"SELEKCIJA I SEMENARSTVO"
PLANT BREEDING AND SEED PRODUCTION, VOL. XIII, No. 3-4 (2007), STR. 7-11, NOVI SAD

STABILITY OF VISUALLY ESTIMATED GRAIN QUALITY OF WINTER WHEAT IN EARLY GENERATIONS

VYTAUTAS RUZGAS, ŽILVINAS LIATUKAS[1]

SUMMARY: The evaluations were set up at the Lithuanian Institute of Agriculture (LIA) during 2004-2006. Results of visual estimation of grain quality traits (VEGQ) showed that dominant populations were with score 4 in F5 and F6, 43 % in 2004 and 52 % in 2005, respectively. The most frequent populations in F5 were with scores 3 (39 %) and 4 (35%) in the season 2005-2006. The fluctuation of VEGQ scores between years was generally plus- minus one score. The populations with stable scores in the cycle F5: F6 accounted for 47.8 % of the total populations evaluated. The populations varying in one score accounted for 43.5 % and those varying in two scores accounted for 8.7 %. VEGQ scores of the populations were mainly influenced by grain quality level of parental varieties. VEGQ scores did not correlate in cycle 2004/2005, but the populations of 2005/2006 highly correlated (r=0.72) by VEGQ scores.

Key words: *Visual grain quality, winter wheat, breeding populations*

INTRODUCTION: Many quality traits although affected by environmental factors, are under genetic control, which allows manipulation and selection by the breeders. The selection for the improvement of several simultaneous traits in autogamous plants is a difficult task, considering the complexity of the genetic basis involved, the need of large size populations for selection, the need of several recombination cycles and the difficulty of environmental control that can interfere with the phenotypic expression of the traits. Considering all the above, the genetic progress obtained with the selection of a unique individual with all the desired traits becomes a very hard task for the plant breeders. It becomes important to develop systems to conduct segregating populations, which increases the efficiency of better genotypes identification (Lukow and McVetty, 1991, de Andrade et al., 2001, Petrovič Sofija et al., 2006).

The level of rainfall in Lithuania during the spring and summer differs greatly from one year to another, so the varieties introduced into cultivation must be capable of giving high values of quality parameters with both an excess and deficit of rainfall. Due to developments in the food and baking industry, grain quality determines prices and market options to a large extent. The introduction of high quality wheat varieties into cultivation requires not only favourable technological parameters, but also good adaptation to unfavourable environmental conditions.

One of the elements of winter wheat breeding process at the Lithuanian Institute of Agriculture (LIA) at early generations (F4-F6) is strict visual evaluation of grain quality (VEGQ). The best ears selected in the nurseries are threshed and evaluated individually for phenotypic grain traits. The VEGQ is based on evaluation of grain filling level (shrivelling), smooth seed-coat, grain size and grain hardness level.

The objectives of this study were to evaluate the stability of VEGQ of wheat in early breeding populations between years differing in weather conditions.

Materials and methods

The evaluations were set up at the Lithuanian Institute of Agriculture (LIA) over the pe-

Originalni naučni rad (Original scientific paper)

[1]VYTAUTAS RUZGAS, Lithuanian University of Agriculture, Akademija, LT-53361, Kaunas district, Lithuania, ruzgas@lzi.lt; ŽILVINAS LIATUKAS, Lithuanian Institute of Agriculture, Akademija, LT-58341, Kdainiai district., Lithuania

riod 2004-2006. During the 2004-2005 cycle we assessed visual grain quality of 46 populations and during 2005-2006 of 100 populations of F5-F6 generations.

VGQ evaluation was done on 1-5 score scale, main factors for score formation were: grain size, grain filling and grain hardness levels. Score explanation: 1 - grain shrivelled, small; 2 - grain slightly shrivelled, small, 3 - grain medium size, seed-coat a little wrinkly, complete soft; 4 - grain medium-large, seed-coat smooth, hardness level low-medium; 5 - grain large, completely filled, hardness level medium-high. The mean population assessment score of VEGQ was general evaluation of selected ear-grains for further testing in the next generation.

The experimental material was sown after fallow in the middle of September in the breeding nurseries with natural infection. Each population of both generations was sown in six-row plots of 1 m length. The soil in the screening plot was loam, with a clay content of 24-27 %, pH 6.5; percentage of organic matter 2.3-2.5; P_2O_5 150-170; K_2O 180-200 mg kg^{-1} soil. N90P60K60 was applied annually. Potassium and phosphorus were applied before sowing, nitrogen in spring after resumption of vegetation. Populations were negatively selected for leaf disease susceptibility at milk stage (BBCH 71-79). Yield harvesting was done at full ripening (BBCH 91-93) by picking 100 best ears from the best rows for both generations. The selected ears were threshed individually for visual evaluation of grain number and quality.

The weather conditions during the experimental period were very different between years. The growing season of 2003/2004 was favourable for crop establishment, over wintering, growing and maturation. The next season 2004/2005 was less favourable due to late spring, water deficiency and high temperature during July. The third season 2005/2006 was very unfavourable. Very cold winter and late spring weakened plants and plant stand; some lines were killed by waterlogging. Spring was droughty and cold, summer was exceptionally dry and hot.

Results and discussion

Results of VEGQ showed (Table 1) that dominant populations were with VEGQ score 4 in F5 and F6, 43 % in 2004 and 52 % in 2005, respectively.

Tab. 1. Distribution of visual evaluation of grain quality scores in F5 and F6 generations during 2004-2006

Grain visual evaluation score	Number of generations			
	2004- 2005		2005- 2006	
	F5	F6	F5	F6
2	0	0	3	1
3	10	11	39	21
4	20	24	35	47
5	16	11	23	31
Total	46	46	100	100

The next cycle, F5 in 2005 and F6 in 2006, was more complicated. The most frequent populations in F5 were with scores 3 (39 %) and 4 (35%). The populations with the lowest VEGQ scores 1 were not observed and with score 2 were very rare (3 populations of F5 in 2005 and 1 population of F6 in 2006). Such relationship was mainly influenced by a strict positive selection of big ears with very good exterior. Also, negative selection for disease susceptibility, discard of highly diseased or defective populations was applied improve in order to selection for positive traits. The fluctuation of VEGQ scores between years was generally plus- minus one score. The populations with stable scores in the cycle F5: F6 accounted for 47.8 % of the total evaluated populations. The populations varying in one score accounted for 43.5 % and those varying in two scores accounted for 8.7 % (tab. 2).

Tab. 2. Score stability of populations between generations grown in 2004 - 2005 and 2005 - 2006

Scores in both years	2004-2005	2005-2006
	F5→F6	F5→F6
2→2	0	1
2→3	0	2
3→3	4	17
3→4	3	20
4→3	6	2
3→5	3	2
5→3	1	0
4→4	12	24
4→5	2	9
5→4	9	3
5→5	6	20
Total	46	100

VEGQ scores were mainly influenced by grain quality level of parental varieties (Anonymous, 2006). The populations of the cycle 2004/2005 with the highest score 5 had in their pedigree one of the two parents with high grain quality traits. Such populations were Astron/Manef, Rostovchanka//Rostovchanka/ Belisar and Pegassos/Lut 96-3 (Tab. 3).

Tab. 3. Populations with stable visually estimated grain quality

Pedigree	2004 F5	2005 F6
Marabu / Ritmo	3	3
Pegasos / Nika Kubani	3	3
Lone / Inna // Lut 96-6	3	3
Lone / Inna // Hereward	4	4
Astron / Athlet	4	4
Rotovchanka // Rotovchanka / Bold	4	4
Astron / Tarso // Zabava odesskaja	4	4
Astron / Manef	5	5
Rostovchanka // Rostovchanka / Belisar	5	5
Pegasos / Lut 96-3	5	5
	2005 F5	2006 F6
Maverich / Lut 9-358	2	2
Flair / Kris	3	3
Marabu / Victo	3	3
Marabu / Ansgar	3	3
Flair / Lars	4	4
Flair / Ukrainka Odesskaya	4	4
Marabu / Juna	4	4
Flair / Charger	5	5
Tarso / Bussard	5	5
Zentos / Arlas	5	5

VEGQ score of populations of the next cycle 2005/2006 were influenced by parental grain quality traits in a similar way. The population Maverich/Lut 9-358 had the worst VEGQ score 2. Higher score 3 was specific to the populations Flair/Kris, Marabu/Victo, Marabu/Ansgar. All these populations contained in their pedigree varieties with low grain quality. The best score 5 was rated for the populations Flair/Charger, Tarso/Bussard, Zentos/Arlas with parental forms in their pedigree characterized by high grain quality (Tab. 3).

The correlation between years in the investigated cycles was extremely different. VEGQ scores did not correlate in cycle 2004/2005, but the populations of 2005/2006 highly correlated (r=0.72) by VEGQ scores (Figs. 1 and 2). Figures 1 and 2 reflect the distribution of VEGQ scores between years. Low correlation between years of cycle 2004/2005 was due to diverse weather conditions. The season of 2004 was favourable for plant growth but not for the formation of high grain quality due to rainy and cold weather during July. 2002 and 2003 seasons were droughty and hot the most advantaged genotypes were with shorter growing season and with tolerance to droughty conditions. Therefore, selection of genotypes shifted from medium or medium-late maturing to early or early-medium maturing genotypes. Growing season 2004 distorted this increasing trend; that year most advantaged were later maturing populations. The seasons of 2005 and 2006 were droughty and hot again. The growing conditions for genotypes with shorter growing period were more favourable. The main reason was that organic substances for grain growing in wheat may originate either from current assimilation or from storage pools in vegetative plant parts. Reserves may accumulate prior to anthesis and during the initial period of grain filling. Therefore, pre-anthesis reserves could contribute significantly to grain yield when conditions for photosynthesis were unfavourable during grain filling (Asseng and van Herwaarden, 2003, Chaves et al., 2004, Pfeiffer et al., 2005).

Fig. 1. Scores of visually evaluated grain quality of F5 and F6 populations during 2004/2005

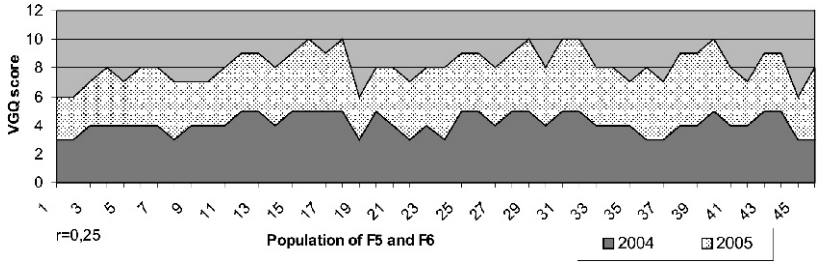
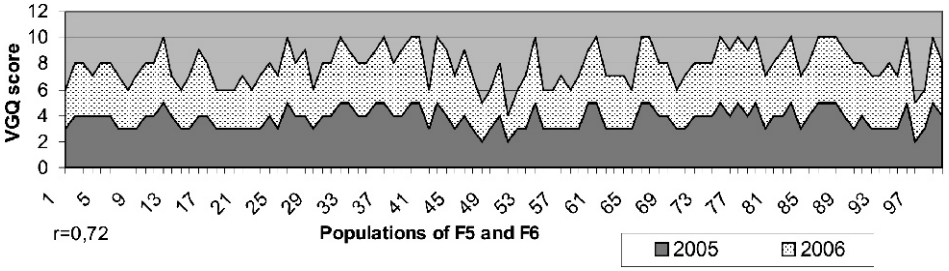


Fig. 2. Scores of visually evaluated grain quality of F5 and F6 populations during 2005/2006



Grain weight is genetically determined and genetic features have more effect than the environment. Highly stable VEGQ scores show that this trait had essential impact on general score. On the other hand, grain filling level is highly influenced by the environment. The main factors are drought and high disease severity. Therefore, populations, with shorter growing season, tolerance to water deficiency and high disease resistance formed well-filled grains. Grain hardness is one of the major grain quality traits, because hard endosperm is usually characterized by good quality traits detected by laboratory methods. On the other hand grain hardness level can indicate a good plant supply with nutrients. This relationship in turn, means that genotype was not affected by diseases and did not lose photosynthetic leaf surface as well as drought did not influence the mentioned parameters. A thousand kernel weight (TGW) genetically is highly determinated and environmental conditions have less influence (Guttieri et al., 2001, Gut and Bichoski, 2004, Barnett et al., 2006). Investigation of the influence of TGW on other quality traits showed that small grain did not affect grain end-use quality negatively. Therefore there is no reason to discard a seed sample due to small grain in the early generations. Much more important is the test weight, which we can predict evaluating grain development.

Conclusions

During the experimental period 2004-2006, we evaluated F5 and F6 early generations populations of winter wheat using visual quality scoring. The largest share of populations (43 % in 2004 and 52 % in 2005) were evaluated by a visual quality score 4. The most frequent populations in F5 (2005) were those with scores 3 (39%) and 4 (35%). Fluctuation of VEGQ scores between years were generally in one score. The populations with stable scores in the cycle F5→F6 accounted for 47.8 % of the total evaluated populations. The populations varying in one score accounted for 43.5 % and those varying in two scores accounted for 8.7 %. VEGQ scores were mainly influenced by grain quality level of parental varieties. The correlation between years in the investigated cycles depended on the difference in the weather conditions between years. In years with significant weather differences (2004/2005) VEGQ scores did not correlate in cycle, but in years with similar conditions (2005/2006) the VEGQ scores of populations previous and present year highly correlated (r=0.72).

REFERENCES

DE ANDRADE A. R., RIEDE C. R., DOS SANTOS SCHOLZ M. B., DESTRO D., DE BATISTA FONSECA I. C. (2001): Selection for grain yield and quality in segregating generations of wheat. Brazilian Archives of Biology and Technology 44: 173 - 178.

ANONYMOUS. (2006): Bundessortenamt. Beschreibende Sortenliste 2006. Hannover GmbH: 72-90.

ASSENG S.; VAN HERWAARDEN A. F. (2003): Analysis of the benefits to wheat yield from assimilates stored prior to grain filling in a range of environments. Plant and Soil 256: 217-229.

BARNETT R. D., BLOUNT A. R., PFAHLER P. L., BRUCKNER P. L., WESENBERG D. M., JOHNSON J. W. (2006): Environmental stability and heritability estimates for grain

yield and test weight in triticale. Journal of Applied Genetics 47: 207-213.

CHAVES M. M., OSORIO J., PEREIRA J. S. (2004): Water use efficiency and photosynthesis. In.: Water use efficiency in plant biology. Ed. Bacon M. A. Blackwell Publishing Ltd. 2004, p. 42-74

GUT M., BICHOSKI A. (2004): Technological quality of spring wheat lines at different rainfall levels Acta Agronomica Hungarica. 52: 183 - 188.

GUTTIERI M. J., STARK J. C., OBRIEN K., SOUZA E. (2001): Relative sensitivity of spring wheat grain yield and quality parameters to moisture deficit. Crop Science. 41: 327-335.

LUKOW O. M., MCVETTY P. B. E. (1991): Effect of cultivar and environment on quality characteristics of spring wheat. Cereal Chemistry. 68: 597-601.

PETROVIČ SOFIJA, DMITRIJEVIČ M., BELIČ M. (2006): Phenotypic variability of yield components in wheat grown on different soil types. Plant Breeding and Seed Production. 2006 XII: 55-60.

PFEIFFER W. H., TRETHOWAN R. M., VAN GINKEL M., ORTIZ-MONASTERIO I., RAJARAM S. (2005) Breeding for abiotic stress tolerance in wheat. In.: Abiotic Stresses: plant resistance through breeding and molecular approaches. Eds. Ashraf A., Harris P. J. C. Food Product Press. 2005, p. 401-490.