

EFFICIENCY OF THREE BREEDING METHODS ON TWO BREAD WHEAT CROSSES

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ABSTRACT

This study was conducted at the Experimental Farm of the Sids Agricultural Research Station, Agricultural Research Center, Egypt, during 2007/2008, 2008/2009 and 2009/2010 seasons. The objective of this study was; to estimate the efficiency of pedigree, modified bulk and single seed descent methods in two bread wheat populations. The final evaluation of the F₅ generation was done during 2009/2010 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. The pedigree method expressed significant desirable values for number of spikes per plant, 1000-kernel weight, number of kernels/spike and grain yield/plant than those bulk and SSD method. The pedigree method produced consistently more superior lines for grain yield/plant compared to the best parent and the two checks (Sids1 & Sids12) or the average. The best lines were number 16 (45.80g), no. 14 (43.22g) number 15 (35.67g), no. 5 (35.55g) and no. 13 (34.96g) in pedigree method and no. 6 (39.52g) in bulk method. For number of Spikes/plant the results indicated the pedigree method produced more superior lines followed by bulk and then by SSD over lines with 2, 12, 14 and 16; 14 and Zero lines, respectively. Regarding to 1000-kernel/weight, 2, 3, 5, 8, 10, 13, 18 and 19; 5; and 2 lines showed, significant overlines for pedigree, bulk and SSD methods, respectively. For number of kernels/spike, one line showed significant high. The lines number 1, 16, and 17 in pedigree breeding method and the line number 1 and 10 in bulk method gave the highest number of kernels/spike. The mean squares for breeding methods in the second cross were significant for yield and its components. The pedigree method gave the highest values for grain yield/plant, number of spikes per plant and number of kernels per spike. While the bulk method gave the highest value for 1000-kernel weight. While, SSD method exhibited significantly higher for 1000-Kernel weight and number of kernels per spike. The pedigree method produced consistently more superior lines compared to the best parent and two checks (Sids1 & Sids12) or the average population with no. 7, no. 8, no. 12, no. 13 and no. 16; no. 3, no. 5, no. 10 and no. 15; no. 9 and no. 20 for pedigree, bulk and SSD, respectively. The best lines were number 7 (38.30g), no. 8 (48.23g), no. 12 (40.50g), no. 13 (37.48g) and number 16 (40.71g) in pedigree method.

INTRODUCTION

Wheat is one of the major cereal crops in Egypt, which receives the most attention of specialists in plant breeding. To increase grain yield per unit area which is, in most cases, the main or the only solution for overcoming the increasing demand of food from a limited cultivated area, plant breeders would develop high yielding wheat cultivars. 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 these procedures. Also, plant breeders are continually faced with the problem of how to evaluate available breeding materials (Atkins, 1953). For maximizing efficiency of selection, selection should be started as early as possible, and it's preferable in the F_2 generation (Knott and Kumar, 1975). The pedigree method proved to be most efficient and better method in selection for number of kernels per spike (Verma, *et al.*, 1997) and for 1000-kernel weight (Ismail, 1995, Ronga, *et al.*, 1995 and Verma, *et al.*, 1997). The pedigree selection was the best method for selecting number of spikes per plant, number of kernels per spike, 100-grain weight and grain yield per plant (Pawar *et al.* 1986). The modified bulk method proved to be most efficient and better method in selection for 1000-kernel weight (El-Shamy, 1987). For grain yield (Salmeron, 1985) and Malysh and Fomenko, 1988). The single seed descent method proved to be most efficient and better method in selection 1000-kernel weight (Pawar, *et al.*, 1989) and for grain yield per plant (Srivastava, *et al.*, 1989, Snap *et al.*, 1992 and Pawar, *et al.*, 2001). The single seed descent was considered to be better than bulk selection. Pawar *et al.* (1985), The pedigree and SSD method were equally efficient, but the bulk method turned out to be less efficient. (Arunachalam *et al.* 2002). Successful breeding programs need enough information in breeding methods of selection. The objective of this study was to estimate of efficiency of three breeding methods in two bread wheat populations for three generations by the most economic traits of wheat i. e., number of spikes per plant, number of kernels per spike, 1000-kernel weight and grain yield per-plant at the Sids Agricultural Research Station.

MATERIALS AND METHODS

This study was carried out during the three successive seasons, i. e., 2007/2008, 2008/2009 and 2009/2010, at the Sids Agricultural Research Station conditions, Agricultural Research Center, Egypt. The present study aimed to measuring the efficiency of three methods of selection used in the wheat breeding program namely; pedigree method (PM), modified bulk method (MBM) and single seed descent method (SSDM)). In two hexaploid bread wheat (*Triticum aestivum vulgare.*, L.) populations ($2n = 42$ chromosomes) chosen from breeding wheat program at the Sids Station. The pedigree of the parents of the two wheat populations are given in (Table 1). In 2006/2007 season, about 1600 grains of bread wheat from each F_1 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 2007/2008 season. Selection between and within families was practiced. 40 families were selected from 160 F_3 families to raise F_4 families in 2008/2009 season for each population. 20 families were selected from F_4 generation for each

population and retained to be raised as F_5 generation in the final evaluation trial during 2009/2010 season.

Table (1): The pedigree of the parents of the two wheat populations.

Parental name	Pedigree
Population I (P ₁) Line (P ₂) Sakha93	FLORKA-2 / Kaus "s" Sakha92 / TR810328
Population II (P ₁) Line (P ₂) Sids6	KAUZ//ALTAR84/AOS/3/KAUZ Maya " S " / Mon " S " // CMH 74 A. 592 /3/ Sakha8*2.

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 2007/2008 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 grains sample was taken to be raised as F_4 generations during the growing season of 2008/2009. Similarly, 20 plants per population were selected and were harvested individually. Grains from each plant were kept and were planted separately as F_5 populations during 2009/2010 growing season.

In the single seed descent method, one grain was taken from 500 plant from F_2 population and planted during 2007/2008 season as F_3 generations. One grain was taken from each plant to be grown as F_4 generations during the growing season of 2008/2009. 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 2009/2010 season.

In 2010 season, the high yielding selected lines (20) from each method of breeding (three methods *i.e.* pedigree, bulk and SSD) and the two parents and two check cultivars (Sids1&sids12) were represented by one row per plot, a row was three meters in length, 20 cm. between rows and 10 cm. between grains were evaluated in nested design with three replications in each cross

Sowing date was: 17 November. in the 1st season (F_3 generation 2008), 22 November in the 2nd season (2009); 12 December. in the 3rd season (2010)

The following characteristics were measured on random sample of 10 guarded plants in each plot for each in F_3 and F_4 and each line in F_5 generation. The mean of the 10 plants were subjected to the statistical and genetic analysis for:

- 1- Number of spikes per plant [S/P].
- 2- Number of kernels per spike [K/S]:- Average number of kernels per main spike of the plant.
- 3- 1000-kernel weight [1000-KW] in g.
- 4- Grain yield per plant [GY/P] in g :- It was recorded as the weight of individual plant grains.

RESULTS AND DESCUSSION

First cross

F₅ generation:

Mean squares due to breeding methods were significant for yield and its components (Table 2). This result indicated the differences between breeding methods.

The pedigree method expressed significant desirable values for number of spikes per plant, 1000-kernel weight and grain yield/plant (Table 3). It could be concluded that pedigree method considered the best breeding method for number of spikes per plant, 1000-kernel weight, and grain yield/plant than those of bulk and SSD methods 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, Schutz *et al.* (1968), Allard and Adams (1969), on barley and wheat using two or more methods of breeding.

Whan *et al.* (1982) found that the effect of selection using the means of lines from the F₃ and F₄ rather than the individual F₂ or F₃ derived lines, can be assessed by the yields obtained in the following generations. The improvement obtained in the F₅ by selecting F₂ derived lines was much greater in the second cross. When selection is carried out in an early generation e.g. among F₂ derived lines, the important consideration is the response to this selection in a late generation e.g. the F₅ when lines are approaching homozygosis. In the simulated schemes considered here, the available data enabled each selected line to be continued with one random line only. This caused a less of variation for yield and the gain from selection was often reduced in the generations following selection.

Mean squares due to lines of breeding methods as well as two parents and two checks (Sids1 & Sids12) were significant for the four traits under study (Table 2). 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 and two checks (Sids1 & Sids12)

Data presented in Table (6) show that the pedigree method produced consistently more superior lines for grain yield /plant compared to the best parent and the two cheeks (Sids1 & Sids12) or the average population with no. 2, no.3 ,no. 4, no.5, no.6, no.8, no.13, no.14, no.15, no.16, no.17 and no.19; no.3, no.6, no.9 and no.10; no. 7 for pedigree, bulk and SSD, respectively. The best lines were number 16 (45.80g) and no. 14 (43.22g) in pedigree method, no. 6(39.52g) in bulk method and number 15 (35.67g) , no. 5(35.55g) and no. 13 (34.96g)in pedigree method.

For number of Spikes/plant the results indicated that the pedigree method produced more superior lines followed by bulk and then by SSD compared to the best parent and the two cheeks (Sids1 & Sids12) or average over lines with 14; 9; Zero lines, respectively.

Regarding to 1000-kernels/weight, 2,3,5,8,10,13,19; 5; 2 lines showed, significant higher than the best parent and the two cheeks (Sids1 &

Sids12) and average over lines for pedigree, bulk and SSD methods, respectively. The heavier line was number 10 (71.70g) followed by line number 13 (68.52g) and then by line number 19(68.34g) in pedigree method and number 5 (69.53g) in bulk method and number 2 (68.95g)in SSD method (Table 6).

For number of kernels/spike, one line showed significant higher For number of kernels/spike than the average of all lines or best parent and two cheeks (Sids1 & Sids12). The line number 1, 16, and 17 in pedigree breeding method and the line number 1 and 10 in bulk method gave the highest number of kernels/spike.

Results of the present study indicate that visual selection for yield by pedigree method or early generation testing in wheat can lead to lines with increased yield.

The pedigree method seemed to be an effective than two other methods. Based on the combining ability studies, successfully applied early generation selection procedure for yield improvement in wheat. Accordingly, Casali and Tigchelaar (1975) compared PS, SSD and bulk breeding methods in self-pollinated populations by computer simulation.

Table (2): Mean squares of the breeding methods of the F_5 lines for the four traits studied in the first cross

Source of variation	Degrees of freedom	No. of spikes/plant	1000- kernel weight (g)	No. of kernels/spike	Grain yield/plant (g)
Replications	2	15.26**	18.81	12.83	9.36
Lines (L)	59	10.02**	156.02**	232.28**	123.30**
Methods(M)	2	29.42**	1897.20**	50.25	1298.66**
L/M	57	9.34**	94.93**	238.67**	82.05**
Error	118	1.959	19.467	41.80	9.77

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

Table (3): Mean performance of the breeding methods of the F_5 lines for the four traits studied in the first cross

Breeding methodology	No. of spikes/plant	1000- kernel weight (g)	No. of kernels/spike	Grain yield/plant (g)
Pedigree	10.76	62.29	65.39	32.77
Bulk	9.58	52.42	64.39	26.20
Single seed	9.52	52.69	63.56	23.78
L.S.D 5%	0.51	1.59	2.34	1.13
L.S.D 1%	0.67	2.11	3.09	1.49

Second cross

F_5 generation

The mean squares for breeding methods were significant for yield and its components (Table 4). These results indicated the differences between breeding methods.

The pedigree method gave the highest values for grain yield/plant, number of spikes per plant and number of kernels per spike. While the Bulk method gave the highest values for 1000-kernel weight. While, SSD method exhibited significantly higher for 1000-Kernel weight and number of kernels

per spike (Table 5). It could be concluded that pedigree method considered the best breeding method for grain yield/plant, number of spikes per plant and number of kernels per spike and the third for 1000-Kernel weight, than those pedigree and SSD in this cross.

Mean squares due to lines of breeding methods as well as two parents and two cheeks (Sids1 & Sids12) were significant for the four traits under study. 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 and the two cheeks (Sids1 & Sids12).

Table (4): Mean squares of the breeding methods of the F₅ lines for the four traits studies in the second cross

Source of variation	Degrees of freedom	No. of spikes/plant	1000- kernel weight (g)	No. of kernel/spike	Grain yield/plant (g)
Replications	2	3.69*	35.21	67.48	9.10
Lines (L)	59	8.51**	62.10**	329.98**	110.95**
Methods(M)	2	29.72**	706.02**	2146.20**	807.75**
L/M	57	7.77**	39.51**	266.26*	86.50**
Error	118	0.98	17.41	55.41	15.25

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

Data presented in Table(6) show that the pedigree method produced consistently more superior lines compared to the best parent and two checks (Sids1 & Sids12) or the average population with no. 7, no.8, no. 12, no.13 and no.16; no.3, no.5, no.10 and no.15; no. 9 and no.20 for pedigree, bulk and SSD, respectively. The best lines were number 7 (38.30g), no. 8 (48.23g), no. 12(40.50g), no.13(37.48g) and number 16 (40.71g) in pedigree method

Table (5): Mean performances of the breeding methods in the F₅ lines for the four studied traits in the second cross

Breeding methodology	No. of spikes/plant	1000-kernel weight (g)	No. of kernel/spike	Grain yield/plant (g)
Pedigree	11.23	49.09	68.911	33.29
Bulk	10.79	55.85	57.461	27.83
Single seed	9.86	53.46	66.183	26.31
L.S.D 5%	0.36	1.51	2.691	1.41
L.S.D 1%	0.47	1.99	3.556	1.87

For number of Spikes/plant the results indicated that the pedigree method produced more superior lines followed by bulk and then by SSD compared to the best parent and cheek (Sids12) or average over lines with 2, 3, 11, 13 and 16; 1, 7, 15 and 16; 9 lines, respectively.

Regarding to 1000-kernel/weight, zero; 2, 13, 14 and 16 ; zero lines showed, significant higher than the best parent and two cheek (Sids1 & Sids12) and average over lines for pedigree, bulk and SSD methods, respectively. The heavier line was number 13 (62.88) followed by line number 1(62.76) and then by line number 14 (60.55) and line number 16(59.73) in bulk method (Table 6).

For number of kernels/spike, four lines showed significant higher kernels number than the average of all lines or best parent and two cheeks (Sids1 & Sids12) in pedigree breeding method and SSD breeding method. The line number 2 and 12 in pedigree breeding method and the lines number 2,4 and 7 in SSD method gave the highest number of kernels/spike.

Table (6): Mean performance of the selected lines of breeding methods and two parents and check varieties in the first cross population.

Breeding Method	N. line	POPULATION 1				POPULATION2			
		N.S/P	1000-K.W(g)	N.K/S	GY/p (g)	N.S/P	1000-K.W(g)	N.K/S	GY/P (g)
Pedigree	1	7	54.87	86	30.36	10	52.29	57	25.26
	2	13	68.20	49	34.59	14	43.04	82	35.65
	3	12	65.97	49	34.91	13	54.86	60	35.48
	4	11	59.03	72	34.12	11	48.99	70	34.36
	5	12	68.00	56	35.55	10	50.09	79	27.71
	6	12	62.96	61	34.82	11	52.57	74	32.57
	7	11	62.65	71	25.65	12	56.52	61	38.30
	8	10	65.88	64	33.29	10	47.68	54	48.23
	9	11	62.45	66	23.83	10	48.90	59	35.50
	10	11	71.70	50	26.65	12	50.53	59	28.14
	11	10	62.49	60	22.74	13	42.07	63	30.61
	12	13	62.32	74	30.46	10	50.18	89	40.50
	13	11	68.52	74	34.96	13	49.79	72	37.48
	14	14	63.06	57	43.22	9	50.75	69	28.49
	15	12	60.86	55	35.67	12	49.85	76	33.39
	16	13	57.57	83	45.80	13	50.45	58	40.71
	17	8	43.21	83	34.10	11	47.05	70	25.58
	18	6	62.92	67	29.31	9	46.68	79	27.26
	19	8	68.34	62	34.40	10	42.69	79	32.96
	20	9	54.79	70	30.93	12	46.72	68	27.58
Bulk	1	6	57.83	79	22.67	13	62.76	68	26.27
	2	10	55.06	64	23.47	10	47.55	56	27.20
	3	10	53.21	66	32.37	12	47.48	51	34.53
	4	10	51.58	62	27.89	9	53.30	56	24.30
	5	10	69.53	60	23.28	11	54.66	52	31.62
	6	11	47.55	55	39.52	11	57.09	53	21.73
	7	8	45.96	63	28.86	13	58.89	55	29.27
	8	9	50.22	62	13.93	12	51.12	62	26.79
	9	14	45.70	60	33.06	9	56.34	55	24.40
	10	10	51.68	78	33.60	10	55.27	62	33.84
	11	9	49.20	70	21.89	8	58.66	54	17.70
	12	10	54.20	63	22.29	8	55.37	63	27.52
	13	10	51.41	67	29.68	10	62.88	58	28.57
	14	12	48.68	66	30.57	11	60.55	48	29.14
	15	11	49.99	63	22.76	13	58.93	56	32.72
	16	10	55.58	57	24.98	13	59.73	54	30.62
	17	8	49.15	76	16.99	10	58.35	58	28.69
	18	7	56.87	56	20.66	10	54.15	68	23.24
	19	9	51.09	65	25.19	11	50.26	62	26.28
	20	8	53.83	57	30.31	11	53.64	58	32.18

Table (6): Contact

Breeding Method	N. line	POPULATION 1				POPULATION2			
		N.S/P	1000-K.W(g)	N.K/S	GY/P (g)	N.S/P	1000-K.W(g)	N.K/S	GY/P (g)
Single Seed	1	8	52.82	75	23.75	7	55.16	76	27.41
	2	8	68.95	71	20.53	10	51.02	86	31.60
	3	12	52.41	70	25.20	10	56.77	57	29.12
	4	7	50.03	67	21.71	10	53.55	81	29.98
	5	11	48.14	64	25.41	8	55.07	71	17.70
	6	9	57.37	54	21.21	8	52.16	70	21.44
	7	8	52.49	70	32.78	12	52.51	84	25.91
	8	8	52.02	67	18.86	7	55.93	59	24.79
	9	10	54.57	74	27.17	14	55.79	48	36.10
	10	11	53.53	74	22.78	8	51.06	55	19.00
	11	9	52.30	55	23.57	8	53.87	75	18.57
	12	10	48.19	53	22.55	12	55.03	50	31.98
	13	9	53.09	53	21.73	10	53.04	55	24.65
	14	10	46.50	71	20.26	11	55.69	74	30.77
	15	8	42.23	56	21.17	10	54.99	69	26.90
	16	10	56.02	58	23.97	11	51.42	70	31.61
	17	10	51.98	68	29.81	12	49.26	72	15.98
	18	12	54.87	64	20.88	10	53.66	45	21.70
	19	11	54.73	60	27.31	8	47.97	62	27.03
	20	10	51.53	50	24.89	10	55.32	64	33.95
Parent 1		10	53.21	58	23.30	10	51.94	69	27.88
Parent 2		10	56.89	74	28.47	8	51.25	62	25.58
Sids 1		12	54.29	66	23.27	13	53.01	66	30.04
Sids 12		8	51.65	67	26.28	11	51.23	64	28.63
Over mean		10	55.80	64	27.58	11	52.80	64	29.14
L.S.D 5%		2	7.13	10	5.06	2	6.75	12	6.31
L.S.D 1%		3	9.43	14	6.68	2	8.92	16	8.34

Results of the present study indicate that visual selection for yield by pedigree method or early generation testing in wheat can lead to lines with increased yield.

The pedigree method seemed to be an effective than two other methods. Based on the combining ability studies, successfully applied early generation selection procedure for yield improvement in wheat. Accordingly, Casali and Tigchelaar (1975) compared PS, SSD and bulk breeding methods in self-pollinated populations by computer simulation.

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كفاءة ثلاثة طرق تربية علي هجينين من قمح الخبز
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أجريت هذه الدراسة بمحطة البحوث الزراعية بسدس في المواسم المتتالية ٢٠٠٧/٢٠٠٨ و ٢٠٠٩/٢٠١٠ واستخدم فيها عشيرتين من قمح الخبز لتقدير كفاءة ثلاث طرق للتربية هي طريقة تسجيل النسب ، طريقة التجميع المحورة وطريقة الانحدار من الحبة الواحدة / نبات العشيرة الاولى (الجيل الخامس)

أشارت المتوسطات الى أن هناك معنوية لكل طرق التربية بالنسبة لصفات المحصول ومكوناته والنتائج توضح الفروق بين طرق التربية المختلفة.

كانت طريقة النسب هي أفضل طرق التربية المستخدمة بالنسبة لصفات محصول الحبوب/نبات ووزن ال ١٠٠٠ حبة و عدد الحبوب/السنبلة وعدد السنبال/النبات مقارنة بطريقة التجميع وطريقة الحبة الواحدة لهذا الهجين.

كانت أفضل السلالات لصفة محصول الحبوب للنبات هي السلالة رقم ١٦ وأعطت ٤٥.٨٦ جم و السلالة رقم ١٤ وأعطت ٤٣.٢٢ جم وذلك في طريقة النسب والسلالة رقم ٦ وأعطت ٣٩.٥٢ جم حبة للنبات وذلك في طريقة التجميع وكذلك السلالة رقم ١٥ و ٥ و ١٣ وأعطوا ٣٥.٦٧ جم و ٣٥.٥٥ جم و ٣٤.٩٦ جم على التوالي وذلك في طريقة النسب العشيرة الثانية (الجيل الخامس)

أشارت المتوسطات إلى معنوية كل طرق التربية لصفات: المحصول ومكوناته. تعتبر طريقة النسب أفضل طريقة تربية بالنسبة لصفات المحصول العالي للنبات، عدد حبوب السنبلة و عدد السنبال في النباتات مقارنة بطريقتي التجميع و الحبة لكل نبات بينما أعطت طريقة التجميع أعلى قيمة في وزن ال ١٠٠٠ حبة عن باقي الطرق .

تم تقييم كفاءة طرق التربية في الدراسة استنادا إلى عدد التراكيب الوراثية المتوقعة ذات المحصول العالي مقارنة بالأب وصنف المقارنة الأعلى.

كانت أفضل التراكيب الوراثية بالنسبة لمحصول الحبوب في النبات في طريقة النسب السلالة رقم ٨ (٤٨.٢٣ جم) والسلالة رقم ١٦ (٤٠.٧١ جم) والسلالة رقم ١٢ (٤٠.٥٠ جم) ورقم ٧ (٣٨.٣٠ جم) والسلالة ١٣ (٣٧.٤٨ جم)

أظهرت النتائج بالنسبة لصفة عدد السنبال للنبات أنه لا توجد سلالات متفوقة عن الصنف سدس ١ معنويا ولكن طريقة تسجيل النسب نتج عنها أفضل السلالات يليها طريقة التجميع ثم طريقة الانحدار عن حبة واحدة

كانت أفضل سلالة بالنسبة لصفة وزن ال ١٠٠٠ حبة هي رقم ١ (٦٢.٧٦ جم) يليها السلالات رقم ١٣ و ١٤ و ١٦ وكان محصولهم ٦٢.٨٨ و ٦٠.٥٥ و ٥٩.٧٣ على التوالي وذلك باستخدام طريقة التجميع.

أظهرت النتائج بالنسبة لصفة عدد الحبوب بالسنبلة اربع سلالات معنوية عالية بالنسبة لصفة عدد الحبوب بالسنبلة مقارنة بالمتوسط العام وكذلك بالأب وصنف المقارنة الأعلى وهما السلالة رقم ١٢ و ٢ في طريقة النسب والسلالة رقم ٢ و ٤ و ٧ في الحبة لكل نبات

أوضحت نتائج هذه الدراسة إلى أن الانتخاب للمحصول بطريقة النسب في محصول القمح من الممكن أن يقودنا للتعرف على السلالات عالية المحصول.

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