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DIRECT SELECTION FOR EARLY HEADING AND CORRELATED RESPONSE IN GRAIN YIELD AND ITS COMPONENTS OF BREAD WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Effect of two cycles of direct selection on early heading and correlated response in yield components were studied in the F_3 generations of a cross between Gemmeiza 3 and Sids 1 cultivars. Significant genotypic variations among the F_3 families were obtained for heading date and yield components. Estimates of genotypic and phenotypic coefficients of variability showed the presence of sufficient variability for direct selection for all studied traits. Estimates of broad sense heritability were relatively high and ranged from 65.06% for grain yield per plant to 73.94% for number of spikes per plant, indicating that the proportion of genetic effects were greater than those of environment. Heading date revealed positive genotypic correlations with number of spikes per plant (0.41) and grain yield per plant (0.39). Whereas, the genotypic correlation between heading date and 1000- grain weight was negative (-0.37). These finding indicates that selection for early heading may slightly decrease number of spikes per plant and grain yield per plant. After two cycles of selection in the F_3 families, the genotypic and phenotypic coefficients of variability decreased rapidly for all studied traits. Consequently, the values of broad sense heritability reduced from 73.6% and 65.1% to 47.4% and 48.1% for heading date and grain yield per plant, respectively. These results showed that two cycles of selection in the F_3 generations exhausted the genetic variation and further selection will not be effective. The results of observed gain after two cycles of direct selection showed that days to heading was reduced by 9.1 and 7.0 days from F_3 bulk families and the earliest parent, respectively. Direct selection for early heading was accompanied with a slightly decrease of 2.5 and 3.4 gm. in grain yield per plant after two cycles of direct selection compared to the F_3 bulk families and the better parent, respectively. Although the reduction after two cycles of selection in yield components, some early families still had high grain yield over both F_3 bulk families and better parent. The early high yielding lines obtained from this study could be used in developing new wheat varieties for cultivation in new reclaimed areas, in Upper Egypt, where the water supply is limited.

INTRODUCTION

In upper Egypt, water stress is the most limiting factor in the new reclaimed areas such as Toshky and west and east desert. Breeding for drought resistance through developing of early heading wheat cultivars to escape from water stress is the ultimate aim of plant breeder. In this direction, the effect of earliness selection throughout the segregating generations on grain yield and its components could be useful.

Heading date in wheat displayed high heritability estimates, suggesting effectiveness of selection in early segregating generations to produce early genotypes (Frederickson and Kronstad, 1985; Wells and Kofoid, 1986; Kherialla *et al*, 1993 and Eissa and Awaad 1993).

The estimates of genotypic coefficient of variability, heritability and genotypic and phenotypic correlations provide plant breeder with valuable genetic information for selecting desirable segregants. In this concern, May and Sanford (1992), Kherialla *et al.*(1993) and El-Sherbeny *et al.*(2001) obtained high estimates of genotypic coefficient of variation and broad sense heritability for heading date and grain yield and its components. Mahdy (1988) and Kherialla *et al.*(1993) found a positive genotypic correlation between heading date and yield components.

The present work was undertaken to study the effect of two cycles of direct selection for early heading and its relation with yield components.

MATERIALS AND METHODS

The present study was carried out at Sohag Fac. of Agric. Res. Farm, South Valley Univ., The genetic materials used in this study consisted of 60 F_3 families bread wheat traced back to a random sample from F_2 single plants originated from a cross between Gemmeiza 3 and Sids 1 cultivars.

In 2000/2001 growing season, the 60 families (C_0) and their parents were grown in a randomized complete block design with three replications. Each plot was single row 3 m long, 30 cm. apart and 10 cm between grains within row. All agricultural practices were applied as recommended for wheat production. Heading date (HD) was recorded and the earliest head of each plot were labeled. At maturity, individual plant data were recorded on 20 random plants from the middle portion of each plot. The following characters were determined on each plant, i.e. number of spikes per plant (S/P), 1000 grain weight (1000 GW) and grain yield per plant (GY/P).The earliest plant from the earliest 10 families were selected (first cycle of selection, C_1).

In the growing season of 2001/2002 season, The F_3 bulk families (C_0), parents and the selected families (C_1) were evaluated for earliness and grain yield and its components. The experimental design and studied traits were the same in the previous growing season. The earliest plant from each family was chosen (second cycle of selection C_2).

In 2002/2003 growing season, the F_3 bulk families (C_0), parents and the best plants (C_2) from the 10 selected families for earliness were evaluated as before.

Data were subjected to analysis of variance. The heritability in broad sense was also estimated. Genotypic variance was computed from the expected mean squares from the analysis of variance. The genotypic (GCV%) and phenotypic (PCV%) coefficients of variability were calculated as $\sigma G/x$ and $\sigma P/x$, respectively. Genotypic and phenotypic variances, covariances and correlations were calculated as outlined by Al- Jibouri *et al.*(1958) and Miller *et al.*(1958).

RESULTS AND DISCUSSION

Genetic variability and heritability in F_3 families

The results of the analysis of variance (Table 1) of F_3 families (C_0) showed highly significant for all studied traits, reflecting the presence of large variation among them. These variations were expected where the two parents used in this study were variable in their performances for all studied traits. Estimates of genotypic and phenotypic coefficients of variability showed the presence of sufficient variability for direct selection for all studied traits . High genotypic coefficients of variability were observed for number of spikes per plant (11.92) followed by grain yield per plant (11.61),1000-grain weight (5.61) and heading date (2.53).

Table 1: Mean performances, mean squares, genotypic (GCV%) and phenotypic (PCV%) coefficients of variability and heritability (H) in the F_3 families for heading date and grain yield and its components.

Traits	Mean			Mean squares			GCV%	PCV%	H
	F_3	P_1	P_2	Reps.	Families	Error			
Heading date	84.7	84.6	92.9	3.79	18.64**	4.92	2.53	2.94	73.59
Spikes/plant	9.27	7.39	10.48	1.15	4.95**	1.29	11.92	13.86	73.94
1000grain weight	55.5	58.9	46.1	6.61	40.46**	11.39	5.61	6.62	71.83
Grain yield/plant	29.5	31.6	24.5	5.60	54.09**	18.91	11.61	14.40	65.06

Significant at 1% level of probability.

Estimates of broad sense heritability (H) were relatively high and ranged from 65.06% for grain yield per plant to 73.94% for number of spikes per plant, exhibiting that the proportion of genetic effects were greater than those of environment. It is clear that the F_3 families having a great value of genotypic coefficient of variability and high values of broad sense heritability for days to heading and yield components. Consequently, a greater response to selection was expected to obtain a desirable segregants in subsequent generations. These results are confirmed with those obtained by Mahdy (1988), Kherialla *et al.*(1993) and El-Sherbeny *et al.*(2001).

Genotypic and phenotypic correlations in F_3 families

The results of genotypic (r_g) and phenotypic (r_p) correlations among heading date and yield components (Table 2) indicated that the values of the genotypic correlation were relatively higher than the corresponding phenotypic correlations. It is also showed that both types of correlations were similar in signs in all relationships, reflecting the fact that significant phenotypic correlations were properly due to genetic back ground.

Table 2: Genotypic correlations (above diagonal) and phenotypic correlations (below diagonal) estimated from the F_3 families.

Traits	Heading date	Spikes/ plant	1000 grain weight	Grain yield/plant
Heading date	--	0.41	-0.37	0.39
Spikes/plant	0.36	--	0.46	0.68
1000 grain weight	-0.32	0.41	--	0.54
Grain yield/plant	0.34	0.65	0.46	--

Significant at 5% and 1% levels of probability, respectively.

Positive genotypic correlations were obtained between heading date and each of number of spikes per plant (0.41) and grain yield per plant (0.39). Whereas, heading date was found to be negatively correlated with 1000-

grain weight (-0.37). Generally, the phenotypic correlations were closely agreed with genotypic ones for all relationships. These correlations indicate that selection for early heading could slightly decrease number of spikes per plant and grain yield per plant except 1000- grain weight which may increase. The results are agreement with those reported by Noaman *et al.* (1990), Kherialla *et al.*(1993) and Kherialla (1994)

Table 3: Genotypic (^{2}G), phenotypic (^{2}p) variances, their corresponding coefficient of variability and heritability values for all studied traits in F_3 before and after two cycles of direct selection.

Traits	Selection cycle	^{2}G	GCV%	^{2}P	PCV%	H
	C_0	4.57	2.53	6.21	2.94	73.6
Heading date	C_1	1.25	1.40	2.14	1.83	58.4
	C_2	0.83	1.18	1.75	1.72	47.4
	C_0	1.18	11.72	1.65	13.86	71.5
Spikes/plant	C_1	0.79	9.81	1.28	12.48	61.7
	C_2	0.49	7.89	1.02	11.39	48.0
	C_0	9.69	5.61	13.49	6.62	71.8
1000grain weight	C_1	6.83	4.80	10.30	5.89	66.3
	C_2	3.48	3.48	8.41	5.41	41.4
	C_0	11.73	11.61	18.03	14.40	65.1
Grain yield/plant	C_1	5.53	8.18	9.37	10.64	59.0
	C_2	2.18	5.40	5.18	8.32	48.1

Genetic variability and heritability after two cycles of selection.

The genotypic (^{2}G) and phenotypic (^{2}p) variances, genotypic (GCV%) and phenotypic (PCV%) coefficients of variability and heritability estimates for early heading after two cycles of selection are presented in Table 3. The results showed that the C_0 families possessed considerable amount of genetic variability more than that exist in the C_1 families and C_2 families for heading date and yield components. The results also indicates that the genotypic and phenotypic coefficients of variability decreased rapidly after two cycles of selection in the F_3 families(C_0) for all studied traits. Moreover, the values of broad sense heritability reduced from 73.6% and 65.1% in the C_0 to 47.4% and 48.1%in C_2 for heading date and grain yield per plant, respectively. These results indicate that further selection could not be effective after two cycles of selection in the F_3 generation of the population under study.

Mean performances after two cycles of selection.

Mean performances of number of days to heading of each of ten selected families and correlated response in yield components after the first (C_1) and the second (C_2) cycles of selection are presented in Table 4. It is observed that the overall family means in C_1 (79.9 days) and C_2 (76.8 days) were reduced compared to the mean of the F_3 bulk families and the earliest parent for number of days to heading. In the same direction, the overall family means for grain yield per plant in C_1 (28.8 gm.) and C_2 (27.3 gm.) were decreased in comparison with the mean of the F_3 bulk families and the better parent. It is also appeared that number of spikes per plant and1000- grain weight traits were decreased in C_1 and C_2 in comparison with both F_3 bulk families and the better parent. Although the reduction after two cycles of selection in yield components, some early families still had high grain yield over both F_3 bulk families and better parent.

Table 4: Mean performances of days to flowering and other traits of the early families in the first and second cycles of selection.

Early Families	Heading date		Spikes/plant		1000-grain weight		Grain yield/plant	
	C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2
1	78.1	75.3	8.43	8.02	52.4	51.8	25.2	24.8
2	77.7	75.2	10.57	10.54	54.6	52.5	31.4	29.6
3	79.4	76.4	7.62	8.12	49.8	50.6	24.7	24.1
4	80.3	77.1	8.73	8.25	55.7	53.9	27.1	26.4
5	81.1	78.4	9.51	9.13	58.5	58.4	32.4	29.7
6	79.5	76.6	7.53	8.34	53.6	52.7	26.6	25.2
7	81.3	77.7	9.22	8.88	50.8	51.4	30.3	28.5
8	82.2	78.2	10.52	10.22	57.3	56.2	32.8	30.3
9	80.4	77.3	8.12	8.10	59.2	57.8	26.5	26.1
10	78.6	75.5	10.36	10.06	52.4	50.6	30.6	28.6
Average	79.9	76.8	9.06	8.87	54.4	53.6	28.8	27.3
P_1	84.4	83.8	7.26	7.32	57.6	56.3	31.3	30.7
P_2	93.1	92.6	10.42	10.12	46.4	45.8	24.6	24.9
F_3 bulk	86.6	85.9	9.82	9.77	56.8	57.1	30.1	29.8
LSD 5%	2.31	1.79	2.15	2.11	5.24	3.12	5.32	4.58

Observed gain from selection

Observed gain from direct selection for early heading and correlated response in yield components are presented in Table 5. The results indicated that direct selection was effective in decreasing heading time and yield components. Days to heading was reduced by 6.7 and 9.1 days from the F_3 bulk families after C_1 and C_2, respectively. While, the reduction in heading time reached to 4.5 and 7.0 days after C_1 and C_2 as compared to the earliest parent.

Response to direct selection for early heading was accompanied with a decrease of 2.5 and 3.4 in grain yield per plant after two cycles of direct selection compared to the F_3 bulk families and the better parent, respectively. In this respect the decrease, after two cycles of selection, reached to 0.96 and 3.5 in number of spikes per plant and 1000- grain weight, respectively, compared to the F_3 bulk families. While, the decreases in number of spikes per plant and 1000- grain weight after two cycles of selection compared to the better parent were 1.3 and 2.7, respectively.

Table 5: Observed gains and correlated response to selection for heading date in F_3 population.

Characters	Selection Cycle	Response to selection as deviation of:	
		F_3 bulk	Best parent
Heading date	C_1	-6.7	-4.5
	C_2	-9.1	-7.0
Spikes/plant	C_1	-0.76	-1.4
	C_2	-0.90	-1.3
1000 grain weight	C_1	-2.4	-3.2
	C_2	-3.5	-2.7
Grain yield/plant	C_1	-1.3	-2.5
	C_2	-2.5	-3.4

These results were expected since the genotypic correlations between days to heading and each of number of spikes per plant and grain yield per plant were positive. Similar results were obtained by Mahdy (1988), Youins *et al.*(1988)Noaman *et al.*(1990), May and Sanford (1992) and Kherialla *et al.*(1993).

In conclusion, the heritability values and amount of genotypic and phenotypic coefficient of variability in F_3 families were sufficient for direct selection of desirable segregants in subsequent generations. Direct selection for early heading was accompanied with the slightly decrease in yield components compared with both F_3 bulk families and the best parent. These results could be explained by the genetic correlations obtained between heading time and yield components. Although the reduction in yield components after tow cycles of selection, some early families still had high grain yield over both F_3 bulk families and better parent. The early high yielding lines obtained from this study could be used in developing new wheat varieties for cultivation in new areas in upper Egypt where the water supply is limited.

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الانتخاب المباشر للتزهير المبكر وأثره علي المحصول ومكوناته في قمح الخبز

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تم إجراء دورتي انتخاب علي الجيل الثالث الناتج من التهجين صنفين من قمح الخبز هما جميزه ٣ ، سدس ١ وذلك لدراسة تأثير الانتخاب المباشر للتزهير المبكر وأثره علي الاستجابة المرتبطة للمحصول ومكوناته.

ويمكن تلخيص أهم النتائج فيما يلي:

- أوضحت النتائج أن هناك اختلافات معنوية بين عائلات الجيل الثالث قبل الانتخاب لصفات: ميعاد التزهير، عدد سنابل النبات، وزن الـ ١٠٠٠ حبة ومحصول حبوب النبات. أشارت نتائج تقديرات معاملي الاختلاف المظهري والوراثي أن التباين بين عائلات الجيل الثالث يعتبر كافيا للانتخاب. وكانت تقديرات معامل التوريث في المدى الواسع عالية نسبيا وتتراوح بين ٦٥,٠٦% لصفة وزن حبوب النبات إلي ٧٣,٩٤% لصفة عدد سنابل النبات. كما كان الارتباط الوراثي بين ميعاد التزهير وكل من عدد سنابل النبات ووزن حبوب النبات موجبا بينما كان سالبا مع صفة وزن الـ١٠٠٠ حبة.
- أظهرت النتائج بعد إجراء دورتين متتاليتين من الانتخاب أن التباين الوراثي والمظهري وكذلك معامل التوريث قد تناقص بسرعة وذلك لصفة التزهير والصفات المرتبطة. أشارت النتائج أن ميعاد التزهير قد تناقص بمقدار ٩,١ ، ٧,٠ يوم بالمقارنة بمتوسط عائلات الجيل الثالث والأب المبكر علي الترتيب. وأدي الانتخاب المباشر للتزهير المبكر إلي تناقص في وزن حبوب النبات بمقدار ٢,٥ ، ٣,٤ بالمقارنة بمتوسط عائلات الجيل الثالث وأحسن أب علي الترتيب. وعلي الرغم من الانخفاض في محصول النبات بعد دورتين من الانتخاب فإن بعض العائلات المنتخبة المبكرة كانت عالية في المحصول. وتشير نتائج هذه الدراسة إلي إمكانية استخدام هذه السلالات المبكرة عالية المحصول في استنباط أصناف جديدة من القمح يمكن زراعتها في الأراضي المستصلحة حديثا في جنوب الوادي حيث تقل فيها المياه.