

Regression Analysis, Heritability and Inter-Generation Correlation in Wheat (*Triticum aestivum* L.)

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ABSTRACT

*In the present study F₅ and F₆ generation of crosses between WH 711 and WH 542 of bread wheat (*Triticum aestivum* L.) was evaluated for yield and its contributing traits under timely and late sown condition. Parent progeny regression analysis was undertaken to determine the genetic potential transferred from one generation to next generation. The significant and positive inter-generation correlation and regression was observed for character like grain yield per meter, grain length, plant height, harvest index, grain weight per spike, grain breadth, number of tillers per meter and biological yield per meter. It indicates the chances of selecting high yielding segregants at early generations. The narrow sense heritability for different characters based on parent offspring regression coefficient was moderate for grain yield per meter (78.80%), grain weight per spike (68.60%), harvest index (63.20%) and number of tillers per meter (54.00%) under both timely and late sown conditions. Higher the narrow sense heritability, higher is the chances of improving the characters through selection.*

Keywords: Wheat, Narrow-sense heritability, Inter-generation correlation, Regression.

INTRODUCTION

Wheat is the world's most important crop that excels all other cereal crops both in area and production, thereby providing about 20.0 per cent of total food calories for the people of the world (Nukasani, Potdukhe, Bharad, Deshmukh, & Shinde, 2013). Globally the area production and productivity of wheat was

220.06 mha and 763.18 mt and 3.47 MT/ha respectively, during the year 2018-2019 (USDA, 2019). India is the second largest producer of wheat in the world with area, production and productivity of 29.55 mha, 101.20 mt and 3.42 MT/ha, respectively, during 2018-2019 (Anonymous, 2019).

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Approximately 90% of the total wheat production of India is contributed by the five states *i.e.*, Uttar Pradesh, Punjab, Haryana, Madhya Pradesh and Rajasthan (Ramdas, Singh, & Sharma, 2012). In Haryana, wheat was grown over an area of 25.10 Lha, with a production of 11.65 mt and productivity of 4.64 t/ha during 2018-2019 (Anonymous, 2019). In view of increasing population and global demand there is an imperative need to increase 40–60% of wheat production, to meet out the requirement of developing world in the coming 40 years (Goutam, Kukreja, Yadav, Salaria, Thakur, & Goyal, 2015). Indirect selection has been shown to be more efficient, less efficient, or equally efficient compared to direct selection when selection was practiced to improve a trait in one environment by selecting the trait in another environment (Sinebo, Gretzmacher, & Edelbauer, 2002). Efficiency of indirect selection compared to direct selection depends on the heritability of the trait used as selection criterion and on correlation between this trait and the indirectly targeted trait (Falconer & Mackey, 1996, Hannachi, Fellahi, Rabti, Guendouz, & Bouzerzour, 2017). Regression analysis is the better way to make crop yield prediction (Massart, Vandeginste, Buydens, De jong, Lewi, & Smeyers-Verbeke, 1997, Qingwu, Zhu, Musick, Stewart, & Dusek, 2006). 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. Ibrahim and Quicke (2001) evaluated F_3 and their F_4 progeny derived from two crosses involving heat tolerant and heat sensitive genotypes to study the genetic variability for heat tolerance measured by MTS. 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_5 and F_6 generations.

MATERIALS AND METHODS

Planting material

A total of 238 progenies each of the F_5 and F_6 generations along with parents (WH 711 / WH 542) were planted at the experimental area of Wheat and Barley Section of the Department of Genetics and Plant Breeding CCS Haryana Agricultural University, Hisar, during *Rabi* season of 2016-2017 and 2017-2018 under two planting conditions, timely (November 6, 2016 and November 8, 2017) and late sown (December 9, 2016 and December 8, 2017) conditions. The seed of each progeny was sown in a row of 2.5 meter length, with a spacing of 20 cm in a randomized complete block design (RBD) with two replications. Recommended package of practices for the agro-climatic zone were followed to raise the crop experiment.

Statistical analysis

Regression coefficient

The degree of dependence of one variable 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_6) upon the value of a character in the parent (F_5) (Lush, 1940). 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:

$$t = byx / S.E. (b)$$

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)

Narrow sense heritability

Based on parent offspring regression, narrow sense heritability was calculated as suggested by (Smith & Kinmann, 1956).

$$H (n.s.) = 2 \times b$$

Where,

b = regression coefficient

Intergeneration correlations

Intergeneration correlation coefficients (r) were calculated for each trait between F₅ and F₆ generations. In each case progeny means (y) of F₆ generation were regressed on the individual plants (x) of F₅ generation.

$$\text{Intergeneration correlation (r)} = b_{yx} \times \frac{\sigma_x}{\sigma_y}$$

Where,

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

σ_x = Standard deviation of x

σ_y = 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 Fisher and Yates (1963). If the observed value is more than the tabulated one, the correlation coefficient is said to be significant.

RESULTS AND DISCUSSION

Narrow sense heritability

Narrow sense heritability estimates helps to understand the nature of inheritance of a trait from generation to generation. Narrow sense heritability based on parent offspring regression analysis of F₆ generation over F₅ generation for 19 traits under timely sown and late sown conditions are presented in Table 1. Narrow sense heritability, under timely sown

conditions for grain yield per meter (78.80%), grain weight per spike (68.60%), plant height (65.40%), grain length (65.20%), harvest index (63.20%) and number of tillers per meter (54.00%) showed moderate narrow sense heritability whereas biological yield per meter (40.40%), grain breadth (36.40%), number of grains per spike (21.20%), spike length (20.00%), number of spikelets per spike (19.80%), carotenoids (18.00%), days to heading (16.80%), 100-grain weight (16.40%), chlorophyll-b (11.40%), days to maturity (11.40%), canopy temperature (10.20%), chlorophyll-a (5.20%) and seed density (4.40%) had low narrow sense heritability. Under late sown conditions, number of spikelets per spike (74.00%) grain weight per spike (66.40%) and grain yield per meter (62.40%) had moderate narrow sense heritability whereas plant height (47.80%), harvest index (46.40%), number of grains per spike (43.60%), number of tillers per meter (43.40%), carotenoids (40.60%), seed density (40.40%), chlorophyll-a (37.00%), days to maturity (36.60%), spike length (36.40%), canopy temperature (35.80%), 100-grain weight (35.20%), biological yield per meter (32.60%), days to heading (30.80%), grain length (26.00%), grain breadth (18.60%) and chlorophyll-b (4.00%) had low narrow sense heritability. Higher the narrow sense heritability, higher is the chances of improving the characters through selection. Similar results were also reported by Mohamed, El-Said, & Abd-El-Haleem (2013) 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 & Al-Sawaf (2012), Foroozanfar & Zeynali (2013), Singh, Punia, Singh, & Jagdale (2017) and Hari Kesh, Yadav, Sarial, Khajuria, & Jain (2017).

Table 1: Narrow sense heritability (%) for different traits based on the parent-offspring regression analysis

Sr. No.	Traits	Timely sown	Late sown
1.	Days to heading	16.80	30.80
2.	Canopy temperature (°C)	10.20	35.80
3.	Chlorophyll-a (mg/g)	5.20	37.00
4.	Chlorophyll-b (mg/g)	11.40	4.00
5.	Carotenoids (mg/g)	18.00	40.60
6.	Days to maturity	11.40	36.60
7.	Plant height (cm)	65.40	47.80
8.	Number of tillers per meter	54.00	43.40
9.	Spike length (cm)	20.00	36.40
10.	Number of spikelets per spike	19.80	74.00
11.	Number of grains per spike	21.20	43.60
12.	Grain weight per spike (g)	68.60	66.40
13.	100 grain weight (g)	16.40	35.20
14.	Seed density (g/cc)	4.40	40.40
15.	Grain length (mm)	65.20	26.00
16.	Grain breadth (mm)	36.40	18.60
17.	Grain yield per meter (g)	78.80	62.40
18.	Biological yield per meter (g)	40.40	32.60
19.	Harvest Index (%)	63.20	46.40

Regression coefficient and Intergeneration correlation

The success of early generation selection usually depends on high correlation between the performance of the selected genotypes in one generation and their performance in the next generation (Barma, Islam, Hakim, & Sarker, 2011). Intergeneration correlation studies by parent-offspring regression method gave an idea about the extent of transmission of the genetic information from one generation to another generation. The parent progeny correlation and regression between the two generations is very useful for the selection of superior recombinants in the segregating population, to develop new and improved genotypes (Kumar, Kumar, Singh, Samita, Chaudhary, Sheokand, & Kumar, 2020). The present investigation was aimed at studying the response of selection for yield and its component traits through parent progeny correlation and regression method between F₅ and F₆ generations. The degree of dependence of one variable on the other is measured by regression coefficient. The parent progeny regression analysis was calculated on F₆ over F₅. The regression coefficient b was calculated

by using the formula suggested by Lush (1940). In timely sown conditions significantly positive coefficient values were observed for grain yield per meter (0.394**), grain weight per spike (0.343**), plant height (0.327**), grain length (0.326**), harvest index (0.316**), number of tillers per meter (0.270**), biological yield per meter (0.202*) and grain breadth (0.182**) whereas, under late sown conditions significantly positive coefficient values were observed for number of spikelets per spike (0.370**), grain weight per spike (0.332**), grain yield per meter (0.312**), plant height (239**), harvest index (0.232**), number of grains per spike (0.218**), number of tillers per meter (0.217**), carotenoids (0.203**), seed density (0.202**), chlorophyll-a (0.185**), canopy temperature (0.179**), days to heading (0.154**), spike length (0.182*), 100-grain weight (0.176*), biological yield per meter (0.163*), grain length (0.130*) and grain breadth (0.093*) respectively (Table 2). Intergeneration correlation analysis was done using parent-offspring regression to transfer of characters from one generation to other generation. Under timely sown conditions

highly significantly intergeneration correlation was observed for grain yield per meter (0.344**), grain length (0.307**), plant height (0.279**), harvest index (0.246**), grain weight per spike (0.226**), grain breadth (0.180**), number of tillers per meter (0.179**) and biological yield per meter (0.159*) whereas, under late sown conditions number of spikelets per spike (0.368**), grain weight per spike (0.305**), grain yield per meter (0.266**), carotenoids (0.251**), seed density (0.250**), harvest index (0.233**), plant height (0.226**), number of grains per spike (0.201**), chlorophyll-a (0.199**), canopy temperature (0.187**), days to heading (0.180**), number of tillers per meter (0.169**), grain breadth (0.160*), spike length (0.155*), 100-grain weight (0.151*), biological yield per meter (0.150*) and grain length (0.136*) showed significant positive intergeneration correlation in Table 2. The F₅ generation depicted highly significant and positive intergeneration correlation and regression with F₆ generation for plant height,

number of tillers per meter, grain weight per spike, grain length, grain breadth, grain yield per meter, biological yield per meter and harvest index under both environments which indicated that these traits had high heritability, with more additive effect. Laala, Benmahammed, Oulmi, Fellahi, & Bouzerzour (2017) observed significant intergeneration correlation for days to heading, plant height, 1000-grain weight and harvest index in wheat. Similar findings were also observed by Wagoire, Ortiz, Hill, & Stolen (1999) for grain yield and Suwanto, Untung, & Siti (2015), Singh et al. (2017) for plant height in F₂ and F₃ generations. Shanatava, Veerghanti, Suresh, Mahadevu, & Hittalmani (2014) reported significant intergenerational correlation between F₂ and F₃ generations for almost all the characters except plant height. Manohara & Shashidhar (2018) reported non-significant and low intergeneration correlation for grain yield indicated that early generation selection for grain yield was not effective.

Table 2: Regression coefficient and intergeneration correlation between F₅ and F₆ generations of the cross WH711 x WH542 for different characters in bread wheat

Sr. No.	Traits	Timely sown		Late sown	
		b	r	b	R
1.	Days to heading	0.084	0.073	0.154**	0.180**
2.	Canopy temperature (°C)	0.051	0.054	0.179**	0.187**
3.	Chlorophyll-a (mg/g)	0.026	0.020	0.185**	0.199**
4.	Chlorophyll-b (mg/g)	0.057	0.045	0.020	0.015
5.	Carotenoids (mg/g)	0.090	0.066	0.203**	0.251**
6.	Days to maturity	0.057	0.054	0.183	0.111
7.	Plant height (cm)	0.327**	0.279**	0.239**	0.226**
8.	Number of tillers per meter	0.270**	0.179**	0.217**	0.169**
9.	Spike length (cm)	0.100	0.094	0.182*	0.155*
10.	Number of spikelets per spike	0.099	0.097	0.370**	0.368**
11.	Number of grains per spike	0.106	0.096	0.218**	0.201**
12.	Grain weight per spike (g)	0.343**	0.226**	0.332**	0.305**
13.	100 grain weight (g)	0.082	0.065	0.176*	0.151*
14.	Seed density (g/cc)	0.022	0.026	0.202**	0.250**
15.	Grain length (mm)	0.326**	0.307**	0.130*	0.136*
16.	Grain breadth (mm)	0.182**	0.180**	0.093*	0.160*
17.	Grain yield per meter (g)	0.394**	0.344**	0.312**	0.266**
18.	Biological yield per meter (g)	0.202*	0.159*	0.163*	0.150*
19.	Harvest Index (%)	0.316**	0.246**	0.232**	0.233**

b- Regression coefficient

r- Intergeneration correlation

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

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