.25	6.31
Aheloy 2	4.81	4.11	5.13	4.68	5.08	3.00	5.90	4.66	7.86	7.06	5.80	6.91
Panagon	4.10	3.72	4.10	3.97	4.49	3.93	7.10	5.17	7.81	8.06	5.61	7.16
Radul	4.35	3.92	4.49	4.25	4.81	3.79	5.30	4.63	8.34	8.47	5.65	7.49
Hemus	4.93	3.92	5.23	4.69	5.30	3.60	5.28	4.73	8.13	6.90	5.75	6.93
Mean	4.59	3.94	4.79	4.44	4.77	3.52	5.93	4.74	7.79	7.47	5.61	6.96

showed variety Radul (7.49 t/ha). In Karnobat with the highest mean yield was variety Panagon (5.17 t/ha) and in location Sredets – variety Hemus (4.69 t/ha). Analysis of variance for grain yield revealed highly significant differences among genotypes, location, year, year x location, year x genotype, location x genotype, year x location x genotype (Table 4). Location was the most important source of yield variation (59.20%) and environment significantly explained 90.58% (4.40, 59.20 and 26.98% for year, location and their interactions) of the total sum of squares due to G + E + GEI. The partitioning of variance components for environment revealed that both predictable (locations) and unpredictable (year) components were important sources of variation. When GEI is due to variation in predictable factors, a plant breeder has the choice of either developing specific genotypes for selected environments or broadly adapted genotypes that can perform well under variable conditions (Dehghani et al., 2006). Anyhow, when GEI results from unpredictable sources, a plant breeder needs to develop stable genotypes that can perform reasonably well under a range of environmental conditions. A remarkable grain yield variation explained by environments indicated that the environments tested in the study were diverse, with large differences between environmental effects causing the most variation in grain yields of barley genotypes. The Y × L × G or GEI significantly explained 2.23% of the G + E + GE variation in grain yield. The magnitude of the GEI sum of squares was almost four times larger than that for genotype, indicating that there were sizeable differences in responses according to genotype across environments. Kang and Pham (1991) indicated that GEI minimize the usefulness of genotype by confounding yield performance. To better investigate GEI, Becker and Leon (1988) showed that assessment of yield stability across many locations and years could increase both repeatability and heritability of the studied characters such as grain yield. The significance of GEI indicated that differential genotype expression across environments depends on the reaction of genotype on changing environmental conditions across locations and years. Some genotypes showed wide adaptation and stability over a range of environments, while others exhibited specific adaptation to specific environments. The inconsistent yield ranking in different environment indicates the presence of possible cross over GEI as described by Baker (1988), Crossa (1990), Yan and Hunt (2001), Kaya et al. (2006). This study agrees with cross over GEI reports of Ceccarelli (1989), Ceccarelli and Grando (1991), Jacson et al. (1993), Dehghani et al. (2006) and Jalata et al. (2011) in barley.

Figure 1 shows average environment coordination (AEC) view of the GGE biplot which indicated the mean performance and stability of genotypes (Yan and Hunt, 2002; Yan, 2002). In this method, an average environment is defined by the average PC1 and PC2 scores of all environments, represented by a small circle. A line is then drawn to pass through this average environment and the biplot origin. This line is called the average environment axis and serves as the abscissa of the AEC. The ordinate of the AEC is the line that passes through the origin and is perpendicular to the AEC abscissa. The AEC ordinate separates genotypes with below-average means from those with above-average means. In our study varieties with above-average means were Radul and Hemus, while genotypes with below-average means were Aheloy 2, Panagon and Veslets.

The length of the average environment vector (the distance from biplot origin and the average environment marker), relative to the biplot size, is a measure of the relative importance of genotype main effect vs. GEI. The longer it is, the more important is the genotype main effect, and the more meaningful the selection based

Table 4. Analysis of variance for grain yield of 5 winter feed barley varieties

Source of variation	SS	df	MS	Explained variation, %
Total	481.77	224	10.59***	
Year	21.19	2	142.61***	4.40
Location	285.21	2	0.68***	59.20
Genotype	2.70	4	32.50***	0.56
Year x Location	130.00	4	1.44***	26.98
Year x Genotype	11.50	8	2.24***	2.39
Location x Genotype	17.94	8	0.67***	3.72
Year x Location x Genotype	10.75	16	0.01	2.23
Error	2.48	180		0.51

*** Significant at 0.01 probability level; SS – sum of squares; df – degrees of freedom; MS – mean square;

Table 5. Mean of grain yield, regression coefficient (bi), deviation from regression (SDi), Lin and Binns superiority index (Pi) for 5 winter feed barley varieties

Varieties	Mean grain yield, t/ha	bi	SDi	Lin and Binns	
				Pi	Rank
Veslets	5.16	0.81	0.32	0.17593	5
Aheloy 2	5.42	0.98	0.33	0.05771	3
Panagon	5.44	1.14	0.58	0.06232	4
Radul	5.46	1.17	0.45	0.04962	1
Hemus	5.45	0.91	0.41	0.05676	2

on mean performance. For this study, the length of the average environment vector was not sufficient to select genotypes based on yield mean performances.

A longer projection to the AEC ordinate, regardless of the direction, represents a greater tendency of the GEI of a genotype, which means it is more variable and less stable across environments or vice versa. The results showed that from the studied varieties Veslets was the most stable genotype, but have low mean performance. Similar results were described by Yan and Tinker (2006) and Jalata et al. (2011). Varieties Hemus and Panagon have the longest vectors indicating unstable grain yield. The best combination between mean performance and stability, according GGE biplot analysis, showed Radul.

Linear regression for the average grain yield of a single genotype on the average yield of all genotypes in each environment resulted in regression coefficients (bi values) ranging from 0.81 to 1.17 for grain yield (Table 5). This large variation in regression coefficients indicates different responses of genotypes to environmental changes. Lin and Binns (1985) reported that genotypes with a bi value between 0.7 and 1.3 have average stability and wide general adaptability. Regression values above 1.0

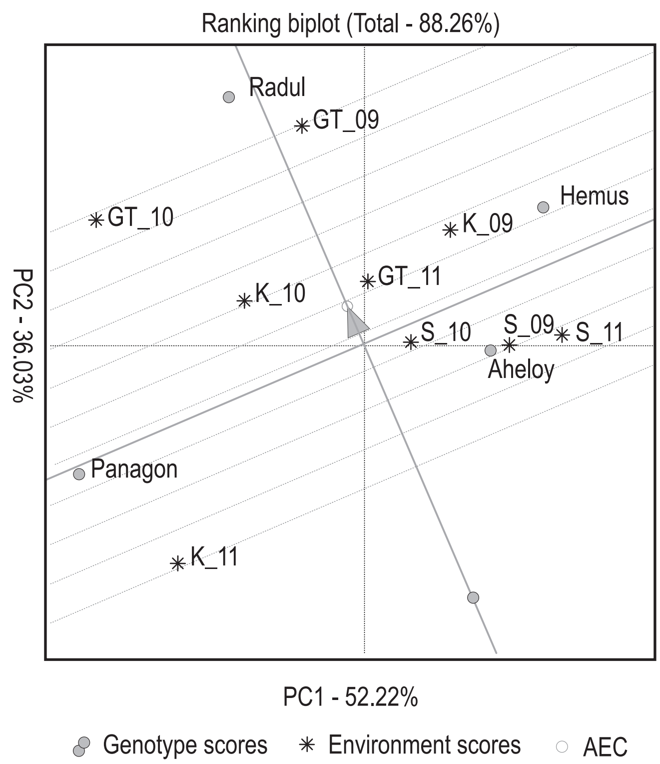

Figure 1. GGE biplot of mean and stability of 5 winter feed barley varieties for grain yield

describe genotypes with higher sensitivity to environmental change (below average stability) and greater specificity of adaptability to high yielding environments. A regression coefficient below 1.0 provides a measurement of greater resistance to environmental change (above average stability), and thus increases the specificity of adaptability to low yielding environments (Wachira et al., 2002). Accordingly, varieties Radul and Hemus showed higher grain yields than the mean yield and average stability. This genotype was considered the best in terms of adaptation to all environments. Genotypes with a regression coefficient equal to the unity (bi = 1) and small deviations from regression (SDi = 0) are considered stable (Finlay and Wilkinson, 1963; Eberhart and Russell, 1966). Varieties Aheloy 2 and Veslets were the most stable for grain yield because their regression coefficients were near to unity and they had lower deviations from regression. According to Lin and Binns (1988) index Pi constitutes a single measure of stability and performance superiority of a genotype. With this index, the most stable genotype was Radul, followed by Hemus, Aheloy 2 and Panagon (Table 5). The ranks of the Pi and mean grain yields were nearly similar and indicate that the Pi is a good indicator of stability. Similar results were obtained by Pavlov et al. (2011) and Abbott et al. (2012) finding that the highest yielding genotype had the lowest Pi value.

Conclusion

According to the results, the location was the most important source of yield variation (59.20%). Environment significantly explained 90.58% (4.40, 59.20 and 26.98% for year, location and their interactions) of the total sum of squares due to G + E + GEI. The average grain yield of the studied varieties of winter feed barley ranged from 5.16 t/ha (Veslets) to 5.46 t/ha (Radul). The variety Radul was the best at combining yield stability and high mean grain yield based on most stability statistics. Variety Veslets was the most stable, but lower yielding than other studied varieties

References

Abbott L, Filippini S, Delfino H and Pistorale S, 2012. Stability analysis of forage production in *Bromus catharticus* (prairie grass) using three methodologies. Ciencia e Investigación Agraria 39, 331-338.

Allard RW and Bradshaw AD, 1964. Implications of genotype-environmental interactions in applied plant breeding. Crop Science, 4, 503-508.

Baker RJ, 1988. Tests for cross over genotype-environment interactions. Canadian Journal of Plant Science, 68, 405-410.

Becker HB and Leon J, 1988. Stability analysis in plant breeding. Plant Breeding, 101, 1-23.
Ceccarelli S, 1989. Wide adaptation: How wide. Euphytica, 40, 197-205.
Ceccarelli S and Grando S, 1991. Selection environment and environmental sensitivity in barley. Euphytica, 57, 157-167.
Crossa J, 1990. Statistical analysis of multilocation trials. Advances in Agronomy, 44, 55-85.
Dehghani H, Ebadi A and Yousefi A, 2006. Biplot analysis of genotype by environment interaction for barley yield in Iran. Agronomy Journal, 98, 388-393.
Eberhart SA and Russell WA, 1966. Stability parameters for comparing varieties. Crop Science, 6, 36-40.
Eberhart SA and Russell WA, 1966. Stability parameters for comparing varieties. Crop Science, 6, 36-40.
Finlay KW and Wilkinson GN, 1963. The analysis of adaptation in a plant breeding programme. Australian Journal of Agricultural Research, 14, 742-754.
Gabriel KR, 1971. The biplot graphic display of matrices with application to principal component analysis. Biometrika, 58, 453-467.
GenStat, 2009. GenStat for Windows (12th Edition) Introduction. VSN International, Hemel Hempstead.
Hebert Y, Plomion C and Harzic N, 1995. Genotypic × environment interaction for root traits in maize as analysed with factorial regression models. Euphytica, 81, 85-92.
Jackson PA, Byth DE, Johnston RP and Fischer KS, 1993. Genotype x environment interactions in progeny from a barley cross. 1. Patterns of response among progeny genotypes for grain yield and time to anthesis. Australian Journal of Agricultural Research, 33, 619-627.
Jalata Z, Ay A and Fufa F, 2011.Assessment of Yield Stability and Disease Responses in Ethiopian Barley *(Hordeium vulgare* L.) Landraces and Crosses. International Journal of Agricultural Research, 6, 754-768.
Kang MS and Pham HN, 1991. Simultaneous selection for high yielding and stable crop genotypes. Agronomy Journal, 83, 161-165.
Kaya Y, Akcura M and Taner S, 2006. GGE-Biplot analysis of multi-environment yield trials in bread wheat. Turkish Journal of Agriculture and Forestry, 30, 325-337.
Lin CS and Binns MR, 1985. Procedural approach for assessing cultivar-location data: pairwise genotype-environment interactions of test cultivars with checks. Canadian Journal of Plant Science, 65, 1065-1071.
Lin CS and Binns MR, 1988. A Superiority Measure of Cultivar Performance for Cultivar x Location Data. Canadian Journal of Plant Science, 68, 193-198.
Pavlov J, Delić N, Stevanović M, Čamdžija Z, Grčić N and Crevar M, 2011. Grain yield of ZP maize hybrids in the maize growing areas in Serbia. Proceedings 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia, 395-398.
SPSS-Inc., 2010. IBM SPSS statistics 19 core system user's guide. USA: SPSS Inc., an IBM Company Headquarters.
Valcheva D, Michova G, Vulchev D and Venkova I, 2009. Influence of the enviroment on yield of some barley varieties. Field Crop Studies, VI, 7-16.
Vulcheva D, Valchev D and E Penchev, 2007. Plasticity and stability of yield from drought resistant winter barley varieties and lines. Field Crop Studies, IV, 49-56.
Vulcheva D, Valchev D, Michova G, Doneva M and Dyulgerova D, 2012. Productive capacity of the winter malting barley varieties in the terms of the Northeast and Southeast Bulgaria. Field Crop Studies, VIII, 209-217.
Wachira F, Wilson NG, Omolo J and Mamati G, 2002. Genotype x environment interactions for tea yields. Euphytica, 127, 289-296.
Yan W, 2002. Singular value partitioning in biplot analysis of multienvironment trial data. Agronomy Journal, 94, 990-996.
Yan W and Kang MS, 2003. GGE biplot analysis: A graphical tool for breeders, geneticists, and agronomists. CRC Press, Boca Raton, FL.
Yan W, Hant LA, Qinglai S and Szalvincs Z, 2000. Cultivar evaluation and mega-environment investigation based on the GGE biplot. Crop Science, 40, 597-605.
Yan W and Hunt L, 2001. Interpretation of genotype X environment interaction for winter wheat yield in Ontario. Crop Science, 41, 19-25.
Yan W and Tinker NA, 2006. Biplot analysis of multi-environment trial data: Principles and applications. Canadian Journal of Plant Science, 86, 623-645.

CONTENTS

Review

Genetics and Breeding

Production Systems

Agriculture and Environment

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 8, Number 1
March 2016

Journal web site:
www.agriscitech.eu

Publisher:
www.alfamarket.biz