

## Selection for Early Heading and Correlated Response in Yield Attributes of Bread Wheat

Thrwat-El Ameen

Department of Genetics, Faculty of Agriculture, South Valley University, Qena 83523, Egypt

**Abstract:** This study was conducted to determine genetic gain to heading after three cycles of phenotypic selection in F<sub>2</sub> population (long spike-35x Giza-168). Highly significant differences among F<sub>3</sub> families, F<sub>4</sub> families and F<sub>5</sub> families for days to heading were observed. Direct response to selection for early heading date was -7 – 7 and – 12 days in three cycles of selection, respectively. The genetic gains for early heading date were 9.41% in the first cycle (C<sub>1</sub>), 10.50% in the second cycle and 15.21% in the third cycle of selection (linear response to selection for days to heading). Correlated response to selection was significant and positive for grain yield in the first and second cycles, but for 1000 grain weight in the three cycles of selection. Heritability estimates ranged from 0.10 for 1000 grain weight to 0.95 for days to heading. Negative correlation between heading date and grain yield in third cycle and positive in first and second cycle. This result has been indicated before from the highest to indirect response before grain yield in third cycle. Uniformally, the observed response was greater than predicted response head indicate the presence of dominance gene action controlling the heading date.

**Key word:** Earliness, Heading date, Attribute yield, Direct response.

### INTRODUCTION

Earliness is an important trait in plant breeding. Wheat (*Triticum aestivum* L.) is produced world wide under largely temperature but also under tropical and subtropical such as south valley region.

High temperature during the post heading stages detrimentally affect it yield (Wieg and Cuellar 1981).

Early heading cultivars out performed later heading cultivars because of two distinct advantages, the early heading cultivars had longer post. heading and, therefore, longer grain filling period than the later heading cultivars. In addition, early-heading cultivars completed a greater fraction of the grain filling earlier in the season when air temperature were lower and generally more favorable. The results suggest that early heading is an important and effective single trait defining wheat cultivars adopted to production systems prone to high temperature stress during the post-heading period (Tewolde *et al.* 2006).

Heading date in what is an easily identifiable character that can be modified through selection (Allard and Hardings 1963; Avey *et al.* 1982).

Obari (1990) confirms earliness and good adaptability of landraces to high temperature.

Van Sanford (1985) found that the two entries in the uniform southern soft red winter wheat nursery flowered 8 days apart reached physiological maturity at approximately the sometimes.

He concluded that selection for early anthesis and high yield might procedure genotype that reach physiological maturity than that flower late.

Correlation analysis showed close relation between earliness in heading and in maturity and negative relation between late heading and grain filling period (Dotlacil *et al.* 2003). Moreover, the number of days to maturity was negatively associated with drought susceptibility index (DSI) (Hassan Kille and Tacctim Yag 2010).

Positive direct effect of days to heading days to maturity and biological yield with grain yield were observed (Tieu *et al.* 2005).

(Frohbery 1987) suggested that selection for high kernel growth rate and short filling period might be appropriate to develop earlier maturing genotypes.

Direct response to selection for early heading date was -5 and -10 days respectively, in two populations, correlated response to selection was not significant in population I (Maya and Van Sanford 1992).

Diallel cross analysis of the number of days to heading indicated significant additive and dominance genetic variances, a high average degree of dominance for earliness (Klaimi *et al.* 1973)

Selection for yield and earliness in mutant genotypes of spring barley was studied by (Niz 2007).

He indicated that grain yield was generally higher in the genotypes which had a short maturity period and fewer associated growing degree days (GDD) and therefore negative relationship between grain yield and phenological growth traits observed.

Results indicates a consistent trend of earlier heading or flowering dates across all sites but rates of the trend differ (from 0.8 to 1.8 days per 10 years). Because the heading of flowering date is governed primarily by temperature, the earlier heading or flowering dates indicates warming temperature in the spring (Qi Hu 2006).

**Corresponding Author:** Thrwat-El Ameen, Department of Genetics, Faculty of Agriculture, South Valley University, Qena 83523, Egypt

Two cycles of pedigree selection for the days to heading, grain yield and 1000 grain weight were practiced in two segregating populations. Highly significant differences among  $F_3$  families in both populations.

Estimates of realized gains showed that heading date were earlier by 4.10 and 6.91% for populations I and II, respectively than the bulk sample after the two cycles of selection. Selection also improved grain yield/plant in both populations over the bulk sample by 12.20 and 3.7 for population I and 7.93 and 1.69 for population II (Ali 2012).

Highly significant differences were observed among the genotypes for days to heading, grain yield and 1000 grain weight. Analysis of genetic components revealed significant additive (D) and dominance (H) genetic variation for days to heading, grain yield, 1.5 grain weight and number of grains (Farhed Ahmed *et al.* 2011).

The parents and the NIs were tested during two to four year in three diverse field environmental. Results showed that genotypes 3 to 7 earlier than NGN warrant increased breeding emphasis because they had high yield potential across all environments and often had enhanced test weight, kernel weight and harvest index.

The earliest NIs had limited yield potential in the cool-moist medium growing season environment, but they had high yield potential in the temperate long growing season environment (Edgaras and Allan 1995).

This study was conducted (i) to determine genetic gain for days to heading after three cycles of selection (ii) the indirect effects of the selection for grain yield, 1000 grain weight, number of grains and spike length (iii) estimate genetic correlations among and heritability of traits related to maturity such as grain yield and to develop early heading advanced lines adopted to production systems.

## MATERIALS AND METHODS

Selection studies were initiated in the  $F_2$  generation of the cross (long spike-35x Giza-168).

The population was planted at the experimental form of south valley university on 25 Nov 2009 in six row plots in 3m length with 20 cm, row spacing. Heading date for an individual plants was defined as the days of complete spike emergence from the flag leaf sheath. 10 plants which earliest were selected. From the other plants five plants were harvested to form  $F_3$  bulk. Next season, the 10  $F_3$  selected and  $F_3$  bulk families were planted on 28 Nov. For the second cycle of selection, the first of 2.22% of the plants to heading date were tagged and selected. In 2011 winter season the 10  $F_4$  selected families and bulk were planted on 30 Nov. For the third cycle of selection within each family, one plant with first to heading date (1/15) intensity selection were selected to form  $F_5$  selected families, seeds per plant for five random families harvested and bulked for each family.

The  $F_5$  selected families and  $F_5$  bulk families were planted on 30 Nov in 2012 season.

The soil type as sandy soil, infertile soil, deficit moisture.

The experimental design was randomized complete block design with three replications.

Response variables included heading date, number of grains/ spike, grain yield per spike, spike length/plant and 1000 grain weight/plant.

### *Statistical Analysis:*

All response variables were subjected to analysis of variance (ANOVA) in the selection study (Snedecor and Cochran 1980). Genotypic and phenotypic correlation were computed according to (Miller *et al.* 1958). The predicted response to selection ( $R_x$ ) was estimated as  $R_x = ih^2\sigma_p$  (Falconer 1989), where  $i$ =standardized selection differential,  $h^2$ = heritability, and  $\sigma_p$ =phenotypic standard deviation while, the indirect response to selection ( $CR_x$ ) was estimated as  $CR_x = i \cdot h^2 \cdot \sigma_p \cdot r_{xy}$ , where  $r_{xy}$  is the genetic correlation between selected trait and unselected trait. The realized gains from selection (observed response) as a percentage deviation from the selected entires and bulk sample were estimated for the selection criteria and the correlated traits.

Heritability =  $\sigma^2_g/\sigma^2_p$ , where  $\sigma^2_g$  the genetic variance and  $\sigma^2_p$  phenotypic variation (Mather and Jinks, 1971).

## RESULTS AND DISCUSSION

The means, observed and predicted responses to selection for days to heading in the three cycles of selection are presented in Table 1, while the analysis of variance are given in Table 2.

In the first cycle of selection significant positive response to selection was obtained for days to heading. However, the observed response to selection for heading date was 9.41% of the mean. Results showed that the  $F_3$  selected families earlier than  $F_3$  bulk by 7 days. Generally, the predicted response to selection for heading date greater than observed response indicating the dominance gene effect involved in the inheritance of that trait. As to indirect response to selection, significant positive correlated responses to conventional selection were obtained in grain yield (12.63%), 1000 grain weight (6.01%). The observed correlated responses to selection for grain yield was greater than the predicted response, while the reverse was true for 1000 grain weight confirming the dominance gene effects play important role in the inheritance of these traits.

These results are in agreement with those obtained by (Klaimi *et al.* 1973); Niz (2007) who found the grain yield was generally higher in the genotypes which had a short maturity period.

Here too in the second cycle of selection, significant positive response to selection for heading date was obtained Table 2.

The observed response to selection was 10.50% of the mean. Results revealed that the F<sub>4</sub> selected families earlier than the F<sub>4</sub> bulk with 7 days. Greater progress for early heading date was made in the second cycle of selection than in the first Table 3. Attributed greater response in the second cycle (C<sub>2</sub>) versus first cycle (C<sub>1</sub>) to selection for major genes affecting heading date in the second cycle of selection and for minor genes in the first cycle (Avey *et al.* 1982). Also greater response in the second cycle of selection in this study could simply reflect a higher selection intensity. While selection intensity in the first cycle was known to be 10% we estimated a selection intensity of 2.2% in the second cycle of selection. The observed response to selection was greater than predicted response indicated that dominance gene effects was found.

Positive correlated responses to selection for heading date in grain yield and 1000 grain positive weight were significant table 2.

The observed correlated responses to selection for grain yield and 1000 grain weight were greater than predicted responses promoted that these traits controlled by the type of dominance gene effects.

Similar results were obtained by Ali (2012) who reported that the realized gains for heading date were 4.10 and 6.9% for population I and II. Analyze of genetic components revealed significant additive (D) and dominance (H) genetic variation for days to heading, grain yield and 1000 grain yield (Farhed and Ahmed *et al.* 2011).

Data in Table 2 showed significant positive response to selection for days to heading.

The genetic gain for days to heading was 15.21% in third cycle. The F<sub>5</sub> selected families earlier than F<sub>5</sub> bulk by 12 days of the mean.

**Table 1:** Means, observed and predicted response to selection for heading date, grain yield, 1000 grain weight, number of grains and spike length in three cycles of selection.

cycle	Heading date				Grain yield				1000 grain weight				Number of grain				Spike length *		
	Selected	Bulk	O%	P%	Selected	Bulk	Cr %	P%	Selected	Bulk	Cr %	P%	Selected	Bulk	Cr %	P%	Selected	Bulk	Cr
C <sub>1</sub>	66.73	73.66	941	12.16	2.14	1.90	12.63	0.61	43.54	41.07	6.01	9.53	48.86	53.20	-8.15	1.37	10.30	11.58	10.66
C <sub>2</sub>	63.10	70.5	10.50	5.50	2.30	1.97	15.22	0.93	45.36	36.23	25.20	3.30	50.27	54.40	-7.59	21.20	11.23	11.00	2.09
C <sub>3</sub>	65.96	77.80	15.21	6.79	2.50	2.10	19.05	0.23	48.11	42.15	14.14	1.31	51.90	51.20	1.36	1.77	10.90	10.73	1.58

**Table 2:** Analysis of variance in C<sub>1</sub>, C<sub>2</sub> and C<sub>3</sub> cycles of selection.

Item	Heading date	Grain yield	1000 grain weight	Number of grain	Spike length
Among F <sub>3</sub> entries	42.66**	0.27**	34.70*	223.35**	5.37**
F <sub>3</sub> selected	12.87**	0.36**	27.80	239.86**	4.33**
F <sub>3</sub> bulk	0.17	0.12**	43.62*	195.10*	5.26**
F <sub>3</sub> selected vs F <sub>3</sub> bulkies	480.24**	1.33**	86.83**	173.26	15.13**
Error	2.02	0.007	9.32	36.22	0.60
Among F <sub>4</sub> entries	50.36**	0.41	101.72**	153.21	1.76
F <sub>4</sub> selected	16.81**	0.43	52.46	127.16	1.86
F <sub>4</sub> bulk	2.93	0.38	27.57	206.40	1.83
F <sub>4</sub> selected vs F <sub>4</sub> bulkies	709.4	3.06**	858.95**	201.26	3.87
Error	1.66	0.16	20.37	66.11	0.97
Among F <sub>4</sub> entries	103.13**	0.21*	30.66	80.05	1.99
F <sub>4</sub> selected	0.99	0.15	20.46	44.23	2.60
F <sub>4</sub> bulk	13.93**	0.02	7.98	23.76	0.56
F <sub>4</sub> selected vs F <sub>4</sub> bulkies	1569.61**	0.89	1280.04**	500.34**	32.77**
Error	0.82	0.06*	27.84	72.80	0.80

\* significant at 0.05.

\*\* significant at 0.01

Greatest progress for early heading date was made in third cycle of second cycle of selection. Greatest response in the third cycle of selection in our study could simply reflect a highest selection intensity.

While selection intensity in the first cycle was 10% and in the second cycle was 2.2% estimated a selection intensity of 0.06 in the third cycle of selection.

The observed correlated responses to selection for heading date in 1000 grain weight, number of grains and spike length were significant and positive.

Selection for days to heading, also improved grain yield in both populations over the bulk sample by 12.2 and 3.7% for population I and 7.9 and 1.69% for population II (Ali 2012)

The remarkably high positive correlated responses were obtained in grain yield and 100 grain weight by selecting for earliness of heading date could be attributed to the negative genetic correlations found between the two characters.

The average degree of dominance for days to maturity (2006) and grain filling period (1.68) indicated the presence of over dominance gene action controlling these yield attributes. (Zahid Akram *et al.* 2008). Results shoed that genotypes 3 to 7 earlier than NGN warrant increased breeding emphasis because they had high yield potential across all environments and often had enhanced test weight, kernel weight and harvest index (Edgars Haro and Alian 1995).

**Table 3:** Direct and correlated response to selection for early heading date in three cycles of selection.

Cycle	Heading date	Grain yield	1000 grain weight	Number of grain	Spike length
C <sub>1</sub>	66.73 <sup>a</sup>	2.4 <sup>a</sup>	43.54 <sup>a</sup>	48.86 <sup>a</sup>	10.30 <sup>a</sup>
C <sub>2</sub>	63.10 <sup>b</sup>	2.30 <sup>b</sup>	45.36 <sup>b</sup>	50.27 <sup>b</sup>	11.23 <sup>b</sup>
C <sub>3</sub>	65.96 <sup>c</sup>	2.50 <sup>c</sup>	48.11 <sup>c</sup>	51.90 <sup>c</sup>	10.90 <sup>c</sup>

Mean heading date was significantly earlier after one cycle of selection with gain of 3 days Table 3. After two cycles mean heading date was one day earlier than C<sub>1</sub> cycle but was 12 days earlier than bulk sample Table 1. These results agree with other studies reporting response to selection for early heading date (Allard and Harding 1963). However, some C<sub>1</sub> advanced lines headed on the same day but differed in grain yield by almost 1 gram. Also, some C<sub>3</sub> advanced line headed in the same day (66 days) but differed in grain yield which ranged from 2.24 to 2.81 gram Table 4. Heading entries gave higher grain yield than some earlier – heading entries. There were exceptions to the high correlation between heading date and grain yield calculated from all entries and cycles of selection. Heritability estimates for heading date ranged from 0.45 for C<sub>2</sub> to 0.95 for C<sub>1</sub> of selection. While, for grain yield heritability estimates ranged from 0.63 for second cycle (C<sub>2</sub>) to 0.91 for first cycle (C<sub>1</sub>). Overed three cycles of selection heritability estimates ranged from 0.10 for 1000 grain weight to 0.95 for heading date similar results were obtained by (May and Evan Sanford 1992).

**Table 4:** Means and standard errors (S,E) of heading date effective grain yield, 1000 grain weight, number of grain and spike.

	Entry	Heading date	Grain yield	1000 grain weight	Number of grain	Spike length
C <sub>1</sub>	1	66	2.65	32.28	39	9
	2	63	2.25	43.36	36	10
	3	67	1.90	45.23	42	9
	4	66	2.93	47.17	41	9
	5	69	2.56	44.53	58	12
	6	65	2.56	44.41	57	11
	7	69	2.40	40.96	52	10
	8	66	1.92	38.42	50	10
	9	69	2.23	42.93	53	12
	10	65	2.49	42.03	60	11
	S.E	0.63	0.10	1.3	2.73	0.36
C <sub>2</sub>	1	61	1.81	49.82	37	11
	2	62	2.17	44.49	48	12
	3	63	2.67	46.65	57	11
	4	60	2.21	44.64	51	11
	5	61	2.14	44.79	48	11
	6	66	1.87	40.67	46	11
	7	67	2.10	42.54	49	11
	8	61	3.03	54.79	56	11
	9	63	2.54	42.5	60	12
	10	65	2.15	42.35	50	11
	S.E	0.75	0.11	1.33	2.05	0.13
C <sub>2</sub>	1	66	2.81	50.25	57	12
	2	65	2.68	47.25	57	12
	3	65	2.50	44.81	58	12
	4	66	2.24	43.26	52	11
	5	66	2.26	43.63	52	10
	6	66	2.29	48.55	48	10
	7	65	2.37	43.01	55	10
	8	66	2.35	46.01	51	10
	9	67	2.84	48.88	58	11
	10	65	2.53	48.24	49	11
	S.E	0.21	0.007	0.82	1.19	2.29

**Table 5:** Correlations between heading date, grain yield, 1000 grain weight, number of grain and spike length in three selection cycles.

Cycles	Grain yield	1000 grain weight	Number of grain	Spike length
C <sub>1</sub>	0.12	0.07	0.09	0.08
C <sub>2</sub>	0.29	0.11	0.33	0.18
C <sub>3</sub>	-0.22	-0.34	0.18	0.20.

**Table 6:** Bread sense heritability, genetic variance for traits in three cycle of selection.

Traits	H <sup>2</sup>			σ <sup>2</sup> g		
	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>	C <sub>1</sub>	C <sub>2</sub>	C <sub>3</sub>
Heading date	0.95	0.45	0.92	40.42	1.33	12.87
Grain yield	0.91	0.63	0.85	0.11	0.24	0.017
1000 grain weight	0.76	0.26	0.10	33.36	7.80	2.82
Number of grain	0.70	0.61	0.10	138.5	127.4	2.25
Spike length	0.83	0.44	0.60	4.40	0.80	1.19

H<sup>2</sup> = Heritability in broad sense.

σ<sup>2</sup>g = Genetic variance.

**Conclusion:**

From the results obtained in this study, it can be concluded the some advanced lines in C<sub>3</sub> (third cycle) in F<sub>6</sub>- generation with earliest in days to heading and had high grain yield such as selected entries 1, 2, 9 used in breeding program and increased breeding emphasis.

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**Abbreviation:**

HD, heading date; C<sub>1</sub>, first cycle; C<sub>2</sub>, second cycle; C<sub>3</sub>, third cycle; h<sup>2</sup>, heritability; σ<sup>2</sup><sub>g</sub>, genetic variance.

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