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Inter-Generation Correlation and Regression Analysis in F_2 and F_3 Generations of Wheat

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ABSTRACT

In the present study F_2 and F_3 population of four crosses of bread wheat (Triticum aestivum L.) were evaluated for yield and yield contributing traits. Parent progeny regression analysis involving F_2 and F_3 generation of four crosses in wheat was undertaken to estimate the genetic potential transferred from one generation to other by selection for single plant yield. The results revealed that significant positive inter-generation correlation and regression was observed for character like plant height in all four crosses Raj3765 x Syn 27, WH1105 x Syn27, Raj3765 x WH711 and WH1105 x WH711 and grain yield per plant was found significant in crosses Raj3765 x Syn 27 and WH1105 x Syn27. It indicates the chances of selecting high yielding genotypes at early generations. The narrow sense heritability for different characters based on parent offspring regression coefficient was high for 100 grain weight in all crosses. Higher the narrow sense heritability, higher is the chances of improving the characters through selection. Hence, 100 grain weight and grain yield per plant has the better chances of improvement through selection.

Key words: *Wheat, Inter-Generation Correlation, Regression, Selection.*

INTRODUCTION

Bread wheat (*Triticum aestivum* L. em Thell.) is an allohexaploid species with its extremely huge genome (2n = 6x = 42, approx. 16,000 Mbp). Wheat provides over 20% of calories, nearly 55% of the carbohydrate and protein in human nutrition, and is the staple food in more than 40 countries for over 35% of the world's population[1]. It belongs to family Poaceae, the largest family within the monocotyledonous plants. It is the most widely cultivated food crop, from the southern regions of South America and Australia to the northern latitudes of Canada and China and can grow over a wide range of elevations, climatic conditions and soil fertility[2]. Crop improvement for grain yield can be achieved in wheat through effective use of F_2 and F_3 segregating populations and fixing desirable character combinations.

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However, there are still possibilities to increase the yield output through proper breeding technologies in wheat. Grain yield is a complex trait and is the result of interaction of many variables. Regression analysis is the better way to make crop yield prediction[3,4]. The degree of dependence of one variate on the other is measured by regression coefficient. Regression coefficient was estimated on the basis of parent-offspring regression. Parent progeny regression is a method commonly used for estimating the amount of genetic potential transferred from parent to progeny. Inter-generation correlation studied by using parent offspring regression which helps in estimating the extent of transferring the genetic potentials of the character from one generation to other generation. The present investigation was aimed at studying the response of selection for yield and its component characters through parent progeny correlation and regression method between F_2 and F_3 generations.

MATERIAL AND METHOD

The experiment was conducted at the Research Farm, Department of Genetics and Plant Breeding, Chaudhary Charan Singh Haryana Agricultural University Hisar (India) during *rabi* season of 2013-2014. The experimental material comprised of the F_2 population of four crosses (C-I) Raj3765 x Syn 27, (C-II) WH1105 x Syn27, (C-III) Raj3765 x WH711 and (C-IV) WH1105 x WH711. 300 F_2 seeds generated from each cross were space planted along with resistant and susceptible parents, keeping plant to plant distance of 10 cm and row to row distance of 30 cm and each row was of two meter length. All the plants were individually tagged before flowering and data were recorded at the time of maturity for various quantitative traits *viz.*, plant height (cm), number of tillers per plant, number of spikelets per ear, ear length (cm), ear weight (g), number of grains per ear, number of grains per spikelet, 100 grain weight (g), biological yield per plant (g), grain yield per plant (g), harvest index and field reaction of yellow rust on individual plant basis. From F_2 population of each cross agronomically superior plants were selected after maturity. Only selected plants from F_2 material of each cross were sown in year 2014-2015 in *rabi* season. One hundred and forty families (35 families from each cross) of four crosses were raised in F_3 in a (RBD) Randomized block design replicated twice) having paired rows of 1m length during the year 2014-15 For evaluation of F_3 progenies, data were recorded on the 5 plants/ replication/ progeny. In F_3 same observations were recorded in randomly chosen five single plant per family in each replication. Mean values were used to estimate the parent offspring correlation and regression between F_2 and F_3 generations.

The degree of dependence of one variate on the other is measured by regression coefficient (b). For regression analysis, parent progeny regression coefficients were calculated by regression of the mean value of a character in the progeny (F_3) upon the value of a character in the parent (F_2) [5]. The data was standardized by dividing individual values by respective standard deviation values and then the regression coefficient was calculated.

$$b_{(\text{parent-offspring})} = \frac{\text{Covariance of parent-offspring}}{\text{Variance of parent}}$$

b= regression coefficient

The way to test the null hypothesis (b=0) is through the application of "t" test:

$t = b_{yx}/ \text{S.E.(b)}$

Then, this t value was compared with t value from the table at the desired level of significance with the degree of freedom of the S.E. (b).

Based on parent-offspring regression narrow sense heritability was calculated[6].

Whereas, Intergeneration correlation coefficients (r) were calculated for each character between F_2 and F_3 generations. In each case progeny means (y) of F_3 generation were regressed on the individual plants (x) of F_2 generation

$$\text{Intergeneration correlation (r)} = byx \times \frac{\sigma x}{\sigma y}$$

Where,

$$byx = \frac{\text{Covariance (xy)}}{\text{Variance of x}}$$

σx = Standard deviation of x
σy = Standard deviation of y
Cov(x,y)= covariance between x and y

The observed value of correlation coefficient was compared with the tabulated value for (n-2) degree of freedom. The tabulated values used are of Fischer and Yates[7]. If the observed value is more than the tabulated one, the correlation coefficient is said to be significant.

The present experiment was undertaken to evaluate how far the genetic potential is transferred from F_2 to F_3, based on selection for single plant yield in F_2.

RESULTS AND DISCUSSION

The parent progeny regression analysis was carried out by regressing the mean values of a character in the progeny (F_3) upon the value of a character in the parents (F_2) The regression coefficient b was calculated by using the formula suggested by Lush (1940). In C-I regression coefficient values was calculated on F_3 over F_2 and it was significantly positive observed in plant height (0.232**) and grain yield per plant (0.27**), whereas, it was non significant and lowest for biological yield/plant and number of grains per spikelet. In C-II regression coefficient maximum value and significantly positive value was observed in plant height (0.41**) whereas non significant and positive lowest value were observed for biological yield/plant and harvest index in C-II. In C-III regression coefficient significantly positive values observed for plant height (0.41**), ear weight (0.28*), number of grains per ear (0.374**), whereas, it was non significant and lowest for harvest index and grain yield per plant. Regression coefficient values in cross-IV was significant and positive observed in plant height (0.40**), 100 grain weight (0.306**) and number of grains per spikelet (0.277**). Non significant and lowest values of regression coefficient was observed for number of grains per ear.

Inter generation correlation studies by using parent offspring regression helps in estimating the extent of transferring the genetic potentials of the character from one generation to other generation. The parent progeny correlation and regression between two generations shows lesser sensitivity to environmental effect and is very useful for selection in segregating population for the production of new and improved genotypes. The intergeneration correlation and regression for yield component characters are presented in Table 3. It was calculated for selected F_3 over F_2 plants in four crosses for all different characters. Significant and positive correlation was observed for plant height in all crosses. However, 100 grain weight was also significant in C-I, C-III and C-IV. Grain yield per plant was also significantly positive correlated in C-I and C-II. In C-III it was significant and positively correlated in ear weight, number of grains per ear and number of grains per spikelet was correlated in C-IV. But number of tillers per plant, ear length, biological yield/plant and harvest index had not shown any significant correlation in all crosses

The significant and positive intergeneration correlation of grain yield in this study is similar to the findings of Mishra *et al*.[8] in rice and Wagoire *et al*.[9] reported

Parent-offspring regressions were highly significant for grain yield in the F_2-F_3 generation. This indicated the effectiveness of selection for these characters. However, grain yield showed non significant correlation and regression in cross C-III and C-IV between F_2 and F_3 generations. This indicated that selection for grain yield on the basis of phenotypic performance during early generation may or may not be effective depending upon the performance of its progenies in the succeeding generations. Similar results were also reported by Barman *et al*.[10] for plant height and grain yield.

The significant correlation was also reported in number of grains/ear in cross C-III and number of spikelets/ear and 100 grain weight in cross C-IV. This indicated the effectiveness of selection for these characters in F_2 or latter generation. The selection importance of these traits had been already suggested by Rao and Saxena[11] for number of grains per panicle; Kole[12] for 100-grain weight. An intergeneration correlation was also observed for grain number per spikelet, and grain number per ear by Islam *et al*.[13] in wheat.

Further it was also observed that the regression coefficient was significant for ear length, number of grains/ear in C-III and number of grains/spikelet and 100 grain weight in C-IV. From these observations, it can be concluded that selection for these characters like plant height can be made in the early segregating generation. Therefore, this study concluded that the performance of the plants in F_2 generation is a reliable indicator of the performance of their progeny in subsequent generations. Suwarto *et al.*[14] also showed similar results for correlation and regression for plant height and number of grain per panicle in F_2 and F_3 generations.

The worth of the early generation selection can be known by intergeneration correlation and narrow sense heritability. Selection is generally practiced in segregating F_2 generation based on high mean and high heritability. However, the elimination of environmental variance and estimating the genetic variance that is being inherited from F_2 to F_3 generation by parent offspring regression helps in knowing the nature of inheritance and possible selection[15]. Similar conclusions were drawn by Pawar *et al*[16].

Gilbert[17] further observed that parent offspring regression method was the more appropriate way to estimate narrow heritability than components of variance method. Some heritability estimates in parent offspring method turned out to be higher than 1 (or 100%). This is weakness of this method. But it can be solved by appropriate transformation prior to analysis.

Narrow sense heritability based on regression coefficient of F_3 over F_2 generation of C-I for different characters is given in Table 4. Narrow sense heritability was highest for the number of tillers per plant (65.4) followed by 100 grain weight (58.0), grain yield per plant (54.0), plant height (46.4) and ear weight (32.0) and it was found lowest for number of grains per spikelet (2.8). In C-II narrow sense heritability observed maximum in 100 grain weight (88.0) followed by plant height (82.0) and grain yield per plant (78.0) whereas, it was minimum in biological yield/plant (9.0) and harvest index (5.8).

Narrow sense heritability was highest for 100 grain weight (89.6) followed by plant height (82) and number of grains per ear (74.8%) and it was lowest for harvest index (9.8%) in C-III. In C-IV narrow sense heritability observed highest for plant height (80) followed by 100 grain weight (61.2) and number of grains per spikelet (55.4). It was observed lowest for harvest index (19.8) and number of grains per ear (11.3).It was found that the narrow sense heritability for different characters based on parent offspring regression coefficient was high for 100 grain weight in all crosses, plant height in the crosses C-I, C-II and C-III and grain yield in C-I and C-II. As narrow sense heritability is the ratio of additive variance to the total phenotypic variance, it includes additive and additive x additive component of variance, which are fixable. Higher the narrow sense heritability, higher is the chances of improving the characters through selection. Hence, 100 grain weight and grain yield per plant has the better chances of improvement through selection. For characters like harvest index, biological yield/plant in all crosses, number of grains per spikelet in C-I and C-III and ear length in C-II and C-IV, narrow sense heritability was low, so these characters cannot be improved through simple selection as dominance or epistatic effect may be present. Thus, to improve these characters hybridization is needed. Similar results were also reported by Mohamed *et al.*[18] for moderate narrow sense heritability for plant height, grain yield/plant (g) and 1000-kernel weight (g). These results are in line with those obtained by Al-Saffar *et al.*[19] and Foroozanfar *et al*[20].

Table 1: Mean performance of selected plants in F_2 and F_3 generation for different characters in crosses Raj3765 x Syn27 (Cross-I) and WH1105 x Syn27 (Cross-II)

	Cross-I				Cross-II			
	F_2 population		F_3 population		F_2 population		F_3 population	
Characters	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Plant height	123.5	105-140	113.8	101-129.3	127.91	99-145	120.6	100-134
Number of tillers/ plant	10.48	8-13	8.56	6-11	10.85	7-14	9.42	6.5-13
Ear length	11.65	9-13	11.03	9-12	10.94	8-13	9.93	8-11.5
Ear weight	2.52	1-3.5	2.15	1.43-3.46	2.66	1.6-3.6	2.25	1.46-3.43
Number of grains/ ear	36.25	26-49	31.99	22-42.83	37.26	19-47	30.44	25.6-38.16
Grain weight/ Ear	1.5	1-2.1	1.41	0.9-2.08	1.66	1-2.3	1.33	1.1-1.8
Number of grains /Spikelet	2.74	2-4	2.55	1.83-3.5	3.20	2-4	2.95	2-4
Number of spikelets /Ear	19.4	17-21	17.49	14.66-19.83	19.35	15-21	18.20	15-21.33
100 Grain weight	4.07	3-4.5	3.97	3-4.55	4.18	3.33-4.8	3.95	2.9-4.54
Grain yield/ plant	12.2	5.9-21.1	10.31	6.41-15.49	12.73	5-21.7	12.62	8.3-17
Biological yield/ plant	31.45	8-53	30.98	22.83-41.83	31.52	21-47	30.43	23.95-39.66
Harvest index	0.36	0.21-0.46	0.32	0.24-0.38	0.38	0.23-0.47	0.31	0.27-0.44

Table 2: Mean performance of selected plants in F_2 and F_3 generation for different characters in crosses Raj3765 x WH711(Cross-III) and WH1105 x WH711 (Cross-IV)

	Cross-III				Cross-IV			
	F_2 population		F_3 population		F_2 population		F_3 population	
Characters	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**	**Mean**	**Range**
Plant height	99.39	85-120	93.17	80.66-104.83	86.77	71-100	92.96	75.83-103.83
Number of tillers/ plant	10.07	5-13	9.47	6.16-11.5	5.2	2-8	7	3-11.33
Ear length	10.26	8-13	12.60	10.83-14.16	9.16	7-11	11.86	10.16-13.83
Ear weight	2.8	1.9-4	3.09	2.4-3.95	2.75	1.6-3.2	2.65	1.78-3.8
Number of grains/ ear	42.89	32-56	46.82	37.5-59.16	42.52	26-56	43.13	35-53.33
Grain weight/ Ear	1.83	1.1-2.8	1.98	1.5-2.51	1.75	1.2-2.4	1.95	1.38-2.38
Number of grains /Spikelet	3.46	3-4	3.25	3-3.66	3.58	3-4	3.27	2-3.83
Number of spikelets /Ear	19.96	15-23	19.78	17-21.33	19.5	17-23	19.90	17.66-22.3
100 Grain weight	3.90	2.8-4.4	3.83	2.7-4.45	4.12	3.07-4.47	4.24	3.35-4.57
Grain yield/ plant	11.60	3.6-24	14.07	7.3-18.74	9.50	4.5-16.2	11.10	5.17-17.65
Biological yield/ plant	32.5	18-58	36.15	21.83-45.83	22.55	10-35	31.00	11.66-52.33
Harvest index	0.35	0.23-0.46	0.36	0.24-0.44	0.39	0.21-0.47	0.37	0.26-0.47

Table 3: Parent offspring correlation in F_2 and F_3 and regression of the crosses over segregating generation for different characters in all crosses

S. No.	**C-I (RAJ 3765 x Syn 27)**		**C-II (WH 1105 x Syn 27)**		**C-III (RAJ 3765 x WH 711)**		**C-IV (WH 1105 x WH 711)**	
Characters	**b**	**R**	**b**	**R**	**B**	**R**	**b**	**R**
Plant height	**0.232***	**0.348***	**0.41****	**0.677***	**0.41****	0.616*	**0.40****	**0.520***
Number of tillers/plant	0.327	0.327	0.21	0.198	0.126	0.152	0.151	0.081
Ear length	0.128	0.126	0.087	0.110	0.14	0.261	0.095	0.125
Ear weight	0.16	0.187	0.26	0.265	**0.28***	0.359	0.122	0.119
Number of grains/ear	0.11	0.151	0.135	0.233	**0.374****	**0.480***	0.0565	0.078
No. of grains/ear weight	0.079	0.117	0.055	0.104	**0.24***	**0.426***	0.0632	0.075
Number of grains/spiklelet	0.014	0.022	0.111	0.229	0.085	0.222	**0.277***	**0.355***
Number of spikelets/ear	0.129	0.125	**0.28***	**0.356***	0.181	0.297	0.131	0.207
100 grain weight	0.290	0.348	0.44	0.280	0.448	0.356	**0.306****	**0.487***
Grain yield/plant	**0.270***	**0.401***	**0.39****	**0.600***	0.100	0.176	0.126	0.093
Biological yield	0.084	0.185*8	0.045	0.103	0.102	0.182	0.199	0.120
Harvest index	0.023	0.049	0.029	0.052	0.049	0.104	0.099	0.116

b- Regression coefficient

r- Intergeneration correlation

*, **- significant at the 5% and 1% level, respectively

Table 4: Narrow sense heritability for different characters of all crosses, according to the parent-offspring regression analysis of F_3 over F_2

S. No. / Characters	C-I (RAJ 3765 x Syn 27)	C-II (WH 1105 x Syn 27)	C-III (RAJ 3765 x WH 711)	C-IV (WH 1105 x WH 711)
Plant height	46.4	82.0	82.0	80.0
Number of tillers/plant	65.4	42.0	25.2	30.2
Ear length	25.6	17.4	28.0	19.0
Ear weight	32.0	52.0	56.0	24.4
Number of grains/ear	22.0	27.0	74.8	11.3
Number of grains/ear weight	15.8	11.0	48.0	12.64
Number of grains/spiklelet	2.8	22.2	17.0	55.4
Number of spikelets/ear	25.8	56.0	36.2	26.2
100 grain weight	58.0	88.0	89.6	61.2
Grain yield/plant	54.0	78.0	20.0	25.2
Biological yield/plant	16.8	9.0	20.4	39.8
Harvest index	4.6.0	5.8	9.8	19.8

CONCLUSION

Significant positive inter-generation correlation and regression was observed for character plant height in all four crosses Raj3765 x Syn 27, WH1105 x Syn27, Raj3765 x WH711 and WH1105 x WH711 and grain yield per plant was found significant in crosses Raj3765 x Syn 27 and WH1105 x Syn27. This indicated the effectiveness of selection for these characters. Higher the narrow sense heritability, higher is the chances of improving the characters through selection. Hence, 100 grain weight and grain yield per plant has the better chances of improvement through selection.

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