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Comparison Among Three Breeding Methods In Bread Wheat

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Abstract

The objective of this study was to compare the effectiveness of pedigree (PM), modified bulk (MBM) and single seed descent (SSD) breeding methods for increasing grain yield in wheat. This study was conducted on the Experimental Farm of Sids Agricultural Research Station, Agricultural Research Center, Egypt, during 2007/08, 2008/09 and 2009/10 seasons. The final evaluation of the F_5 generation was conducted during 2009/10 season. The selected lines were sown in the nested design with three replications. The efficiency of the breeding methods was evaluated on the basis of the following parameters: mean performance results in the first cross indicated that, the differences between breeding methods. In the first cross the (MBM) gave the highest values for grain yield/plant, while, (SSD) method exhibited significant grain weight and (PM) gave the highest value for number of spikes/plant and number of grains/spike. It could be concluded that (MBM) is considered the best breeding method for grain yield/plant and number of spikes/plant, comparing to (PM) and SSD in this cross. In the second cross the (PM) expressed significant desirable values for number of spikes/plant and grain yield/plant, while, the best lines were number 4 (80g) in the (PM), number 12 (90g) in (MBM) and number 12 (69g) in SSD method. The SSD method exhibited highly significantly heavy grain weight and high number of grains/spike. It could be concluded that (PM) is considered the better breeding method for number of spikes/plant and grain yield/plant than those (MBM) or SSD method in this cross.

Keywords: Breeding methods, Pedigree, modified bulk, single seed descent, wheat.

Abbreviations: PM, pedigree Method; MBM, modified bulk method; SSD, single seed descent; GY/P, Grain yield per plant (g); No. of S/P, Number of spike per plant; No. of G/S, Number of grain per spike; 1000GW, 1000 grains weight (g)

Introduction

Wheat (*Triticum aestivum, vulgare* L) crop is considered as one of the essential strategic cereal crops not only in Egypt, but also all over the world. In addition wheat is the world's single most important food crop in terms of tons of grain produced each year. Wheat trade represents a significant component of the trade balance of national economic. Wheat is utilized and processed for a multitude of products, reflecting the large quantities produced by people of diverse cultures and social groups [Faridi and Faubion, 1995].

Production of the new high yielding Egyptian cultivars affected wheat imports, which was reduced from around 7.5* million tons in 1987 and dropped to around 5.5* million tons by year 2000 since the acreage of wheat reached 3.07* million Feddan in 2010/2011 season and it produced about 8.25* million tons with average production of Feddan nearly 18* Ardab = 2.7* tons per feddan.

Several methods of selection can be used in segregating generations after crossing in self pollinated crops. The information for each method of selection as well as the relationship between these methods of selection and yield would help in determining the best method of selection for breeding program to obtain high yielding cultivars of wheat and to apply this method in the following breeding program.

Plant breeders are seeking continuously for more effective and efficient selection procedure. Numerous methods have been proposed, but only a few valid comparisons have been made among there procedures. Also, plant breeders are continually faced with the problem of how to best evaluate available breeding materials [Atkins, 1953]. The main

objective of this investigation was to estimate the efficiency of three breeding methods, i. e. pedigree, modified bulk and single seed descent methods by using the lines produced from F_5
*(refer to the ministry of agriculture and land reclamation- economic affairs sector).

Materials and Methods

This study was carried out during the three successive seasons, i. e., 2007/08, 2008/09 and 2009/10, at Sids Agricultural Research Station conditions, Agricultural Research Center, Egypt, aiming to measuring the efficiency of three methods of selection used in wheat breeding program namely; pedigree method, bulk method and single seed descent method. The study was conducted on two hexaploid bread wheat (*Triticum aestivum vulgare.*, L.) populations chosen from breeding wheat research program at Sids Station. The pedigree of the parents of the two wheat populations are given in (Table 1).In 2006/07 season, about 1600 grains of bread wheat from each F_2 population were planted. Selection was practiced twice in season, at heading and at maturity stages, on the bases of high yield and yield components in addition to earliness and shortness. In the pedigree method, each selected plant was sown in a separate row as F_3 families during 2007/08 season. Selection between and within families was practiced. Forty families were selected from 160 F_3 families to raise F_4 families in 2008/09 season for each population. Twenty families were selected from F_4 generation for each population and retained to be raise as F_5 generation in the final evaluation trial during 2009/10 season.

Table 1. The pedigree of the four parents of the two wheat populations.

Pop parent	Pedigree
P1	WEAVER/WL3926//SW893064
P2	Desconocido #6/4/Bl 1133/3/Cmh 79A.955*2/ Cno 79//Cmh 79A.955/Bow's'
P3	LFN/1158.57//PRL/3/HAHN/4/KAUZ/5/KAUZ
P4	maya"s"/mon"s"//CMH74A.592/3/ 2* Sakha 8

In the modified bulk method, few grains from each selected plant from each F_2 population were mixed to form the population grain bulk. The mixed grains were planted during 2007/08 growing season as F_3 generations. Selection was practiced on the basis of best plants per each population. Grains of the selected plants were mixed to form grains bulk and a sample was taken to be raised as F_4 generation during the growing season of 2008/09. Similarly, 20 plants per population were selected and were harvested individually. Grains from each plant were kept and planted separately as F_5 population during 2009/10 growing season.

In the single seed descent method, one grain was taken from 500 plants from F_2 population and planted during 2007/08 season as F_3 generation. One grain was taken from each plant to be grown as F_4 generation during the growing season of 2008/09. Similarly, 20 plants were selected from each population and were harvested individually. Grains from each plant were kept and planted separately as F_5 plants during 2009/10 season.

In 2010 season, the high yielding selected lines (20) from each method and the two parents and two check cultivars (Sids12 & Sids13) were represented by one row per plot, a row was three meters in length, 30 cm. between rows and 15 cm. between grains were evaluated in nested design with three replications in each cross. The following characteristics were measured on a random sample of 10 guarded plants in each plot in F_5 generation. The mean of the 10 plants were subjected to the statistical analysis for: number of spikes per plant, number of grains/spike, 1000-grains weigh and grain yield per plant

Results and Descussion

1- First cross

The mean squares for breeding methods were significant for yield and its components (Table 2). These results indicated the differences among the three breeding methods.

Table 2. Mean squares of the breeding methods for the four studied characters in the first cross.

SV	DF	No. of S/P	No. of G/S	1000-GW (g)	GY/P(g)
Replications	2	16.331**	88.763**	4.954	18.743
Lines	59	43.376**	427.310**	52.702**	530.620**
Methods	2	14.955*	68.021*	99.976**	1111.210**
Lines/Methods	57	44.373**	439.916**	51.044**	510.249**
Error	118	3.328	17.215	1.857	14.489

*, ** Significant and highly significant at 0.05 and 0.01 respectively.

The modified bulk method gave the highest values for grain yield/plant, while, the single seed descent method exhibited significant grain weight. Moreover, pedigree method gave the highest value for number of spikes/plant and number of grains/spike (Table 3). It could be concluded that modified bulk method considered the best breeding method for grain yield/plant and the second for number of

spikes/plant, comparing to those pedigree and SSD in this cross.

Table 3 Mean performance of breeding methods of lines for the four studied characters in the first cross.

Breeding methodology	No. of S/P	No. of G/S	1000-GW (g)	GY/P(g)
Pedigree	20.087	72.527	47.431	61.041
Modified Bulk	19.608	70.405	49.282	63.121
Single seed descent	19.088	71.311	49.915	54.848
LSD 5%	0.660	1.500	0.493	1.376
LSD 1%	0.872	1.982	0.651	1.819

This result is attributed to working on self pollinated crops, breeders apply one or more of different breeding methods efficient in selecting for high grain yield. Among those are [Salmeron and Kronstad (1986), F.H. Shalaby, Sabah M. Attia; H.M. Ibrahim; S.R. Saleeb; Kh.A. Al-Assily and Sohir A. Mokhtar (2001), K.P. Arunachalam, K.K. Viswantha, A. Chakravarthy, Manjunathe and M.K. Jayashree (2002).and Shoba-Immadi; Kajjidoni; S.T. and P.M. Salimath (2004)]. on wheat, Cowpea, soybean and faba bean using two or more methods of breeding. On the other hand, [I.S. Pawar, R.S. Paroda and S. Singh (1989)] indicated that single plant selection and single seed descent were almost equally effective and both were superior to bulk selection.

[B.R Whan, R. Knight and A.J. Rathjen (1982)] found that the effect of selection using the means of lines, from the F_3 and F_4 rather than the individual F_2 or F_3 derived lines, can be assessed by the yields obtained in the following generations. Mean squares due to promising lines and two parents were significant for the four characters under study (Table 4).

Table 4. Mean squares of the promising lines and both parents for the four studied characters in the first cross.

SV	DF	No. of S/P	No. of G/S	1000-GW (g)	GY/P(g)
Replicates	2	17.7**	88.4**	4.3	20.4
Lines	63	42.4**	404.1**	51.2**	506.4**
Error	126	3.3	16.8	1.8	14.1

*, ** Significant and highly significant at 0.05 and 0.01 respectively.

Also, the efficiency of the breeding methods in the present study was evaluated based on the number of superior lines having higher values of grain yield/plant than the better parent.

Data presented in Table (5) show that the modified bulk method produced consistently more superior lines for grain yield compared with the better parent or the average population or Sids 13. The best lines were number 18 (95.4g), number 12 (94.4g), number 5 (82.4g) and number 2 (78.5g) in modified bulk method and number 13 (80.9g) in pedigree method. But single seed descent number 15 (80.9g) produced consistently more superior lines compared to the best parent or the average population.

Table 5a. Mean performance of the selected lines of breeding methods and two parents and check varieties in the first cross population.

Breeding Methods	No. of lines	No. of S/P	No. of G/S	1000 - GW (g)	GY/P(g)
Pedigree	1	24	80	50.0	71.9
	2	15	57	48.0	59.1
	3	19	73	43.7	57.9
	4	14	65	51.5	59.5
	5	23	73	42.8	65.2
	6	20	79	39.7	49.3
	7	22	63	44.3	60.5
	8	18	57	50.8	60.5
	9	21	55	45.8	47.4
	10	23	64	40.5	45.2
	11	30	72	51.3	75.1
	12	20	84	47.0	70.8
	13	21	66	53.3	80.9
	14	20	64	52.2	52.9
	15	18	78	52.0	48.4
	16	18	68	45.6	73.7
	17	24	78	42.3	56.9
	18	18	81	48.0	64.0
	19	12	117	53.3	50.0
	20	20	77	46.5	71.8
Modified Bulk	1	23	84	40.5	61.6
	2	22	78	44.8	78.5
	3	21	47	52.1	65.4
	4	20	68	48.4	75.8
	5	18	72	53.9	82.4
	6	16	66	51.1	46.8
	7	13	84	50.4	33.7
	8	20	81	42.1	55.6
	9	19	87	54.4	61.2
	10	16	86	44.7	59.9
	11	15	62	52.3	50.7
	12	24	66	57.3	94.4
	13	20	59	47.9	64.5
	14	12	82	45.9	50.2
	15	18	67	48.7	57.7
	16	22	45	52.3	47.9
	17	28	72	45.9	53.8
	18	19	72	49.3	95.4
	19	20	72	55.2	60.4
	20	26	59	48.6	66.7

For number of spikes/plant the results indicated that the pedigree method produced more superior lines followed by modified bulk and then by SSD comparing to the better parent or average over lines with one, one and one lines, respectively.

Regarding to grain weight, five, six and three lines were, significantly heavier kernels than the best parent for SSD, bulk and pedigree methods, respectively. However, the heavier line was number 10 in grain weight (g) than grand mean in SSD methods.

For number of grains/spike, the results indicated that the pedigree method produced more superior lines followed by SSD single seed descent and then by bulk compared to the best parent or average over lines with two, five and five lines, respectively. The best lines were number 19 in pedigree method, number 9 in bulk methods and 12 in SSD method.

Table (5b. continued

Breeding Methods	No. of lines	No. of S/P	No. of G/S	1000-GW (g)	GY/P (g)
Single Seed	1	24	69	54.8	72.6
	2	17	69	50.2	47.2
	3	23	65	49.5	52.0
	4	19	66	47.2	41.6
	5	19	83	47.3	52.4
	6	20	64	48.8	37.1
	7	18	76	46.7	62.7
	8	18	66	49.3	41.1
	9	20	67	44.8	57.2
	10	21	64	58.3	73.4
	11	17	88	52.4	56.0
	12	16	91	49.0	48.3
	13	28	77	50.6	46.0
	14	15	83	45.4	45.2
	15	24	66	46.4	80.9
	16	15	62	53.4	55.2
	17	23	88	46.8	71.5
	18	15	64	56.2	39.2
	19	13	63	50.5	61.5
	20	18	53	50.6	55.7
Parent 1		22	75	50.0	63.4
Parent 2		24	69	48.0	66.0
Sids 1		20	71	48.9	59.8
Sids 12		18	74	46.5	60.9
Over mean		23	64	43.2	72.0
L.S.D 5%		3	7	2.2	6.2
L.S.D 1%		4	9	2.9	8.1

2. Second cross

Mean squares due to lines, breeding methods and lines/ methods were significant for yield and its components (Table 6). Result show highly significant differences among the three breeding methods for all traits.

Table 6. Mean squares of the breeding methods for the four studies characters in the second cross.

SV	DF	No. of S/P	No. of G/S	1000-GW (g)	GY/P (g)
Replications	2	51.9**	17.7	0.9	35.6
Lines	59	47.7**	280.9**	43.3**	411.3**
Methods	2	299.6**	331.1**	372.0**	236.8**
Lines /Methods	57	38.9**	279.1**	31.8**	417.4**
Error	118	3.5	30.7	2.9	28.6

*, ** Significant and highly significant at 0.05 and 0.01 respectively.

The pedigree method expressed significant desirable values for number of spikes/plant and grain yield/plant (Table 7). Meanwhile the SSD method exhibited significantly grain weight and high number of grains/spike. It could be concluded that pedigree method considered the best breeding method for number of spikes/plant and grain yield/plant than those modified bulk and SSD method in this cross.

Working on self pollination crops, breeders applied one or more different breeding methods in order to investigate or compare their efficiency in selecting high grain yield. Among those [I.S. Pawar, R.S. Paroda; M. Yunus and S. Singh (1985), I.S. Pawar, R.S. Paroda and S. Singh (1989), I.S. Pawar, A.S. Redhu; S. Iqbal and M. Yunus (2001) and K.P. Arunachalam, K.K. Viswantha, A. Chakravarthy, Manjunathe and M.K. Jayashree (2002).] on self pollination crops using two or more methods of breeding.

Table 7. Mean performances of the breeding methods for the four studied characters in the second cross.

Breeding methodology	No. of S/P	No. of G/S	1000-GW (g)	GY/P(g)
Pedigree	20.312	66.199	50.306	56.181
Modified Bulk	16.767	62.705	48.532	54.024
Single seed descent	16.183	67.173	53.449	52.213
LSD 5%	0.680	2.003	0.618	1.932
LSD 1%	0.899	2.648	0.817	2.554

[B.R Whan, R. Knight and A.J. Rathjen (1982)] found that the effect of selection using the means of lines from the F_3 and F_4 rather than the individual F_2 or F_3 derived lines, can be assessed by the yields obtained in the following generations.

Table 8. Mean squares of the breeding methods and their parents (F_5-lines) for the four studied characters in the second cross.

SV	DF	No. of S/P	No. of G/S	1000-GW (g)	GY/P(g)
Replications	2	47.8**	8.7	0.9	55.5*
Lines	63	48.2**	269.8**	43.7**	405.2**
Error	126	3.5	20.3	2.8	18.2

*, ** Significant and highly significant at 0.05 and 0.01 respectively

Mean squares due to lines of breeding methods as well as two parents were significant for the four characters under study (Table 8). Also, the efficiency of the breeding methods in the present study was evaluated based on the number of superior lines having higher values of grain yield/plant than the best parent.

Data presented in Table (9) show that the pedigree method produced consistently more superior lines for grain yield per plant compared with the better parent or the average population or check (Sids 13 and Sids 12). The best lines were number 4 (86.1g) in pedigree method number 12 (89.9g) in modified bulk method and number 12 (69.4g) in SSD method.

For number of spikes/plant, the results indicated that the pedigree method produced more superior lines followed by modified bulk and then by SSD comparing to the better parent or average population or checks (Sids 13 or Sids 12). Seven lines from twenty lines showed significant higher spike number than the average of all lines or better parent for pedigree breeding method. But modified bulk methods, three lines showed significant higher spike number than the average of all lines or better parent. However, in SSD, three lines from twenty lines were significantly higher.

Regarding to grain weight, ten, two and two lines were, significantly higher than the average of all lines for SSD, pedigree and modified bulk methods, respectively. However, the heavier line was number 17 in this trait than grand mean in single seed descent method.

For number of grains/spike, line number one was significantly higher in grain number comparing to the average of all lines or better parent or check for pedigree breeding method. Line number 1 in pedigree breeding method gave the highest number of grains/spike. Meanwhile modified bulk method none of the lines showed significant higher grain number than the average of all lines or better parent or check. However, the third method in this cross is SSD, four lines were significantly higher in grain number than the high number from the average of all lines or better parent or check (Sids 12).

Table 9a. Mean performance of the selected lines of breeding methods and two parents and check varieties in the second cross population.

Breeding Methods	No. of lines	No. of S/P	No. of G/S	1000 - GW (g)	GY/P (g)
Pedigree	1	21	80	45.3	37.5
	2	23	69	47.2	67.2
	3	27	62	53.0	48.5
	4	24	63	50.4	86.1
	5	22	76	48.0	59.1
	6	16	65	47.9	47.6
	7	18	66	54.0	46.9
	8	20	72	50.4	68.6
	9	17	69	50.0	62.3
	10	17	72	50.0	39.1
	11	26	54	50.9	73.9
	12	20	70	49.9	56.9
	13	26	63	52.8	59.3
	14	19	54	51.4	62.1
	15	19	52	52.7	47.0
	16	14	61	47.9	53.3
	17	21	67	50.4	60.1
	18	16	77	49.2	53.5
	19	19	68	53.8	38.6
	20	21	63	51.0	56.1
Modified Bulk	1	13	73	52.8	37.1
	2	20	66	48.6	47.0
	3	20	42	40.6	50.2
	4	20	58	50.7	57.4
	5	23	71	53.6	75.3
	6	14	63	45.9	36.6
	7	17	68	47.6	65.9
	8	19	66	45.9	51.5
	9	16	67	43.9	48.8
	10	16	57	50.2	55.0
	11	12	46	47.6	48.7
	12	21	68	49.0	89.9
	13	11	53	46.3	42.2
	14	14	73	50.9	45.7
	15	14	59	50.5	50.8
	16	13	61	55.4	53.5
	17	19	67	51.2	62.3
	18	17	71	45.0	49.6
	19	14	62	45.4	48.9
	20	22	63	49.4	64.0

Table (9b. continued

Breedig Methods	No. of lines	No. of S/P	No. of G/S	1000 - GW (g)	GY/P (g)
Single Seed	1	21	68	44.7	52.4
	2	19	52	48.8	49.9
	3	11	81	50.4	47.1
	4	14	57	52.8	50.5
	5	14	71	51.0	55.3
	6	16	69	56.1	59.7
	7	15	79	54.8	52.6
	8	13	72	49.5	33.1
	9	17	65	59.0	45.7
	10	16	67	57.2	61.1
	11	15	64	53.9	58.3
	12	20	85	52.5	69.4
	13	16	58	52.9	69.1
	14	14	70	54.7	47.9
	15	15	54	56.6	32.6
	16	22	50	55.9	44.7
	17	21	54	59.4	66.0
	18	14	100	57.0	49.6
	19	9	66	51.0	41.2
	20	20	62	51.0	58.2
Parent 1		11	60	44.8	53.0
Parent 2		18	67	48.6	50.3
Sids 1		18	65	50.6	54.1
Sids 12		13	70	47.6	63.1
Over mean		15	65	46.3	69.2
L.S.D $_{5\%}$		3	9	2.8	8.6
L.S.D $_{1\%}$		4	12	3.7	11.4

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