International Journal of Genetics
ISSN: 0975-2862 & E-ISSN: 0975-9158, Volume 8, Issue 4, 2016, pp.-204-206.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000226

Research Article

GENERATION MEAN ANALYSIS FOR YIELD AND YIELD COMPONENTS IN WHEAT *(Triticum aestivum L.)*

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Received: March 03, 2016; Revised: August 10, 2016; Accepted: August 11, 2016; Published: August 14, 2016

Abstract- The objective of this study was to estimate gene effects for some agronomical traits (Days to earhead emergence, 1000 grain weight, Plant height (cm), Number of effective tillers per plant, Number of grains per earhead, Grain weight per earhead (g), Grain yield per plant (g) using six generations (P1, P2, F1, F2, BC1 and BC2) of AKAW – 2956 X LOK – 58 cross in order to improve yield contributing traits. Heritability and gene action of yield and yield components were estimated in an AKAW – 2956 X LOK – 58 cross-using generation mean analysis.

The six-parameter model was fitted for explaining genetic variation for Plant height, No. of grains per earhead, Grain wt. per earhead and Grain yield per plant. Considering the importance of grain yield per plant very high broad sense heritability 99.4% were recorded in AKAW – 2956 X LOK – 58. Significance of scale B and C for the character number of grain per ear head indicated the presence of non-allelic interactions for grain per ear head. Similarly, the significance of scale C indicated the presence of a dominance x dominance type of non-allelic interactions for a number of grain per earhead and significant additive gene effect was exhibited by AKAW-2956 X LOK-58) for grain yield per plant, thereby indicated the scope for selection in early generations.

Keywords- Wheat, Joint scaling test, Six parameter models, Gene effects

Citation: Ninghot C.J., et al., (2016) Generation Mean Analysis for Yield and Yield Components in Wheat *(Triticum aestivum L.)*. International Journal of Genetics, ISSN: 0975-2862 & E-ISSN: 0975-9158, Volume 8, Issue 4, pp.-204-206.

Academic Editor / Reviewer: Dr Tejbir Singh, Dr S V Sai Prasad

Introduction

Wheat (*Triticum aestivum* L.) is an important cereal crop widely cultivated in India and World providing ample food calories and protein to the human population. It is the second most important cereal crop after rice grown under diverse agro-climatic conditions. Wheat is an important winter cereal crop, contributing about 32 per cent of total food grain production in India. It is the staple food crop in at least 43 countries.

Wheat is an annual plant belongs to tribe Triticeae, sub family Pooideae of family Poaceae. Wheat is having 7 pair of chromosome (2n=14). The different species of Triticum are grouped into diploid (2n=2x=14), tetraploid (2n=4x=28) and hexaploid (2n=6x=42) [1]. Out of 50 wild species three species are being cultivated in India *viz*., *Triticum dicoccum* L. (2n=14) also called as emmer wheat, Triticum durum L. (2n=28) as macaroni wheat and *Triticum aestivum* L. (2n=42) as a bread wheat. About 87 per cent of total wheat production is of bread wheat 12 per cent of durum wheat and very less i.e. 1 per cent of dicoccum wheat, which is having therapeutic value. Wheat is having wider adaptability i.e. tropical, sub-tropical as well as temperate zone. It can tolerate severe cold as well as snow and resume growth with a grain setting in a warm weather in spring.

The choice of selection and breeding procedures for genetic improvement of any crop is largely depend upon the knowledge of the type and relative amount of genetic component and the presence of non-allelic interaction of different characters in the plant materials under investigations. Information on the type of gene action involved in the inheritance of a character is helpful in deciding the breeding procedures to be followed for improvement. To develop a population with a broad genetic base, it is essential to use diverse parents in hybridization programme. Plant breeders and geneticists frequently use generation to mean the analysis to obtain information on gene action controlling the economic traits in wheat [2-10]. Therefore, the present study was carried out to obtain information about gene action on yield and its components in the four wheat crosses. Introgression of desirable genes following backcross broadens the genetic base in wheat. The main objective of wheat breeding is to increase grain yield, however, yield is a quantitative trait and is affected by many genetic and non-genetic factors. To increase yield, it is necessary to improve agronomic traits which affect grain yield, but in order to achieve this, more information on the inheritance pattern of these traits is necessary [11]. Generation mean analysis is a simple and useful method for estimating gene effects of polygenic traits [12]. Determined more significance of dominance gene effects than additive gene effects for grain yield and its components. Also, additive x additive type of epistatic interaction was found to be significant for a number of tillers per plant [13]. Pedigree method and simple selection were suggested for improvement of traits governed by additive and additive x additive gene effects in some crosses. Inheritances of some agronomical traits were analyzed with three parameter and six parameter model. Gene effects in the cross populations and also, identification of optimum selection periods for these traits were aimed.

Materials and Methods

Six generations P_1, P_2, F_1, F_2, BC_1 and BC_2 of cross AKAW – 2956 X LOK – 58 were planted during the Rabi 2008-09 at wheat research unit (Dr Panabrao Deshmukh Krishi vidyapeeth, Akola) in RBD with three replications in 2 rows with 2m long and 18 cm apart with 10 cm between plants. Parents, F_{1s}, BC_1 and BC_2 planted in two rows and F_{2s} in five rows. The data were first subjected to test the differences between parental genotypes by applied 't' test for the studied characters before considering the biometrical analysis, as well as, the scaling test (A, B and C) were applied to detect the presence of epistasis [14]. Joint scaling test [15] as indicated by (2) was applied to test the adequacy of the genetic model

controlling the studied characters. The simple genetic model (m, d, and h) was applied when epistasis was absent, whereas in the presence of non-allelic interaction the analysis was proceeded to estimate the inter-action types involved using the six parameters genetic model i.e. (m, d, h, i, j, and l) [16]. Heritability and genetic advance under selection were also estimated [17]

Results & Discussion

Generation means:

The mean values and their standard errors for analyzed traits are presented in [Table-1]. The F_1 mean plant height exceeded the better parent for days to earhead emergence, 1000 grain weight, number of grains per earhead and grain weight. These results indicated that over-dominance of genes was controlling these characters. On the contrary, the mean values were lower than that of the two parents for plant height, number of effective tillers and grain yield per plant indicating the role of partial dominance. These results are in accordance with [18] for a number of days to physiological maturity, number of spikes per plant, kernel weight and grain yield per plant and [19] for number of spikes per plant, number of kernels per spike, kernel weight and grain yield per plant.

The mean values of the F_2 populations comparing with their parents were higher than parent for days to earhead emergence, 1000 grain weight, number of grains per earhead and grain weight per earhead indicating appreciable amount of genetic variability for these characters in the cross [Table-1].

Table-1 *Mean performance of seven morphological and yield characters recorded on per plant basis of cross AKAW – 2956 X LOK – 58*

Sr. No.	Generations	Days to earhead emergence	1000-grain wt. (g)	Plant height (cm)	No. of effective tillers per plant	No. of grains per earhead	Grain wt. per earhead (g)	Grain yield per plant (g)
		AKAW – 2956 X LOK – 58						
1	P_1	54.00±0.57	36.39±0.57	82.00±2.33	9.80±1.61	58.26±2.96	2.08±0.26	15.61±2.10
2	P_2	54.36±0.88	35.84±0.88	84.04±1.57	7.73±1.39	60.66±1.99	2.14±0.20	12.50±1.04
3	F_1	55.66±1.20	38.90±1.20	82.72±0.52	7.20±0.11	62.33±1.63	2.55±0.06	12.36±0.38
4	F_2	56.36±0.33	39.75±0.33	81.92±1.48	5.93±0.87	69.46±1.03	2.42±0.06	13.39±1.55
5	BC_1	59.36**±1.33	36.80±1.33	84.99±1.39	6.13±0.40	66.26±0.78	2.37±0.24	12.52±1.21
6	BC_2	58.66*±0.66	38.45±0.66	84.90±2.30	7.20±0.70	73.53±2.54	2.50±0.29	14.03±1.68

Scaling test:

In case of AKAW–2956 X LOK–58 cross-scaling test was found to be non-significant for four characters plant height, number of effective tillers per plant, grain weight per earhead and grain yield per plant, thereby indicating the absence of non-allelic interactions in the expression of these characters. Significance of scale B and C for the character number of grain per earhead indicated the presence of non-grain per ear head. Similarly, significance of scale C indicated the presence of dominance x a dominance type of non-allelic interactions for a number of grain per earhead [Table-2].

Table-2 *Scaling test of the studied characters in AKAW – 2956 X LOK – 58 cross*

	Scale	Plant height (cm)	No. of effective Tillers per plant	No. of grains per earhead	Grain wt. per earhead (g)	Grain yield per plant (g)
AKAW – 2956 X LOK – 58	**A**	1.43±0.67	-1.8	1.62±0.32	0.19±0.06	-0.66
	B	0.62±0.15	0.19	3.60**±1.66	0.48±0.32	1.19±0.53
	C	0.11	-1.89	3.56**±1.61	0.74±0.44	-0.83
	D	-1.3	-0.34	0.12	-0.02	-0.5

Genetic effects for agronomic characters:

Estimates of the six parameters, i.e. additive (d), dominance (h), additive × additive (i), additive × dominance (j) and dominance × dominance (l) are presented in [Table-3]. The results indicated that the mean effects (m) were highly significant for plant height, number of grains per earhead and grain weight per earhead, indicating that these traits are quantitatively inherited. The additive gene effects (d) were positive and significant for grain yield. The obtained results indicated that selection could be effective for these characters in early generations. The results for all studied characters are in accordance with the previous findings of [20]. With regard to the dominance gene effects (h), were found to be positive and highly significant for a number of grains per earhead. These results indicated the presence of dominance gene effect in the inheritance of these characters. These results are in harmony with [21] for plant height, number of spikes per plant, number of kernels per spike, kernel weight and grain yield per plant.

Concerning the dominance × dominance (l) type of gene action, negative and significant values were detected for a number of grains per earhead indicating the scope of heterosis breeding for the development of superior populations. The above results are in conformity with the findings of [22] for plant height and number of spikes per plant and [19] for number of kernels per spike.

Table-3 *Genetic effects for agronomic characters*

Characters	Cross	Mean (m)	Additive (d)	Dominance (h)	Additive x additive (i)	Additive x dominance (j)	Dominance x dominance (l)
Plant height (cm)	I	**8.69**±1.16**	-0.31	1.56±0.53	1.50±1.03	0.36±0.04	-0.92
No. of effective tillers per plant	I	1.45±1.01	0.96±0.06	-0.01	0.76±0.85	-0.23	0.44±0.23
No. of grains per earhead	I	**7..35**±1.84**	-0.15	**2.01*±1.64**	0.25±0.74	-0.44	**-2.69**±1.33**
Grain wt. per earhead (g)	I	**2.46**±0.82**	-0.02	0.42±0.24	0.10±0.80	0.18	0.28
Grain yield per plant (g)	I	0.27±0.12	**2.74* ±1.17**	1.28±1.17	1.53±0.76	-0.11	-0.56

Heritability and genetic advance:

The estimates of different variance components as well as the average degree of dominance (H1/D) 1/2 are provided in [Table-4]. Estimates of variance components revealed that the additive variance (σ2 D) was smaller than dominance variance (σ2 H) for days to ear head emergence, 1000 grain weight, plant height, grain weight per earhead and grain yield per plant. The obtained results indicated the greater role of dominance variance in inheritance of these traits. The average degree of dominance

(H1/D)1/2 [Table-4] is more than unity for the number of grains per earhead. These results indicated the presence of over dominance suggesting early selection might improve these traits. On the contrary, the same parameter is less than unity for days to ear head emergence, 1000 grain weight, plant height, grain weight per earhead and grain yield per plant. These results confirmed the role of partial dominance gene effects in controlling these characters. Hence, the average degree of dominance was not calculated. These results are in agreement with [23] for plant height, number of spikes per plant, number of kernels per spike, kernel weight and grain yield per plant.

Knowledge of the heritability of a trait guides a plant breeder to predict behaviour of succeeding generations and helps to predict the response to selection. Comparison between broad and narrow-sense heritability estimates revealed equal importance of additive and non-additive effects in genetic control of traits. Cross AKAW 2956 X LOK 58 had larger broad-sense heritability for plant height, number of tillers per plant and grain yield per plant. These results suggest that dominance gene action was primarily responsible for the inheritance of these traits in this cross. Heritability in the narrow sense as estimated using F_2 and backcross data were high for the traits under investigation in this cross. These results indicated that selection may be more effective for improving no of tillers per plant, no of grains per ear head and grain weight per ear head in early generations. On the contrary, low narrow sense heritability estimates were recorded for days to ear head emergence 1000 grain weight, plant height, no. of grains per earhead, grain weight per earhead and grain yield per plant. These results indicated that environmental effects have a larger contribution than genetic effects for these traits. Similar approaches of broad-sense heritability estimates were coincident with [24] for days to heading, days to physiological maturity, plant height, number of spikes per plant, number of kernels per spike, kernel weight and grain yield per plant. On the other hand, the results of heritability in narrow sense were similar to [25] for plant height and [21]. The estimates of genetic advance help in understanding the type of gene action involved in the expression of various polygenic characters. High values of genetic advance are indicative of additive gene action, whereas low values are indicative of non-additive gene action [26]. The genetic advance values for the seven characters of the one cross evaluated ware presented in [Table-4]. Data revealed that, moderate genetic advance value was recorded for the characters grain yield per plant, whereas moderate to low genetic advance values were recorded for plant height and number of effective tillers per plant.

Table-4 *Estimates of heritability and genetic advance for polygenic traits in AKAW 2956 X LOK 58 cross*

Characters	Additive variance (D)	Dominance variance (H)	Epistatic variance (E)	Genetic advance (Gs)	(H/D)1/2	Heritability (bs) %	Heritability (ns) % (Warner, 1952)
Days to earhead emergence	-12.66	**16.44**	2.55	-	-0.65	-	-
1000 grain weight (g)	-19.32	**19.26**	6.12	-	-0.50	-	-
Plant height (cm)	-30.33	**54.35**	8.23	4.65	-0.90	87.66	-
No. of Tillers/plant	0.64	-10.36	4.56	3.06	-8.09	98.25	13.97
No. of grains/ear head	-36.02	-183.89	67.2	-	**2.55**	-	-
Grain weight/ ear head	-0.85	**1.29**	0.11	-	-0.76	-	-
Grain yield /plant	-11.31	**28.81**	5.67	5.5	-1.27	99.4	-

Acknowledgements

The study was carried out as a part of M. Sc thesis at Wheat Research Station, Dr. P.D.K.V, Akola. I am sincerely thanking to Dr. N.R. Potdukhe (Senior Scientist, WRU, Dr PDKV, Akola) for undertaking this study.

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