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Inheritance of Spike Traits in F1 Generation in Wheat Depending on Parents' Genetic Diversity

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Abstract

The aim of research was to assess the inheritance of wheat spike length (SL), based on the parents diversity as genes donors, identification and determination the best cross combinations in the F1 generation, as well estimation of heterosis indicators as relation: parents/offspring (P1/F1 and P2/F1). Field trials were conducted during the years 2016/17 and 2017/18, at the Experimental Didactic Farm of the Faculty of Agriculture and Veterinary in Prishtina. Experimental design was a RCBD, with plot size 1m^2 in three replications.The experimental formula was: Parents (20-P) +F1-genotypes (10-GF1) x Replications (3-R) x Plants (10P) =900 results. The mean genes value effect (µ) and genotype variation (gv) for (SL)were: for female parents set (P1) µ = 8.99cm spike^{-1}and gv = ±38.93 %, for the male parents set (P2) µ=8.40cm spike^{-1} and gv= ±39.66 %, for mid-parent (MP), the µ value was 8.69cm spike^{-1} and gv = ±30.67%; while for better parent (BP) µ=9.31cm spike^{-1} and gv = ±37.61%, and for F1 generation µ=10.07cm spike^{-1}and gv = ±22.74%. Magnitude of variation for heterosis (Ht) was 3.47 to 35.30% and for Hb was -11.39 to 28.57%. Through, cross combination of parents, it was possible to identify the superior genotypes in F1 generation: G5; G13 and G24 for SL (11.0cm spike^{-1}). The obtained results were with wide range variability and highly significant differences between parents and genotypes of the F1 generation, on the level of LSDp=0.05 and LSDp=0.01.

Keywords: Wheat, inheritance, parents, spike, F1-generation, hetrosis.

1. Introduction

In principle wheat production is important in both terms: for grain and seed, due to the fact of its use for food and as reproduction material (Fetahu et al., 2017; 2019). Food production, in sufficient and high quality, healthy and economically reasonable, today is a challenge for mankind, but this challenge will be even greater in the future (Fetahuet al., 2013a; 2015a).

The precondition for developing of new genotypes with high production capacity, requires genetic distance among parents that participating in the breeding program (Martin et al. 1995; Morgan, 1998; Dedaniya et al., 2018). Parental impact in the development of new cultivars and the efficient identification of superior combinations is a fundamental issue in plant breeding programs (Morgan, 1998; Gowda et al., 2010). Therfore, it was suggested that the heterosis in relation to the better parent could be useful to optimize heterozygous combination (Kant et al.,2011; Fetahu et al., 2015a). The crop cultivation and realized yield per unit area depends on the influence of factors such as: genotype, environment and applied agrotechnique from the moment of sowing until harvest, including the economic cost (Fetahu et al., 2014b). Information on genotype variability to environmental changes helps to predict the yield of cereals (Yong et al 2004; Fetahu et al., 2014a). Cultivar selection for a specific location is one of the essential challenges for improving yield for grain or seed, without increasing the cost of wheat production (Fetahu et al., 2013b; 2014b; 2019). The goal of each breeding program is to obtain high yielding cultivars and excellent quality, which meets market requirements (Williams et al. 2008). Hybridization is the crossing of two cultivars differing from each other in one or more characters to generate offspring with new desirable characters, as a result of genetic recombination. The hybrid of F1 generation is superior over either parent for one or more characters, and it is known as hybrid vigor or heterosis (Fetahu et. al., 2015a). From the perspective of the breeder, heterosis of superiority over BP, is more effective than heterosis of MP, particularly in the breeding of self-pollinating crops, when the objective is identification of superior genotypes in F1 generation (Fetahu et al., 2015a). The variability, heritability, and components of phenotypic variation for spike length are important for the cultivar creation, as it is recommended by Kraljevic-Balalic et al. (1995). Selection of parents with genetic diversity is the crucial stage from the standpoint of breeding programs in order to develop new genotypes having desirable characters. Therefore, the aim of the research was to assess the inheritance of wheat SL, based on the diversity of parents as genes donors, identification and determination of the best cross combinations in F1generation, as well estimation of heterosis indicators as relation parents/offspring (F1/MP and F1/BP).

2. Material and Methods

2.1. Plant material and experimental design

Twenty parents with genotype diversity and variability were included in the combination and crossing program in order to obtain the hybrid generation in F1. Diversity of crossing parents, both with genotypes of F1 generation were: Jagger x Brea/F1-G5; Lira x Brea/F1-G7; Lorena x Brea/ F1-G12; Gabi/Boema x Gabi/F1-G13; Marina/Dora x Marina/F1-G14; Soys248 x Apach/F1-G16; Victoria/Mambo x Victoria/F1- G18; Lorena x Euclid/ F1- G19; Anica x Srpanjka/F1- G22 and Boema x Lutescens/F1-G24.

Field trials were conducted in randomized complete block design with three replications (RCBD) at Experimental Didactic Farm (EDF), Faculty of Agriculture and Veterinary (FAV) in Prishtina, located in geographical position: 42°38'97"N and 21°08'45"E, altitude of 570 m.a.s.l.

In the autumn of 2015, the seed of the parents were sown in plastic pots, under greenhouse conditions, while in May 2016, emasculation of female parents was done, and then crossings were realized. Then, hybrid genotypes obtained in F1, both with parents, were sown in micro-plots with 500 seeds per 1m^{2}in autumn of 2016. During the growth period, normal agronomic and plant protection care was applied, except irrigation. Plant harvest was done during the sumer of 2017 at full maturity stage, with maxiumum of 14% grain moisture.

2.2. Measurements

After harvesting, the spike length (SL) was determined in 10 plants, for parents P1, P2 and F1. After that, the spike length of the mid-parents (MP) and the better-parents (BP) is determined.

The experimental formula was: EF = 20-Parents + 10-GF1-Genotypes x 3-Replications x 10-Plants = 900 spikes. Heterosis indicators (Ht) and (Hb) are defined as percent increase or decrease of F1 genotype over MP as wellas BP. The possible heterotic effects, was estimated according to formula of Fonseca and Patterson (1968):

$$\boldsymbol{Ht}(\%) = \frac{\boldsymbol{F1 - MP}}{\boldsymbol{MP}} \boldsymbol{x1}$$

$\boldsymbol{Hb}(\%) = \frac{\mathbf{F1-BP}}{\mathbf{BP}} \boldsymbol{x100}$ (Fetahu et al., 2015b)$\boldsymbol{gv}(\%) = \frac{Xg-\mu}{\mu} \boldsymbol{x100}$

Where,*gv-genotype variability; Xg-average genotype value, μ-mean value population;Ht-hetrosis and Hb-heterosis for beter parents.*

2.2. Statistical analysis

The research data were subject of ANOVA, according to the program MINITAB-18©, while the significance is determined for the level of probability P_{005} and P_{001}. The parent's variation P1; P2 and F1, as well as the effect of the parents and the interaction of P1/F1 and P2/F1 were calculated.

3. Results and Discussion

Spike length (SL), has been considered one of the most important contributing factors associated with increases of wheat yield that have occurred in the modern plant breeding. Average results of our research and comparisons for general and genotype variation (gv) for P1; P2; F1; MP and BP are presented in (Table 1), while heterosis indicators for F1/Ht and F1/BP in Figure 1. The variance analysis for spike length shows differences among parental geneotypes P1; P2 and F1; Parents x F1 interaction was also highly significant (Table 2). The significant difference indicates the existence of genetic variability among the parents that is precondition for cross breeding, as objective to obtain F1 genotypes with high heterosis (Ht) over MP and BP.

The average spike length for the parent's set P1 was μP1= 8.99cm spike^{-1}. Among the parents with the maximal and minimal values, were cultivars: Lira with 10.5cm spike^{-1} and Victoria with 7.0cm spike^{-1}, the differences between them were 3.5cm spike^{-1}, and the interval of general variation was gv=±38.93%.

Cultivar Lira, compared with the μP1 value, had a longer spike for 1.51cm or gv = +16.78%, while Victoria cultivar, had shorter spike for -1.99cm or gv = -22.14%. The P2 parent set had average spike length of μP2 = 8.40cm spike^{-1}. While, the genotype Gabi / Brea had maximal length (10.33cm spike^{-1}), whereas cultivars: Victoria and Srpanjka, had minimal length or 7.0cm spike^{-1}, and the difference was 3.33cm or the general variability of gv = ±39.66%. The genotype Gabi/Brea compared to the μP2 value, had longer spikes +1.93cm or gv = 22.98%, while the cultivars Victoria and Srpanjka differed for -1.4cm spike^{-1} or gv = -16.67%.

Average spike length for mid parent (MP) was μMP = 8.69cm spike^{-1}. Genotypes with maximal and minimal values were: G-16 with 9.67cm spike^{-1}, respectively G-7 with 7.0cm spike^{-1}, with a difference 2.67cm spike^{-1} or with general variability gv = ±30.67%.

The combination, Soys248 x Apach/G-16, had longer spike for 0.97cm or gv = 11.22%, respectively the combination Victoria/Mambo x Victoria/G18, was shorter for -1.69cm spike^{-1} or gv = -19.48%.

The average spike length for the better parent (BP) was μBP = 9.31cm spike^{-1}. The genotypes G-7 and G-18 differs between them for 3.5cm spike^{-1}, with a general variation interval of ±37.61%. Genotype G-7, had longer spikes than μBP for 1.19cm or gv = 12.82% and genotype G-18, had shorter for -2.31cm or gv= -24.79%.

Table 1. Spike length (cm) in F1

Nr.	*P1*	*gv (%)*	*P2*	*gv(%)*	*MP*	*gv(%)*	*BP*	*gv(%)*	*F1*	*gv(%)*
G-5	8.60	-4.34	7.66	-8.81	8.13	-6.44	8.60	-7.63	11.00	9.24
G-7	10.50	16.80	7.66	-8.81	9.08	4.49	10.50	12.78	10.00	-0.70
G-12	7.83	-12.9	7.66	-8.81	7.75	-10.87	7.83	-15.90	10.00	-0.70
G-13	9.83	9.34	8.50	1.19	9.17	5.47	9.83	5.59	11.00	9.24
G-14	9.66	7.45	9.33	11.07	9.50	9.26	9.66	3.76	10.00	-0.70
G-16	9.00	0.11	10.33	22.98	9.67	11.22	10.33	10.96	10.00	-0.70
G-18	7.00	-22.14	7.00	-16.67	7.00	-19.45	7.00	-24.81	9.00	-10.63
G-19	7.83	-12.90	9.66	15.00	8.75	0.63	9.66	3.76	10.00	-0.70
G-22	9.83	9.34	7.00	-16.67	8.42	-3.16	9.83	5.59	8.71	-13.51
G-24	9.83	9.34	9.16	9.05	9.50	9.26	9.83	5.59	11.00	9.24
μ	8.99		8.40		8.69		9.31		10.07	

The spikes of F1 generation were of average length μF1 = 10.07cm spike^{-1}, and exceeded the spike length of parents set P1 and P2. F1 genotypes, in relation to the μP1 values, were longer for 1.08cm spike^{-1}or genotype variation was gv = 10.72%, whereas with μP2, the difference was 1.67cm spike^{-1} or gv = 16.58%. Three genotypes: G5/F1; G13/F1 and G24/F1, were 11.0cm long, while the G22/F1 genotype had a length of 8.71cm spike^{-1}, the difference between them was 2.29cm spike^{-1}, with a total variability of ±22.74%. Genotype variability for G5/F1; G13/F1 and G24/F1, compared with μF1, the difference was +0.93cmspike^{-1} or gv = 9.24%, while with G22/F1 genotype, the difference was -1.36cm spike^{-1} and gv = -13.51%.

The results for spike length are in agreement with data of Ullah et al. (2014), who reported results for spike length for the parents from 9.57 to 12.87cm, but not matched the results of Rasul et al. (2002), who reported SL=15.50cm among parents. The similar results were obtained by Fetahu et al. (2008). In the studies of Bilgin et al. (2011) they obtained different results for SL at different wheat genotypes from 8.2 to 11.0cm. Among the F1 hybrids, the maximal spike length was 10.0cm, while the minimal spike length was 8.6cm. Our results are higher for genotypes of F1 generation. These results are also in accordance with Fetahu et al. (2014a; 2015b; 2016); Kant et al. (2011) and Mirza et al. (2017), but not with the results of Kondić et al. (2017) who reported shorter SL.

Heterosis (Ht and Hb): Results and effects of spike length inheritance for F1generation, for heterosis indicators: Ht/F1/MP and Hb/F1/BP are presented in Fig. 1. The magnitude of heterosis provides a basis for genetic diversity and guideline for the selection of desirable parents for the development of superior F1 hybrids in order to exploit the hybrid vigor and for building gene pool to be exploited in population improvement.

All genotypes of F1 generation exceeded MP values, and Ht had positive values with variation intervals of 3.47 to 35.30%, which is realized in genotypes G-16 and G-5. However, such an indicator did not identify all possible differences of MP and F1 values. The heterosis indicator Hb, as a BP/F1 ratio, identified two opposite directions of the inheritance for parents exceed for the spike length. The highest desirable heterosis of F1 generation, over BP, was recorded in cross breeding combination G-5 (Jagger x Brea) with Hb=35.30%, while with negative Hb was the genotype G-22 (Anica x Srpanjka), with Hb=-13.31%.

Table 2. The variance analysis for spike length in parentsgeneotypes P1; P2 and F1

		Parental (P1 and P2)				*F1 generation*			
S. variation	**d.f.**	**MS**	**F**	**LSD0.05**	**Lsd0.01**	**SS**	**F**	**LSD$_{0.05}$**	**LSD$_{0.01}$**
Repition	2	0.175	0.41	/	/	0.0121	0.028	/	/
Tretmans	9	3.915	9.419**	1.1061	1.5152	1.717	4.025**	1.1207	1.5352
Error	18	0.415				0.4026			
Total	29								

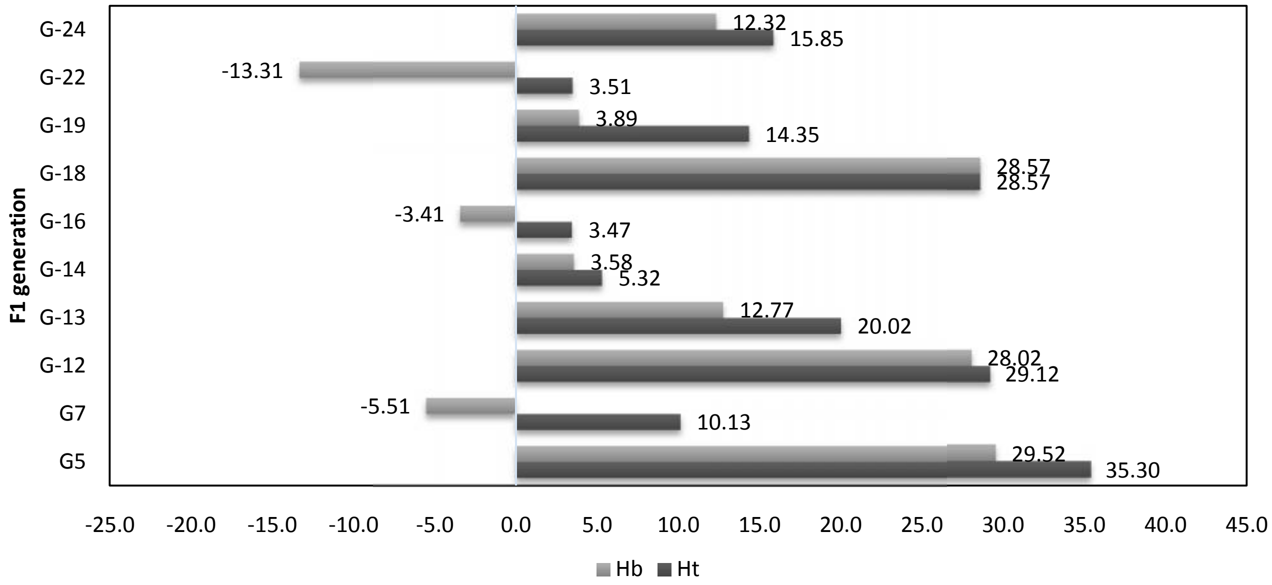

Figure 1. Heterosis inheritance

Table 3. The effect of inheritance from parents to the F1 generation

Sources of variation	d. f.	SS	F	LSD0.05	Lsd0.01
P1 /F1					
Blok	2	0.063	0.15	/	/
Parents (A)	9	3.869	9.54**	0.640	0.876
F1-generation (B)	1	12.97	31.98**	0.388	0.529
Interaction A x B	9	1.764	4.350 **	1.077	1.471
Total	59	0.405	/		
P2/ F1					
Blok	2	0.154	0.210	/	/
Parents (A)	9	4.075	5.54**	1.040	1.425
F1-generation (B)	1	40.671	157.85**	0.273	0.372
Interaction A x B	9	1.511	5.86**	1.205	1.648
Total	59	0.257	/		

Rasul et al. (2002), has reported positive results for heterosis over MP and over BP, with values of Ht = 7.42% and Hb = 6.24%, while our results are significantly higher. The positive heterosis for the spike length is a desirable trait, especially those that exceed BP. In their research Bilgin et al. (2011), reported magnitude of heterosis for SL over MP (8.77 to -18.18%) and BP (8.14 to -25.64%), similar to our research results.

Inamullah et al. (2006), for the Ht and Hb values, also reported different results (+19.11 and +16.2), while Zaazaa, et al. (2012), reported values of MP, Ht (15 to 20.59%) and Hb (13.02 to 19.60%)

4. Conclusions

The identification of the highly significant differences of genotype variation for the spike length and the hterosis indicators for the three sets (P1, P2 and F1), shows the presence of parental diversity, combination abilities through crossing (intraspecific hybridization), to create heterozygous organisms in generation F1, with hybrid vigour.

Research findings identified three superior hybrid genotypes in F1 generation: G-5; G-13 and G-24, obtained from the parents: Jagger x Brea; Gabi/Boema x Gabi and Boema x Lutescens.

Heterosis in relation to mid-parent (Ht/MP) was positive, while the Hb/BP ratio identified the heterosis with two-opposite directions. Therefore, Hb enable to identify parents who have better combinations ability during crossing and expresses maximal heterosis.

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6. References

1. Bilgin O., K.ayihan Z. Korkut, A. Balkan and I. Baser (2011): **Assessment of heterosis and heterobeltiosis for spike characters in durum wheat.** Pakistan J. Agric. Res. Vol 24 No. 1-4, 2011.
2. Dedaniya AP., AG. Pansuriya, DM. Vekaria, JT. Memon, TA. Vekariya (2018): **Estimation of heterosis in different crosses of bread wheat (Triticumaestivum L.)**. International Journal of Chemical Studies.P-ISSN: 2349–8528 E-ISSN: 2321–4902 IJCS 2018; 6(3): 3622-3628.
3. Fetahu S., Rusinovci I., Aliu S., Shabani Q., Beluli A., Zogaj R. (2015b). **Variability of agronomic traits among different wheat cultivars from Croatia under agro ecological conditions of Kosovo.** In: Proceedings 50th Croatian and 10th International Symposium on Agriculture. 226-229.
4. FetahuSh, S. Aliu, I. Rusinovci, R. Zogaj,A.Beluli,D. Zeka, Q. Shabani (2014a): **Spike traits and yield parameters among some wheat cultivars under agro-ecological condition of Kosovo.** International Journal of

Ecosystems and Ecology Sciences (IJEES) Vol. 4 (3): 391-396 (2014).

5. Fetahu Sh., Aliu S., Rusinovci I., Elezi F., Bislimi K., Behluli A., Shabani Q. (2014b). **Variation of physiological growth indices, biomass and dry matter yield in some maize hybrids.** Albanian j. agric. sci. ISSN:2218-2020,Volume 13, Special issue (2014).pp. 69-73.
6. Fetahu Sh., Aliu1 S., Rusinovci I., Zeka D., Shabani Q., Behluli A., Sadriu1 B., Ahmeti B., Elezi F. (2016). **Genetic variation for spike production capacity of F3-generation in bread wheat.** International Journal of Ecosystems and Ecology Sciences 6(3):305-310.
7. Fetahu Sh., I. Rusinovci, S. Aliu, D. Zeka, A. Behluli, Q. Shabani (2019): **Impact of wheat cultivars variability on grain and seed yield.** 54th Croatian & 14th International Symposium on Agriculture | February 17 -22, 2019. Proceedings. ISSN 2459-5543.
8. Fetahu Sh., I. Rusinovci, S.Aliu, A.Behluli, Q. Shabani, K. Gashi, Y. Hoti, B. Sadriu, B. Ahmeti(2017). **Effects of certification of wheat fields and seed yield.** International Journal of Ecosystems and Ecology Sciences 7(3):575-580.
9. Fetahu Sh., Rusinovci I., Aliu S., Salihu S., Zogaj R., Beluli A., Bislimi K., Mankolli H. (2013a). **Evaluation of harvest index and spike traits of different wheat cultivars from Croatia under agro ecological conditions of Kosovo**. 451-456.
10. Fetahu Sh., S.Aliu, I. Rusinovci, D.Zeka, Q. Shabani, H-P. Kaul, F.Elezi (2015a): **Determination of heterosis and heterobeltiosis for plant height and spike grain weight of F1 generation in bread wheat.** International Journal of Ecosystems and Ecology Sciences (IJEES). Vol. 5 (3): 431-436 (2015).
11. Fetahu, Sh., S. Aliu, I. Rusinovci, B. Kelmendi, N. Maliqi (2013b): **Accumulation and distribution of dry matter in some common bean landrace seedlings at the phase of the cotyledons.** Agriculture & Forestry, Vol. 59. Issue 3: 133-141, 2013, Podgorica. UDC (UDK) 633.35 (497.115).
12. Fetahu, Sh., S. Aliu, S. Kaciu, I. Rusinvoci and Gjonbalaj M. (2008). **Characteristics of production potential for yield and biomass of new winter wheat line developed in Kosovo.** Modern variety breeding for present and future needs.Valencia, Spain 367-371.
13. Fonseca, A. and F.L. Patterson (1968): **Hybrid vigour in a seven parent diallel cross in common winter wheat (T. aestivum L.).** Crop Sci., 8: 85-88.
14. Gowda M, Kling C, Würschum T, Liu W, Maurer HP, Hahn V, Reif JC (2010) **Hybrid Breeding in Durum Wheat: Heterosis and Combining Ability.** Crop Sci. 50: 2224-2230.
15. Inamullah, H. A. Mohammad, F. Ud-Din, S. Hassan, G. and Gul, R. 2006. **Evaluation of the heterotic and heterobeltiotic potential of wheat genotypes for improved yield.** Pakistan. J. Bot. 38(4): 1159-1167.
16. Kant L., V. Mahajan, H.S. Gupta (2011): **Mid-parent advantage and heterobeltiosis in F1 hybrids from crosses of winter and spring wheat.** SABRAO Journal of Breeding and Genetics 43 (2) 91–106, 2011.
17. KondićD.,M.Bajić, Đ. Hajder, D. Knezevic, B. Bosancic (2017): **The spike characteristics of winter wheat (Triticumaestivum L.) varieties in agro–ecological conditions of Banja Luka Region**. Agro-knowledge Journal, vol. 18, no. 4, 2017, 263-274.
18. Kraljević-Balalić M., M. Dimitrijević, S. Petrović (1995): **Interakcijagjenotip/sredinazakomponenteprinosa. I simpozijumoplemenjivanjaorganizama.**Vrnjačka Banja.
19. Martin, J.M., L.E. Talbert, S.P. Lanning and N.K. Blacke (1995). **Hybrid performance in wheat as related to parental diversity.** Crop Sci., 35: 104-108.
20. Mirza F. Q., R. Qureshi, N. Illyas, J.U. Din, G. Shabbir (2017): **Multivariate statistical analysis for yield and yield components in bread wheat planted under rainfed conditions.** Pak. J. Bot., 49(6): 2445-2450, 2017.

21. Morgan, C.L. (1998). **Mid-parent advantage and heterosis in F1 hybrids of wheat from crosses among old and modern varieties.**Journal of Agricultural Science, Cambridge, 130: 287-295.
22. Rasul I., Khan S, Ali Z. (2002): **Estimation of heterosis for yield and some yield components in bread wheat.** International journal of agriculture & biology 1560–8530/2002/04–2–214–216.
23. Ullah S. F., G.Hassan, N. Ahmad, S. Javed, I. Ahmad, R. Ali (2014): **Evaluation of Wheat Advance Lines under Rainfed Conditions.** International Journal of Scientific Research in Agricultural Sciences, 1(6), pp. 97-101, 2014. ISSN: 2345-6795; ©2014 IJSRPUB
24. Williams, R. M., L. O'Brien, H. A. Eagles, V. A. Solah and V. Jayasena (2008). **The influence of genotype, environment, and genotype x environment interaction on wheat quality.** Australian Journal of Agricultural Research, 59 (2): 95-111.
25. Yong Z., Zhonghu H., Ye G., Aimin Z., Ginkel M.V. (2004). **Effect of environment and genotype on bread making quality of spring-sown spring wheat cultivars in China.** Euphytica 139(1):75-83.
26. Zaazaa, E.I., Hager M.A., El-Hashash E.F. (2012): **Genetical analysis of some quantitative traits in wheat using six parameters genetic model.** American-Eurasian J. Agric. & Environ. Sci., 12 (4): 456-462, 2012 ISSN 1818-67