SELECTION FOR EARLINESS, YIELD AND ITS COMPONENTS IN BREAD WHEAT

BY

Mohamed Mareei Mohamed Hamouda

B.Sc. Agric. Sci. Minia University, 2002
M.Sc. Agric. Sci. (Agronomy), Fac. of Agric., Minia University, 2007

A Thesis submitted in partial fulfillment of

The requirements for the degree of

DOCTOR OF PHILOSOPHY
In
Agricultural Science
Agronomy (Crop Breeding)

Department of Agronomy

Faculty of Agriculture

Benha University

2012

SELECTION FOR EARLINESS, YIELD AND ITS COMPONENTS IN BREAD WHEAT

BY

Mohamed Mareei Mohamed Hamouda

B.Sc. Agric. Sci. Minia University, 2002
M.Sc. Agric. Sci. (Agronomy), Fac. of Agric., Minia University, 2007

This thesis for Ph.D. degree
in Agriculture (Crop Breeding)

Under The Supervision of:

Prof. Dr. Ali Abd EL- Maksoud EL-Hosary A. A. El-Hosary
Professor of Agronomy
Faculty of Agriculture - Benha University

Prof. Dr. El Sayed Mohamed Hassan Shokr Sayed Shokr
Professor of Agronomy
Faculty of Agriculture - Benha University

Prof. Dr. Mohamed El-Sayed Riad Gomaa M. R. Gomaa
Professor of Agronomy
Faculty of Agriculture - Benha University

Prof. Dr. Mahrous Abdel-Ghani Abo-Sherief M. A. Mahrous
Chief Research, Wheat Research Department, FCRI, ARC

Approval sheet

SELECTION FOR EARLINESS, YIELD AND ITS COMPONENTS IN BREAD WHEAT

BY

Mohamed Mareei Mohamed Hamouda

B.Sc. Agric. Sci. Minia University, 2002
M.Sc. Agric. Sci. (Agronomy), Fac. of Agric., Minia University, 2007

This thesis for Ph.D. degree has been approved by:

Prof. Dr. El Sayed Mohamed Hassan Shokr .... Sayed Shokr
Professor of Agronomy
Faculty of Agriculture - Benha University

Prof. Dr. Mahmoud Soliman Sultan .... M. Sultan
Prof. of Agronomy,
Faculty of Agriculture, Mansoura University

Prof. Dr. Ali Abd EL- Maksoud EL-Hosary .... A. A. El-Hosary
Professor of Agronomy
Faculty of Agriculture - Benha University

Prof. Dr. Mohamed El-Sayed Riad Gomaa .... M. R. Gomaa
Professor of Agronomy
Faculty of Agriculture - Benha University

Dr. Mahmoud El-Zaabalawy El-Badawy .... M. El-Badawy
Assistance Professor of Agronomy
Faculty of Agriculture - Benha University

Date of examination: 22 /2 /2012

Acknowledgment

First of all, full thanks to **ALLAH.**

I wish to express my deep gratitude and sincere appreciation to **DR. Ali Abd-Almksod El-Hosary**, professor of Agron. Fac. of Agric. Moshtohor, Benha Univ. for his guidance and supervision, asking GOD to bless him.

Deep and grateful acknowledgment is also due to **DR. El-Sayed Mohamed Hassan Shokr,** professor of Agron. Fac. of Agric. Moshtohor, Benha University for his supervision and valuable guidance.

I wish to express my thanks to **Dr. Mohamed El-Sayed Riad Gomaa** professor of crop Agronomy, Fac. of Agric., Moshtohor, Benha Univ for his valuable guidance and supervision.

Thanks also due to **DR. Mahrous abdel-Ghani Abo-Sherief**, head of wheat researcher department, Wheat Research Program at Gemmeiza, Agriculture Research Station, Field Crop Research Institute, ARC. Giza, for his encouragement, supervision and valuable during this study.

All Appreciations to **DR. Ahmed Ali Abd-Almksod El-Hosary**, and **DR. Adel Hagras**, for their good advices and help through the study.

Finally, many felt thanks for my family, my colleagues and every one who participated in one way or another in this work; I owe my thanks and appreciation.

CONTENTS

INTRODUCTION

I. INTRODUCTION

Wheat is the world's most important strategic food crop. In Egypt, it is the main winter cereal crop as it occupies approximately 3.07* million feddan producing 8.25* million tons. Moreover, wheat is the primary stable food source of the most Egyptian population; its straw is an important fodder for animal.

Since 70,s of the last century attempts have been made to develop high yielding wheat cultivars aiming to decrease its imports and to meet the consumption of the rapid growing population. These great challenges encourage the Egyptian scientists to develop several adapted wheat genotypes with desirable characteristics and high yield potential (Abd EL Ghani *et al.*, 1994).

The new high yielding Egyptian cultivars affected wheat imports, which reached a maximum level of around 7.5* million tons in 1987 and dropped to around 5.5* million tons by year 2000 the acreage of wheat reached 3.07* million Feddan in 2010/2011 season and it produced about 8.25* million tones with average production of Feddan nearly 17.9* Ardab = 2.685* tone per feddan.

The long term strategic plan of wheat research program in Egypt is aiming to select among introductions and regionally collected germplasm that possess good adaptation to the variable conditions and good tolerance to the major pests (Enayat H. Ghanem, 1993).

Breeding early maturing wheat (*Triticum aestivum, vulgare* L) cultivars is an important objective in most wheat improvement programs. Knowledge of the inheritance of early maturing and its components are important to wheat breeders in developing short duration cultivars.

The development of more efficient breeding procedures is dependent upon a better understanding of the types of gene action controlling the inheritance of quantitative traits. One of the most important procedures used to supply genetic information about the parents and their crosses.

---

*(refer to the ministry of agriculture and land reclamation- economic affairs sector in 2011).

A crop breeding programs amid to increasing plant productivity requires consideration not only for yield but also of its components which have direct or indirect contribution on yield.

Several methods of selection can be used in segregating generation after crossing in self pollinated crops. The information for each of the 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 follow for high yielding varieties of wheat and applied this method in the following breeding program.

Improvement of complex character like yield may be accomplished through component breeding (Grafius, 1964). Also, many workers suggested that selection for component traits can help to increase productivity.

The main objectives of this study were to:

1- Compare the effectiveness of pedigree, bulk and single seed descent (SSD) breeding methods in increasing grain yield in wheat.
2- Compare the effectiveness of indirect selection for yield via yield components with direct one for grain yield.
3- Estimate some genetic parameters *i.e.* heritability, genetic gain and genetic coefficient of variation in F_3 and F_4 generations.

REVIEW OF LITERATURE

II. REVIEW OF LITERATURE

The available literature concerning this study can be reviewed under the following heading.

II.1. Breeding methodology

II.2. Selection criteria

II.3. Heritability and genetic advance

II.1. Breeding methodology:

A synthetic variety is produced by inter crossing a number of genotypes selected for good combining ability in all combinations with subsequent maintenance of the variety by open pollination **(Allard 1960)**.

Briggs and **Shebeski (1970),** compared the results of visual selection with random selection in wheat. They noticed when positive visual selection pressure of ten percent was applied; yielding ability was significantly improved relative to random selections. Visual selection was considered effective.

Tee and **Qualset (1975),** reported that, after four generations, random single seed descent and bulk population derived lines from two hybrids of wheat were evaluated in the F_4, F_5 and F_6 generations in the field experiment at the two locations for yield. Selection for plant height and maturity was practiced in the separate populations during the program. Generation means showed increase in plant height and grain yield per plant from F_3 to F_6 in one hybrid but no change in the second hybrid with the two methods except for plant height in single seed descent method. Genetic variation among families within each generation was greater in single seed descent populations than in bulk populations for heading time and grain yield in hybrid I, but in hybrid II, the reverse was true for plant height and grain yield per plant with no difference for heading time. Significant response to selection during the cycle for tallness and shortness was obtained, but greater for shortness, while slight response for earliness was observed. The single seed descent and bulk population methods were comparable except for the important competition effect to plant height. Thus, tall plants increased in bulk population method changing significantly the gene frequencies. They recommended the random bulk method unless competition effects were important where upon single seed descent become the preferred methods.

Salmon *et al.* (1978), evaluated four F_3 populations of hexaploid triticale for yield. F_3 yield nursery and a head row nursery were planted. Ten high yielding, ten low yielding and ten randomly sampled families along with ten families selected visually for yield in the head row nursery were returned to be used in a ten replications yield trial at the four locations. They did not noticed no significant difference existed between bulk produced from high yielding families selected by the early generation yield test and the head row nursery. Both of the two procedures produced families superior in yield to the bulk of randomly sampled families. The present results suggest that pedigree selection and early generation yield testing procedures were equally efficient for yield selection in triticale. The random selection and visual selection bulk were significantly higher than that of the high yielding bulk and significantly lower than that of low yielding bulk with respect to 200-kernel weight.

Knott (1979) found that, the early generation yield testing lines were slight increase in grain yield/plant over single seed descent lines (1.5 to 3.8 %) in the two wheat crosses. He stated that selection based on F_3 yield test may had a slight effect on yield which would result in undesirable delay in maturity. His results indicated that F_3 selection based on a two replications test compared with families from single seed descent lines did not justify the extra work and labor more than the simple test with no replications.

Whan *et al.* (1982) investigated aspects of selection for yield and harvest index by simulating selection using data from random pedigree F_2, F_3, F_4 and F_5 derived lines from two crosses of wheat grown in plots at two sites over two years. Improvement in yield through selection was pained when the response was measured at the same site and in the same year as the selection. Selecting the best 10% of F_2 to F_4 derived lines gave F_5 derived lines that out yielded random selection by 19 to

53% for one cross and 5 to 23% for the second cross. These lines were 41 to 50 percent better than mid-parent in one cross, but were less than the mid-parent in the other cross. However, the response to selection when measured in a different years was little better than random selection. The effect of different sites also reduced the effectiveness of selection. Selection of harvest index in early generations for improvement of yield was ineffective when response was measured at the same site in the same year, or in different years. Contrary to same theoretical propels, the same improvement in yield was obtained by selecting in early or late generations. While high yielding genotypes may be last by delaying selection, this is counteracted by the better predictive value of late generations due to their greater homozygosis and homogeneity.

Martynov *et al.* (1983) reported that, in a hybrid-population of spring bread wheat (Sarator-Skaya 52 x As 29), subjected to the two selection regimes (two cycles of pedigree selection for yield in the F_3 and F_4, and single seed descent from the F_2 to the F_5), evaluation of F_6 and F_7 families derived from the F_5 obtained by both selection methods were carried out over two sites and two years. The means grain yields of the top 10 % of families were similar under both selection regimes. The single seed descent method was therefore recommended as a means of reducing the area required for sowing breeding material and the time required to produce a new variety.

Pawar *et al.* (1985), studied some crosses up to the F_4 for seven characters (grain yield and its components). Mean values for all characters in the selected F_3 and F_4 were higher than those in the F_2, selection in the F_3 appeared to the better than selection in the F_2, owing to additive gene effects and epistasis. The single seed descent was considered to be better than bulk selection.

Pawar *et al.* (1986), reported that, 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. Selection was more effective at the F_2 than at the F_3 stage.

Picard *et al.* (1986), showed that, the variance in the few doubled haploids was of the same order of magnitude as that in the single seed descent and bulk families for earliness.

Salmeron and **Kronstad (1986),** revealed that, the modified bulk and pedigree methods were most effective in selecting for semi-dwarf stature. Differences between selection methods were slight when selection was for grain weight. For grain yield, the modified bulk method was superior to the others in one cross only when F_5 family values were averaged. The modified bulk method proved to be superior overall when individual F_5 families were compared.

Chen and **Chen (1987),** found that, no significant differences for the means, variances and distributions of several characters.

Pawar *et al.* (1989), found significant differences between populations in the F_3 followed by three procedures of selection: single plant selection, single seed descent and bulk selection. Heritability estimates for number of days to heading and 1000-grain weight were higher than those for number of spikes per plant and grain yield per plant. Single plant selection and single seed descent were almost equally effective and both were superior than bulk selection.

Srivastava *et al.* (1989), found that, the following selection procedures were compared in F_3 and F_4 generations: (1) single seed descent, (2) single plant selection, (3) bulk population and (4) mechanical mass selection. In the F_3, the single plant selection and single seed descent selection methods resulted in higher grain yields per plant and more improvements in many yield components than did the bulk population and mechanical mass selection methods. The F_3 single seed descent population did not differ significantly from the F_3 single plant selection population for any trait but the single seed descent population retained more variability than the other populations. The mechanical mass selection method was useful for increasing grain weight.

Deghais and **Auriau (1993),** applied three breeding methods (pedigree, modified bulk and single seed descent) in six crosses and 20 families per cross (F_6 or F_7), selected by each method, were yield tested The pedigree and single seed descent methods proved to be more efficient than the modified bulk method for selection based on grain yield. The single seed descent method had the additional advantage of requiring less land area and labor.

Ismail (1995), used pedigree selection for two cycles of selection in the two populations. He found that the realized gain for heading date was reduced by 7.58 % ($Pop._1$), and 3.66 % ($Pop._2$) compared to the bulk. Grain yield per plant increased after two cycles of selections in both populations compared to the bulk and the better parent by 8.47 % and 4.86 % ($Pop._1$), and 6.96 % and 6.41 % ($Pop._2$), respectively. Thousand kernel weight was increased by 3.06 % and 3.85 % ($Pop._1$), and 4.05 % and 4.00 % ($Pop._2$) as a deviation from the base populations and the better parent after the two cycles of selection. Pedigree selection was an efficient selection procedure in increasing the selection criterion. However, such increase was accompanied with adverse effects on the correlated traits.

Pawar *et al.* (1995), reported that, five F_3 populations were produced by applying single plant selection, single spike selection, single seed descent, selection on yield per se and mechanical mass selection in the two bread crosses. Comparisons were made between the different selection procedures for six yield components. Single plant selection followed by single spike selection proved better than other selection procedures in terms of mean performance. Highest levels of genetic variance and coefficient of variation were observed for F_3 single seed descent followed by F_3 single spike selection and F_3 single plant selection.

Perovic (1997), evaluated 12 crosses of 11 winter wheat cultivars and 35 breeding families of their F_4 and F_5 hybrid generations for five yield components. He found that plant height and spike length were controlled genetically, while the phenotypic expression of the number of grains per spike and grain weight per spike were predominantly affected by environmental conditions. There was significant genetic divergence between parental cultivars and desirable recombination of certain genes were obtained in their crosses. Pedigree method of individual selection was very efficient in breeding for increased values of some grain yield components. Average values of parental cultivars used had powerful influence on the progeny in F_4 and F_5 generations. Realized genetic gain was determined for all the examined hybrid combinations.

Singh and **Singh (1997),** compared between random bulk and individual plant selection for grain yield and its contributing characters on the basis of performance of five diverse F_2 populations. Yields were similar under both methods; however, higher estimates for component characters were observed using individual plant selection in some of the populations. This trend was not consistent across all the populations. They concluded that, yield would be appropriate to advance the generation from the F_2 to F_3 without any selection.

Pande *et al.* (1998), advanced a segregating population of durum wheat cross CPAN-6140 x Raj 1555 by single seed descent and pedigree selection up to the F_3 generation. Breeding methods were compared with respect to genetic gain and residual variability. Sixty plants selected by single seed descent and pedigree selection were evaluated in the F_4 generation. Single seed descent progenies exhibited good coefficients of variation as compared to pedigree selection progenies. Heritability estimates was also of higher magnitude in single seed descent progenies.

Pawar *et al.* (2001), three selection procedures (single spike selection, single plant selection and single seed descent) were used in F_2 populations of two wheat crosses, (HFW-41 x WH 542 and Raj 3957 x WH 147). The coefficient of variation in single seed descent method was slightly greater than single plant selection and single spike selection. This indicated that single seed descent was better or equal in effectiveness compared to the other two methods. Single spike and single plant selection can be used to supplement pedigree selection in early segregating generation.

Arunachalam *et al.* (2002) evaluated the efficiency of three breeding methods namely; pedigree, bulk and single seed descent (SSD) in Cowpea. The SSD population matured early followed by bulk and pedigree populations. The shift in means in positive direction were better achieved through pedigree method as compared to bulk and SSD methods in F_3 to F_4 generations for all the traits in both the crosses, whereas, in SSD and bulk populations the shift in means were in either directions. The pedigree populations had high heritability estimates. The bulk and SSD populations had moderate to high value of heritability and genetic advance for most of the traits. The pedigree and SSD populations were equally efficient, but the bulk method turned out to be less efficient.

El-Hosary and El-Badawy (2003) estimated the response of faba bean to different methods of plant breeding i.e. pedigree, bulk and single pod descent (SPD) in both crosses Triple white x ILB938 (the first cross) and Rebaya 40 x Line 109 (the second cross). The bulk method led to significant higher no. of pods/plant, seed yield/plant and no. of seeds/pod in the first cross. The pedigree method produced more superior lines compared to the over all mean in the first and second cross, respectively.

II. 2. Selection criteria:

Nass (1973) studied 22 cultivars of spring wheat (*Triticum aestivum L.*) in two years. The results showed that yield per ear and number of ears per plant reduced yield variance. These two components were negatively correlated. Kernels per ear and kernel weight were associated with yield per ear. Morphological characters influenced plot yield indirectly in that ears/area, flag leaf width, and total photosynthetic area above the flag leaf node were associated with yield per ear. Ears per plant, yield per ear and harvest index considered together in a selection program should be an effective means of selection for increased yield.

McNeal et al. (1978) from F2 population of 700 plants from a cross of two spring wheat (*Triticum aestivum L.*) CT13242 and Cher, Selected 10 plants for maximum expression of grain yield per plant, spike number/plant, Kernel number/spike, spikelet number/spike and kernel weight. In each subsequent generation through the F5, selected lines for each of the five characters were advanced by selecting the 10 plants with the highest value from a population of about 400 plants. A performance trial was conducted at three locations in one year with five generations (F1 to F5) of each of the five selection lines and the two parents. Yield and yield components were evaluated and compared with mid parent values and as linear regression on generation number. Selection for kernel weight and kernels/spike in F4 generation gave 11 and 16% yield increases over the mid parent, whereas direct effects of selection for the two characteristics were 13 and 10%, respectively. Direct effects of selection for grain yield and spikes/m2 at the F5 generation were significantly lower than mid parent (-13 and -7%). Non-symmetrical correlated responses for increased kernel weight with selection for high kernel weight were large and unexpected. Spike number per plant was not an effective selection criterion for increasing spike number per m2 or grain yield. Only 3 of 20 regression coefficients for response in F4 through F8 generation were significant compared with 15 of 20 significant differences from the mid parent at F8. Apparently, selection was effective in F2 and F3 generations (13 of 20 mid parent differences were significant at F4) with little subsequent response. In this population, kernel weight and kernel number per spike were good characters for indirect selection for yield improvement.

Lungu et al. (1990) studied the relationships between yield, its components and other associated characteristics, both within and across generations in the f2, F3 and F4 of two hard red spring wheat (*Triticum aestivum L.*) crosses using simple correlation path coefficient and step-wise multiple regression analysis. F2 and F3 plants were grown 50cm apart while in F4 they were grown under the usual farm practices. Selection was practiced for high and low yield in the F2 and F3 mainly on the basis of individual plant yield. Statistically significant, but not always practically useful correlations were found between yield and its components and other associated characters. The relationship between yield and protein content was negative and significant within all generations but not so between F2 (and F3) and F4. The intergeneration correlation coefficients between F4 grain yields and grain yields measured in the F2 and F3 were all positive and highly significant. These coefficients, which are also heritability estimates in standard units, were small in magnitude.

Sharma *et al.* (1995) performed mechanical mass selection for grain size, followed by two cycles of intermating among the high grain-weight populations, to achieve improvement in grain yield. Forty progenies each from five mass selected, eight populations of the first and fourth of the second intermating cycles were evaluated for number of grains/spike, 1000-grain weight, and grain yield. Mechanical mass selection and each cycle of intermating were effective to increase 1000-grain weight, indicating accumulation of favourable alleles in the segregates. There was slight improvement in number of grains/spike also in the progenies of the first intermated populations which increased grain yield. However, the second cycle of intermating was not effective in increasing grain yield due to reduction in number of grains/spike. Correlation studies also revealed the usefulness of one cycle of intermating for improving grain yield. Therefore, it is proposed that one cycle of intermating is needed to achieve optimum expression of yield components.

Dokuyucu and Akkaya(1999). In Turkey found in a trial with 22 common wheat cultivars in 1996-98, that there were positive and significant correlations between grain yield and number of heads/m^2, number of grains/head, grain weight/head and test weight. Path coefficients also indicated that both direct effects of number of heads/m^2 and grain weight/head, and indirect effect of number of grains/head by grain weight/head on grain yield were significant and positive. Therefore, number of heads/m2, grain weight/head, and number of grains/head may be used as selection criteria in breeding programmes to develop high yielding bread wheat varieties.

Baser *et al.* (2000) studied three bread wheat varieties sown at six plant densities in the experimental field of Tekirdag Agricultural Faculty. It was found that the number of fertile tillers/plant was the most suitable character as a selection criterion for improving grain yield in Thrace Region. According to path analysis, the direct and indirect effects of the measured characters on grain yield/ plant and grain yield/hectare showed that the number of spikes / plant and grain weight of tillers / plant had direct positive effect on grain yield / plant. However, the number of spikes / plant and number of tillers / plant had negative effect on grain yield / hectare, while the harvest index and grain yield / plant had positive direct effect.

El-Hosary and El-Badawy (2003) estimated the response of faba bean to direct and indirect selection criteria for increased seed yield in both crosses. The results indicated that selection of high no. of pods/plant gave the highest seed yield/plant and followed by selection of heavier seed index in both crosses. Also in the first cross eight, one, two, four and two lines significantly over yielded population mean when selected plants were of high no. of pods, heavy seeds, high no. of seeds/pod and high and low seed yield/plant, respectively. In addition, in the second cross seven, three, two, three and two lines surpassed significantly the best parent or population mean in the same order.

Tejbir-Singh and Balyan. (2003) evaluated the relative efficiency of various single F_2 plant selection criteria in three F_2 populations of wheat (Triticum aestivum L.). the criteria considered were : (i) selection for high as well as low values of seven individual plant traits (grain yield per se, plant height, grains /spike, 100 grain weight, tiller number, biological yield and harvest index), (ii) selection of single plants based on an index involving greater values of the seven traits rather than their means of the population and, (iii) random selection in association with and without yield testing in the F3 generation. The selection pattern of the parent F_2 plant (s) of each of the selected ten highest yielding F_3 F_4 bulk progenies and F_4 bulk progenies revealed that (i) selection of plants in F_2 populations on the basis of a single trait was relatively more effective than selection at random, while selection based on the index was ineffective, (ii) selection of plants with higher expression of trait (s) resulted into 75% of the highest yielding F_4 bulk progenies, (iii) selection of individual plants in F_2 generation based on grain yield per se proved most effective and, (iv) the yield testing in F_3 generation was only moderately efficient in identification of high yielding F_4 bulk progenies.

Yadav (2007) evaluated thirty diverse genotypes of soybean during Kharif 2003-04, in Raipur, Chhattisgarh, India to study the genetic variability and co heritability with seed yield and its attributes. Seed yield per plant, number of pods per plant, number of seeds per plant, pod bearing length and plant height exhibited maximum genotypic coefficient of variation. High heritability coupled with high genetic advance as percentage of mean was noted for plant height, pod bearing length, pods per plant, seeds per plant and seed yield per plant. Significant contribution of additive genetic variance was observed for all the above characters. Co heritability was high for character pairs like seed yield per plant with all characters. Hence, selection for these characters might be as effective as direct selection for yield itself.

II.3 Heritability and genetic advance:

Allard and **Harding (1963),** found that, the observed gains in the direction of earliness and lateness for F_7 families were 11.30 and 14.40 days, respectively.

Mitchell ***et al.*****(1982),** showed that, the response to selection in the two crosses were 7.10 and 14.00 % for grain yield per plant.

Johanson ***et al.*** **(1983)** found that heritability values computed via components of variance ranged from 0.50 to 0.57 for the three traits, i.e. harvest index, vegetative growth rate and grain yield on oat, where as regression heritability ranged from 0.41 to 0.55 realized heritability were 0.33, 1.00 and 0.89 for the three traits, respectively. Selection via all criteria caused significant changes in nearly all agronomic traits except weight per volume vegetative growth rate, which gave the greatest gain in grain yield, caused less drastic changes in days to an thesis plant height, biological yield and vegetative yield than did direct selection for grain yield.

Pathak and **Nema (1985),** found that, high values of genotypic coefficient of variability and genetic advance for kernel weight, grain yield per plant and number of spikes per plant, indicating that selection for these traits might be effective to improve the landraces of Indian wheat.

Wells and **Kofoid (1986),** estimated the broad sense heritability which were, 69.0, 87.0, 61.0 % for each of grain yield per plant, kernel weight and number of kernels per spike, respectively.

Masood and **Chaudhary (1987),** reported that, broad sense heritability was generally high for number of spikes per plant, number of kernels per spike and grain yield per plant.

Natarajan *et al.* (1988) reported high genotypic coefficient of variation for seed yield, number of pods, and plant height in mung bean. Also, results showed high heritability estimates for 100- seed weight (97.3); followed by days to flowering (93.2), plant height (73.7) and pod length (69.7).

Ehdaie and **Waines (1989),** found that, moderate genetic variation was displayed by the number of spikes per plant, number of grains per spike and 1000-grain weight in the landraces genotypes. Heritability estimates ranged from 43 to 97 %.

Amin *et al.* (1992), found that, in wheat significant differences among genotypes for all the characters studied. The genotypic coefficient of variation (G.C.V.%) was highest for grain yield per plant followed by number of kernels per spike. Broad sense heritability estimates were high values for grain yield per plant, while, it was moderate for 1000-grain weight. High heritability and appreciable genetic advance for grain yield per plant were detecting, predominance of an additive gene effect in controlling of these traits.

Chander *et al.* (1993), showed that, in wheat broad sense heritability varied from 79 to 90 % for number of spikes per plant, 81 to 89 % for number of kernels per spike, 74 to 82 % for grain weight and 79 to 88 % for grain yield per plant.

Raut et al. (1995) from information on genetic variability and yield correlations derived from data on 9 yield components in 32 genotypes of wheat (Triticum aestivum L.) grown at Akola, Maharashtra, during rabi 1989-90 found that grain yield, 100-grain weight, number of tillers/m row and peduncle length exhibited high estimates of heritability accompanied with high genetic advance. Among component characters, harvest index, number of grains/ear and number of spikelets/ear were positively and significantly associated with grain yield. Path analysis revealed the importance of harvest index, 100-grain weight, number of tillers/m row and number of spikelets/ear.

Moshref (1996), reported that, in wheat there were significant differences between the six populations for 1000-grain weight. While, no significant differences for grain yield per plant and number of grains/spike. Broad sense heritability values were high for number of spikes per plant and number of grains per spike, as well as, moderate for 1000-grain weight and grain yield per plant.

Dhonde et al. (2000) recorded information on 9 yield components in 40 genotypes. The higher genotypic and phenotypic coefficient of variations was observed for productive tillers per plant, grain yield per plant and grains per ear. Productive tillers per plant and grains per ear expressed high heritability accompanied with high genetic advance. There were highly significant positive associations of grain yield with productive tillers and grain weight per ear. The number of grains per ear (0.947) and grain weight per ear (0.757) had the highest direct effect on grain yield. Plant height, productive tillers, length of spike, grains per ear and 1000-grain weight are very important yield contributing characters and should be given more emphasis during selection.

Shukla *et al.* (2000) studied some 25 cross combinations of wheat over F_2 and F_3 generations for yield components. High genotypic coefficient of variation, high heritability and high genetic advance were observed for grain yield/plant, 1000-grain weight and harvest index. Good association of desirable traits like grains/ear, tillers/plant, grains/spike, biological yield/plant and harvest index was recorded. Results of the present study suggested that these traits could be utilized as selection criteria for the improvement of grain yield in bread wheat under rainfed condition.

Dixit *et al.* (2002) studied biometrical parameters in 38 newly developed genotypes of soybean. Harvest index, seed yield per plant and biological yield per plant showed comparatively high estimates of genetic variation and heritability; hence, direct selection for these traits would be effective for yield improvement in soybean.

Bangar *et al.* (2003) found that phenotypic coefficient of variation (PCV) was higher than genotypic coefficient of variation (GCV) in soybean. The GCV and PCV estimates were higher for branch number per plant and plant height among the characters. The GCV and PCV were of moderate magnitude for the pod number/plant, 100-seed weight (g) and seed yield/plant (g). Days to 50% flowering and days to maturity had very low GCV and PCV estimates. The differences between GCV and PCV magnitudes were very high for 100-seed weight (12.94) and pod number/plant (10.30). Among the characters, days to maturity (97.80%), branch number per plant (91.39%) and plant height (60.82%) showed the highest magnitude of heritability. Genetic advance was high for branch number/plant and seed yield. The regression of seed yield on seed weight, plant height and pod number/plant was positive and highly significant.

Tammam (2004), found that, significant differences among the selection methods in response to phenotypic selection in all studied characters. The values of phenotypic and genotypic variances were high for number of kernels/spike, while, the values were low for number of spikes/plant, 100-kernel weight and grain yield/plant. But, the values of phenotypic and genotypic coefficients of variability and the values of broad sense heritability were high for all traits.

Chettri *et al.* (2005) studied the genetic variability in 18 soybean genotypes in Darjeeling, West Bengal, India, for the Kharif seasons of 1998, 1999 and 2000. Plant height, days to 50% flowering, days to maturity, number of pods per plant, number of seed per pod, 100-seed weight and seed yield/ unit area were measured. The number of pods/plant showed a wide range of variation (50.78-80.89, general mean of 63.96$\pm$ 12.09). Plant height and seed yield/unit area exhibited high estimates of heritability, genetic advance and genetic advance as percent of mean along with appropriate broad sense heritability values. Days to maturity, followed by days to 50% flowering recorded the lowest phenotypic and genotypic variances and coefficients of phenotypic and genotypic variation. The number of seed per pod and 100- seed weight showed high heritability values but low genetic advance and genetic advance as percent of mean, indicating the presence of poor genetic variance in the materials. Hence, breeding methods that consider heterosis is suggested to make effective improvement in those characters.

Dev Vart *et al.* (2005) found that the phenotypic coefficient of variation was slightly higher than the genotypic coefficient of variation for all the traits in soybean. Heritability was high for all the characters except for pods per plant, whereas expected genetic gain in terms of percentage of mean was highest for clusters per plant and lowest for days to maturity. Traits with high heritability and high genetic advance also had moderate to high genotypic and phenotypic coefficients of variation.

Sultana *et al.* (2005) studied thirty genotypes of soybean with a view to find out genetic variability, correlation, and path coefficient analysis for yield and its quantitative characters. All the tested characters was showed significant variation among the genotypes. The highest genetic variability was found in 100-seed weight followed by pod/plant, grain yield and branch /plant. High heritability together with high genetic advance in percentage of mean was observed for 100-seed weight/plant, and branches/plant and yield/plant. Genotypic correlation coefficients were higher than the corresponding phenotypic correlation coefficients for most of the cases.

Gohil *et al.* (2006) studied the genetic variability, broad-sense heritability and expected genetic advance for seed yield and its component traits in 55 diverse soybean genotypes collected from different soybean growing states of India. The field experiment was conducted in Gujarat during the kharif season of 2001. The highest genotypic coefficient of variation was observed for number of pods per plant followed by seed yield per plant. High heritability was observed for all the characters studied in soybean. Further, plant height, number of clusters per plant, number of pods per plant and seed yield per plant had high genetic advance coupled with high heritability, which suggested that these four traits are under the control of additive gene action and can be improved through simple selection procedures.

Malik *et al.* (2006) subjected data on 16-yield related traits of 25 soybean genotypes to analysis of variance, heritability, correlation coefficient and path analysis in an experiment conducted in Pakistan from July to October 2002. Highly significant differences among the genotypes for all the characters examined were recorded. High heritability was recorded for 100-grain weight, number of days to maturity, number of days to flowering completion, number of days to pod initiation, leaf area, number of days to 50% flowering, oil content, number of shattered pods per plants, grain yield per plant, plant height and protein contents, indicating the additive type of gene action governing these traits.

Mohamed (2006), found that, in wheat the values of actual response to selection for F_5 generation were high for number of days to maturity, number of kernels per spike, 100-kernel weight, grain yield per plant, while, the values were low for number of spikes per plant.

Results for values of phenotypic and genotypic variances were high for number of days to maturity and number of kernels per spike while, the values were low for number of spikes per plant, 100-kernel weight and grain yield per plant in the F_5 generation. Moreover, phenotypic and genotypic coefficients of variability in the F_5 generation were high for number of spikes /plant, number of kernels per spike, 100-kernel weight and grain yield / plant while, the values were low for number of days to maturity. Furthermore, results for values of broad sense heritability in the F_5 generation were high for number of days to maturity, number of spikes/plant, number of kernels per spike, 100-kernel weight and grain yield per plant.

Gupta and Punetha (2007) studied twenty-three genetically diverse genotypes of soybean for genotypic and phenotypic variability, heritability and genetic advance in 12 quantitative traits: field emergence, days to initial flowering, days to 50% flowering, plant height, days to maturity, pods per plant, seeds per pod, 100-seed weight, seed yield per plot, seed vigor I and II, and viability. The pods per plant exhibited the highest amount of genetic variability, followed by the seed vigor-II, seed yield per plot, seed per pod, and 100-seed weight. The pods per plant also expressed the highest heritability and expected genetic advance.

MATERIALS AND METHODS

III. 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 wheat breeding program namely; pedigree method (PM), bulk method (BM) and single seed descent method (SSDM) on two bread wheat from (Wheat Research Program, Field Crops Research Institute, A.R.C. Egypt) chosen from wheat research program on the basis of their genetic diversity and performance under field conditions. Also, direct and indirect selection for increasing grain yield was carried out. Selection intensity was 10 % approximately was used with direct selection(grain yield per plant) while, with indirect selection was yield components in wheat, *i.e*, number of spikes per plant, number of grains per spike and 1000-kernel weight (g). The pedigree of the parents of the two wheat populations is given in (Table 1).

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

Population genotypes		Pedigree
First cross	P1	WEAVER/WL3926//SW893064
	P2	Desconocido #6/4/Bl 1133/3/Cmh 79A.955*2/ Cno 79//Cmh 79A.955/Bow's'
Second cross	P1	LFN/1158.57//PRL/3/HAHN/4/KAUZ/5/KAUZ
	P2	Sids 4

The objective of this study was to estimate the response to different methods of plant breeding *i.e.*, pedigree, bulk and single seed descent (SSD). Also, direct and indirect selection for increased grain yield was carried out. The selection intensity of 10 % approximately was used with direct selection and with indirect selection using yield component in wheat, *i.e.*, number of spikes/plant, number of grains/spike and 1000-grain weight.

In 2007/2008 growing season, two groups each consisted of 400 plants of F_2 populations were sown in the field in spaced 15 cm apart in one row 3 m long and 30cm between rows. The sowing date was: 15 November in the 1st season (F_3 generation 2007/2008), 18 November in the 2nd season (2008/2009), and 19 November in the 3rd season (2009/2010). Under all studied methods, each selected plant, the two parents and the checks cultivar (Sids 12 and Sids13) were represented by one row per plot. Other cultural practices were followed as recommended for wheat production in the area.

From each F_2 population two groups of random plants were taken, each group consisted of 400 plants. The first group of random plants was handled by taken single seed from each plant to produce (SSD), and then plants were harvested in mass to produce bulk population. The second group of random plants was threshed each plant separately and recorded the following characters, *i.e.*, number of spikes/plant, number of grains/spike, 1000-grain weight and grain yield/plant, the highest 10%

approximately of each character was determined. The highest plants of each yield components were used as indirect selection. While, high 10 % approximately of plants for grain yield were used as direct selection and pedigree method. In the F_3 generation 80 families from the first and the second crosses were grown in three replications in a randomized complete block design (RCBD).

Also, high selected plants for pedigree method, number of spikes/plant, number of grain/spike, 1000-grain weight and high grain yield/plant, were grown in 2007/2008. At maturity, selection between and within families was done and the highest yield/plant from each selected family was chosen as the procedure of pedigree method, and 40 plants in the first and second crosses were used for F_4 generation. Also, number of spikes/plant, number of grains/spike and 1000-grain weight were selected from each group to be grown in the F_4 generation.

The SSD population was obtained by composting a single seed taken from each plant. Also, a random sample of 100-grain was taken from all bulk population plants after threshing.

In 2008/2009 season, the number of F_4 families for pedigree method were grown in three replications in a RCBD for each cross, also, bulk and SSD. Also, the selected plants for each number of spikes/plant, number of grains/spike, 1000-grain weight and high grain yield/plant were chosen individually. At maturity 20 lines high yielding, number of spikes/plant, number of grains/spike and 1000-grain weight from each population were selected and evaluated in F_5. Also, high selected plants (20 lines) from each pedigree, SSD, and bulk methods were chosen for evaluation in the next generation (F_5).

In 2009/1010 season, the high yielding selected lines (20) from each method of breeding (three methods *i.e.* pedigree, bulk and SSD) were evaluated in nested design. Also, the high selected lines (20) for direct (grain yield/plant) and indirect selection i.e. number of spikes/plant, number of grains/spike and 1000-grain weight for high yielding, and the two parents were evaluated in nested design in each cross.

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- Days to maturity: was measured as number of days from sowing date to two cm from peduncle leaf became yellow.

2- Number of spikes per plant: was determined by counting the number of spikes per plant.

3- Number of grains/spike: average number of grains per spike (Main spike) counted manually.

4- 1000- grains weight: the weight of 1000-grains from the bulk of the guarded plants in grams.

5- Grain yield/plant: average grain weight of individual guarded plants, in grams.

The heritability in broad-sense, the predicted genetic advance under selection (Δg) and genetic coefficient of variation (G.C.V %) were computed according to **Johanson *et al.* (1955)**. Also, the expected gain represented as a percentage (Δg %) was estimated according to **Merril *et al.* (1958)**.

The form of the analysis of variance used in driving components of variance for estimating heritability of the fine studied traits as mentioned by **Johanson *et al.* (1955),** and is shown in the following table.

Form of variance analysis and mean square expectation:

Source of variance	**df**	**E.M.Square**
Replications	**r-1**	**---**
Families	**F-1**	$\sigma^2 e + r\, \sigma^2 F$
Error	**(r-1)(F-1)**	$\sigma^2 e$

Where: F = number of families.

r = number of replications.

The following variance components were estimated:

σ^2F = the genetic variance *i.e.*, the family component due to genetic differences among family within each of the population (Vg in this study).

σ^2e = plot error variance *i.e.*, environmental variance.

Estimates of the various variance components were substituted in the formula given below to obtain estimates of heritability, genetic coefficient of variation and expected gain (**Merril *et al.* 1958**).

Heritability (h^2) of differences among families means and single plots.

$$\textbf{Family plot basis} = \frac{\sigma^2 F}{\sigma^2 e + \sigma^2 F} \times 100$$

The genetic coefficient of variation (G.C.V) as used by **Johanson *et al.* (1955).**

$$(\text{G.C.V. \%}) = \sigma g / \bar{x} . 100.$$

Where: σ F is the genetic standard deviation and x is the population mean. The genetic advance under selection (Δg) was estimated according to **Merril *et al.* (1958)**, as followed:

$$\Delta g = k \sqrt{\sigma^2} ph . \frac{\sigma^2 F}{\sigma^2 ph}$$

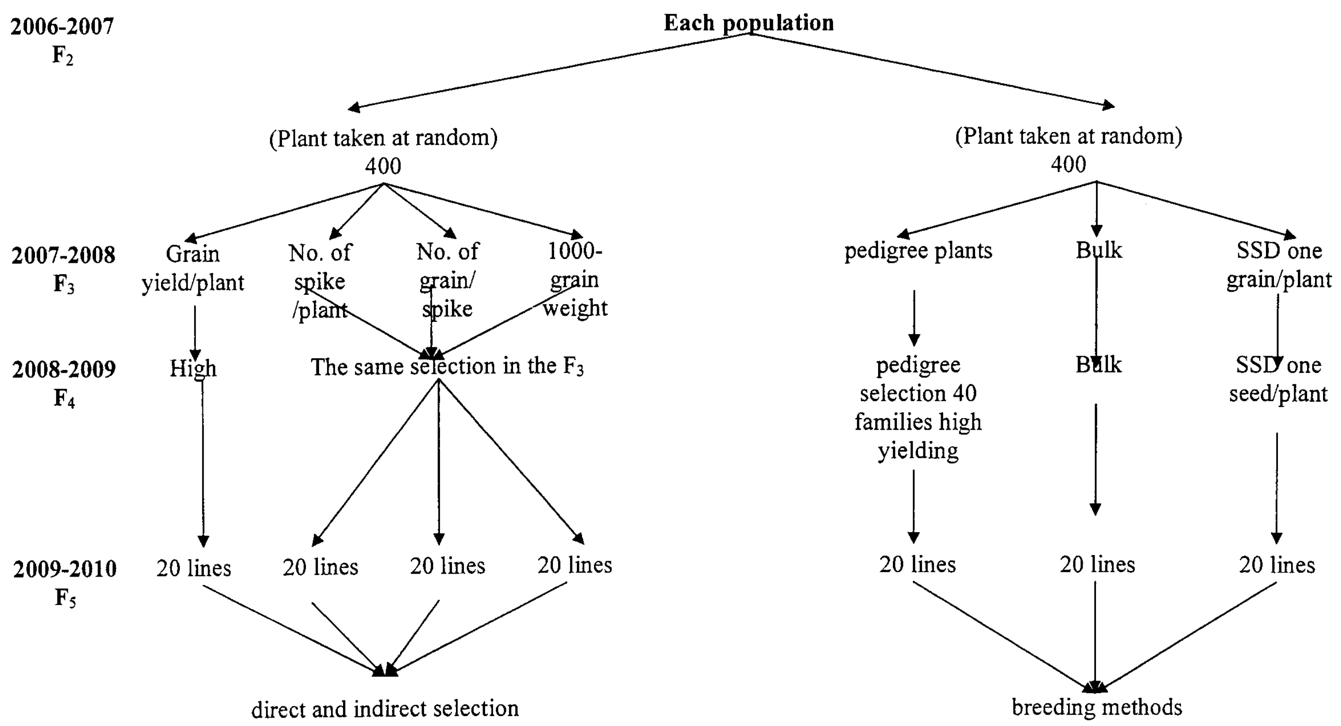
Where: σ^2 ph is the phenotypic variance among family means (σ^2 e + r σ^2F).

$\frac{\sigma^2 F}{\sigma^2 ph}$ is the heritability value in broad- sense,

k: is the selection differential expressed in phenotypic standard deviations. For the purpose of this study, k was given the value 2.06, which is expectation in the case of five percent selection in large samples.

The pattern of generation advance for pedigree, single seed descent (SSD) and bulk breeding methods, direct and indirect selection is presented in Fig (1) for each population.

Fig. (1): Out line of generation advance for pedigree, bulk and SSD breeding methods as well as direct and indirect selection for each population.



RESULTS AND DISCUSSION

IV. RESULTS AND DISCUSSION

4.1. First cross:

4.1.1. F_3 generation:

The mean squares associated with F_3 families were found to be high significant for all studied traits (Table 2).

The mean performance of F_3 families and their parents for the five traits are presented in Table (3).

For maturity date, the families' number 8 and 28 showed significant values for earliness than the early parent.

On the other hand, the families' number 41, 52, 74, 78 and 79 significantly surpassed the better parent for number of spikes/plant. While, the other families showed lower spikes/plant relative to better parent (Parent 1). Also, the families' number 2, 9, 10, 19, 24, 27, 54 and 70 exhibited significant higher grains/spike than the better parent, while, 1000-grains weight, families number 20 and 62 surpassed significantly the heavier parent. With respect to grain yield/plant the family's number 20 and 52 significantly out yielded the better parent (parent 1).

Table (2): Mean squares of the F_3 families for the five studied traits in the first cross.

Source of variation	Degrees of freedom	Days to maturity	No. grain / plant	No. of grain / spike	1000 Grain weight	Grain yield/plant (g)
Replicates	2	87.158**	3.297	22.695	101.151*	31.068
Lines	81	38.156**	56.447**	594.080**	98.774**	259.640**
Erorr	162	6.463	3.308	59.18	27.37	64.883

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

Table (3): Mean performances of the selected F_3 families, their parents and genetic parameters (heritability, genetic coefficient. of variation and genetic gain) in the first cross.

F3 families	Days to maturity (days)	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
1	149.67	9.41	63.67	50.77	18.92
2	151.33	12.40	103.33	43.49	33.93
3	150.33	10.04	66.00	32.90	18.63
4	146.00	6.11	72.33	48.53	17.02
5	149.33	8.31	72.00	44.15	29.25
6	150.33	17.67	50.67	42.77	42.35
7	152.33	13.94	55.00	41.03	31.47
8	136.00	6.67	54.67	37.51	13.30
9	145.00	7.16	82.67	44.91	18.34
10	147.00	7.43	87.00	48.34	20.29
11	145.33	8.68	61.33	56.01	20.55
12	145.00	10.00	65.33	48.69	18.85
13	149.33	8.10	61.33	48.68	13.25
14	148.33	4.64	50.00	56.43	16.73
15	145.00	4.46	65.33	44.65	19.55
16	145.33	5.83	61.33	42.93	9.59
17	145.67	14.86	64.67	48.22	36.73
18	148.00	8.15	68.00	50.37	30.56
19	149.33	11.29	101.33	42.45	35.92
20	151.00	10.45	78.00	57.22	53.02
21	150.33	13.92	54.00	43.73	18.83
22	146.67	7.46	60.67	39.42	18.07
23	149.67	7.26	63.33	34.57	14.69
24	148.67	6.19	87.67	45.45	18.79
25	145.33	8.74	64.67	38.55	32.10
26	143.00	7.00	59.00	45.95	15.90
27	148.33	13.00	85.33	47.09	33.19
28	135.33	4.39	54.33	46.27	12.05
29	147.00	12.33	74.00	39.09	19.54
30	145.33	9.33	49.33	37.77	16.57
31	145.00	7.00	47.67	33.69	13.96
32	144.33	7.19	60.67	46.56	26.02
33	142.67	7.68	49.00	40.16	12.71
34	150.00	11.65	44.33	44.33	28.07
35	148.33	13.33	67.67	47.90	23.85
36	155.00	15.97	70.00	51.41	27.66
37	153.67	13.67	45.33	45.10	21.96
38	141.33	8.67	59.00	43.67	27.34
39	147.33	18.33	71.00	43.78	17.81
40	149.00	18.25	79.33	49.08	18.22
41	149.00	19.00	59.67	54.66	43.15
42	149.00	14.88	45.33	49.20	34.61
43	152.00	11.64	51.00	44.25	22.14
44	151.33	10.54	45.67	51.18	24.53

Table (3): continued

F3 families	Days to maturity (days)	N. of spike/plant	N. of grain/spike	1000- grain weight (g)	Grain yield/plant (g)
45	151.33	10.68	44.67	45.29	19.38
46	148.00	7.50	43.67	51.85	9.80
47	149.00	16.33	40.33	51.71	17.87
48	149.00	16.88	49.00	51.88	27.98
49	146.00	7.79	61.67	41.11	19.73
50	145.67	15.13	60.33	50.50	22.74
51	148.33	8.91	66.33	51.62	26.41
52	153.67	21.79	50.33	52.75	54.49
53	152.00	16.00	65.00	55.44	31.06
54	147.67	13.00	84.33	48.48	29.41
55	147.67	9.42	57.67	40.91	25.26
56	148.33	13.48	57.33	43.73	28.07
57	152.67	8.07	60.33	49.82	20.81
58	149.67	16.91	57.00	49.08	28.33
59	151.00	9.04	62.00	49.63	38.86
60	151.67	11.95	58.33	49.81	22.75
61	151.00	12.51	53.00	47.82	24.41
62	150.33	11.51	68.67	62.68	42.68
63	149.33	13.38	57.00	55.79	38.00
64	150.00	16.67	66.33	49.88	23.50
65	150.67	17.33	43.33	55.88	21.67
66	147.67	9.71	62.00	52.22	29.77
67	147.67	5.67	52.00	54.67	22.86
68	148.67	16.24	37.33	43.50	34.00
69	150.33	12.07	46.00	56.18	26.86
70	149.00	9.08	107.67	53.45	27.53
71	148.67	13.33	65.33	49.64	29.91
72	142.67	13.11	59.33	46.59	23.30
73	144.00	14.00	68.33	40.48	23.31
74	151.00	20.33	52.67	40.46	37.78
75	149.33	15.39	50.33	46.94	24.78
76	151.33	14.10	50.00	48.47	27.45
77	147.33	9.00	42.67	50.38	9.38
78	149.67	21.88	38.00	50.17	41.91
79	151.33	21.62	65.67	39.83	33.61
80	144.00	17.39	62.33	46.76	26.33
Parent 1	144.67	16.00	66.67	45.18	34.87
Parent 2	138.33	13.33	70.00	48.56	34.14
Over mean	148.00	11.82	61.40	47.07	25.62
LSD 0.05	4.15	2.97	12.56	8.54	13.15
LSD 0.01	5.52	3.95	16.71	11.36	17.49
h^2	62.043	84.263	75.080	46.513	50.014
Δg	5.274	7.959	23.834	6.854	11.738
G.C.V	7.14	149.80	290.38	50.56	253.37
Δg%	3.563	67.307	38.816	14.554	45.811

The genetic coefficient of variation (G.C.V %), ΔG, ΔG% and heritability in broad-sense are presented in Table (3). High to moderate estimates of heritability in broad-sense in the F_3 families were detected for all studied traits which ranged from 46.513 to 84.263. The same results had been reported by **Wells** and **Kofoid (1986)** for coefficient of variation for grain yield/plant, kernel weight and number of grains/spike in wheat; **Masood** and **Chaudhary (1987)** and **Ehdaie** and **Waines(1989)** for high heritability for number of spikes/plant, number of grains /spike, 1000-grain weight and grain yield/plant

Genetic gain was rather higher for number of spikes/plant, number of grains/spike and grain yield/plant. However, low to moderate genetic gain from selection was obtained for maturity date and 1000-grain weight (g), respectively. Also, high G.C.V%. was detected for number of spikes/plant, grain yield/plant and number of grains/spike. However, low to moderate G.C.V. was obtained for other traits.

The same results had been reported by **Amin *et al.* (1992);** they found that the genotypic coefficient of variation (G.C.V.%) was highest for grain yield/plant followed by number of kernels/spike.

4.1.2. F_4 generation:

The mean squares due to F_4 selected families were found to be high significant for all studied traits (Table 4), indicating that the forty F_4 selected families behaved some what differently from each to other.

The mean performance of 40 F_4 families as well as the two parents' for the five traits is presented in Table (5).

For maturity date, the range of the selected families ranged from 135.67 to 154.67 with an average of 146.60 days. The two families' number 31 and 37 had earlier compared with early parent.

As for number of spikes/plant, the range of selected families varied from 5 to 21spikes. With the exception of selected families number 11, 12, 15, 28, 33, 39 and 40 none of the selected families' significant superiority than the best parent. The families' number 28 and 33 gave the highest number of spikes/plant. However, the family number 31 gave the lowest one. Concerning number of grains/spike, the range of selected families varied from 46.67(family number 23) to 103 (family number 31). With the exception of families number 2, 9, 14, 15, 27, 29, 30, 31, 32 and 36, all selected families had not significant superiority than the best parent.

Regarding 1000-grain weight with the exception of families' number 2, 16, 25, 28 and 34 none of the selected families surpassed significantly the best parent. The mean values of selected families ranged from 33.19 (family number 6) to 64.58 (family number 34).With regard to grain yield/plant 2 selected families surpassed significant than the best parent. The range of selected families varied from 13.27 (family number 33) to 54.25 (family number 2). The best families were number 2, and 16.

The estimates of genetic components of variation (G.C.V %), genetic gain (ΔG), genetic gain % (ΔG %) and heritability in broad-sense are presented in Table (5).

Table (4): Mean squares of the F_4 families for the five studied traits in the first cross.

Source of variation	Degrees of freedom	Days to maturity	No. spikes / plant	No. of grains / spike	1000 Grain weight	Grain yield/plant(g)
Replicates	2	40.5**	7.214**	75.007**	35.417**	21.693*
Lines	41	64.057**	42.256**	758.553**	135.99**	233.752**
Erorr	82	5.231	1.178	6.552	5.017	5.907

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

Table (5): Mean performance of the selected F_4 families, their parents, heritability genetic coefficient of variation and genetic gain in the first cross.

F4 families	Days to maturity (days)	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
1	144.67	12.33	75.00	42.29	21.94
2	150.67	10.83	80.33	56.10	54.25
3	150.00	11.83	52.33	41.81	26.81
4	146.33	14.33	65.33	40.65	19.29
5	149.67	10.33	74.33	43.77	35.16
6	148.67	9.50	68.33	33.19	21.96
7	148.00	10.00	63.33	51.03	23.34
8	144.67	11.67	60.33	48.69	22.44
9	146.33	10.50	81.67	47.42	20.47
10	149.00	9.89	74.33	41.24	30.47
11	153.00	18.50	56.33	41.36	38.41
12	152.00	19.00	54.33	38.65	32.70
13	149.33	13.00	55.33	42.11	17.08
14	144.33	8.00	85.00	42.15	23.00
15	153.00	17.00	99.33	41.11	23.56
16	145.00	9.53	63.67	61.87	44.36
17	144.67	10.00	67.67	45.39	17.94
18	148.00	13.33	53.67	43.63	21.24
19	145.00	9.00	65.67	38.04	13.43
20	139.00	6.52	47.67	43.76	17.09

Table (5): continued

F4 families	Days to maturity (days)	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
21	145.67	12.50	94.67	33.87	20.77
22	149.33	9.00	51.67	41.20	20.17
23	151.00	11.47	46.67	41.28	29.30
24	148.33	12.50	70.00	42.72	34.57
25	145.33	14.00	76.67	56.36	37.96
26	147.67	9.30	62.33	43.21	31.78
27	152.33	11.93	93.33	42.62	37.15
28	150.33	20.33	49.00	60.80	15.92
29	148.00	12.00	91.33	44.34	20.01
30	143.00	10.00	100.33	34.92	33.33
31	136.00	5.00	103.00	45.84	19.94
32	148.00	10.33	87.67	44.18	34.42
33	154.67	21.00	54.33	42.71	13.27
34	144.67	9.00	56.33	64.58	17.78
35	143.33	9.17	57.33	45.78	29.80
36	137.67	6.50	97.67	44.94	28.89
37	135.67	10.00	53.33	44.14	24.16
38	143.33	9.17	65.00	45.74	28.56
39	147.67	17.00	67.33	43.91	23.85
40	151.67	19.04	70.33	43.41	34.50
Parent 1	145.33	14.33	68.33	45.88	36.22
Parent 2	136.67	12.33	71.00	49.83	33.45
Over mean	146.60	11.93	69.80	44.92	26.92
LSD 0.05	3.697	1.755	4.138	3.621	3.929
LSD 0.01	4.887	2.319	5.469	4.786	5.193
h^2	78.938	92.078	97.453	89.693	92.784
Δg	8.104	7.315	32.197	12.891	17.293
G.C.V	13.376	114.784	359.114	97.197	282.102
Δg%	5.528	61.316	46.126	28.699	64.231

High heritability values were detected for all characters, indicating the effectiveness of selection in this material for these traits. The values of expected gain (ΔG) reported in table (5) show the possible gain from selection as percent increase in the F_5 over the F_4 are selected.

Genetic gain was rather higher for number of grains/spike and grain yield/plant. However, low to moderate genetic gain from selection was obtained for maturity date and 1000-grain weight (g), respectively.

These results are in general agreement with those obtained by **Ehdaie** and **Waines (1989)** who found that, moderate genetic variation was displayed by the number of spikes/plant, number of grains/spike and 1000-grain weight.

Table (5) shows high genetic coefficient of variation (G.C.V) for number of spikes/plant, number of grains/spike and grain yield/plant, moderate G.C.V for 1000-grain weight and low G.C.V value for maturity date, were detected.

Amin *et al.* (1992), found that, significant differences among genotypes for all the characters studied. The genotypic coefficient of variation (G.C.V.%) was highest for grain yield/plant followed by number of kernels/spike. High heritability and appreciable genetic advance for grain yield/plant were detecting, predominance of an additive gene effect in controlling of these traits.

In the present work number of grains/spike and grain yield/plant high genetic gain was found to be associated with rather high heritability and G.C.V. estimate.

Therefore, selection for the two traits should be effective and satisfactory for successful breeding purposes. High heritability values and moderate G.C.V. estimate associated with high gain from selection was obtained for number of spikes/plant. Hence it could be concluded that selection for this trait will be effective but probably of less success than in the former two traits.

4.1.3. F_5 generation:

4.1.3.1. Comparison between three breeding methods:

The mean squares for breeding methods were significant for maturity date, yield and its components (Table 6). These results indicated the differences between breeding methods.

The bulk method gave the best value for maturity date and grain yield/plant. While the single seed descent (SSD) method exhibited significant 1000- grain weight. While, pedigree method gave the highest value for number of spikes/plant and number of grains/spike (Table 7). It could be concluded that bulk method considered the best breeding method for grain yield/plant and maturity date and the second for number of spikes/plant, than those pedigree and SSD in this cross.

This result attributed to working on self pollinated crops, breeders applied one or more different breeding methods efficiency in selecting high grain yield. Among those **Salmeron** and **Kronstad (1986), Shalaby *et al.* (2001), Arunachalam *et al.* (2002) and Shoba-Immadi *et al.* (2004)** on wheat, Cowpea, soybean and faba bean using two or more methods of breeding. On the other hand **Pawar *et al.* (1989)** found that single plant

Table (6): Mean squares of the breeding methods for the five studied traits in the first cross.

Source of variation	Degrees of freedom	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
Replications	2	1.950	16.331**	88.763**	4.954	18.743
Lines	59	128.727**	43.376**	427.310**	52.702**	530.620**
Methods	2	64.267**	14.955*	68.021*	99.976**	1111.210**
Lines/Methods	57	130.988**	44.373**	439.916**	51.044**	510.249**
Error	118	1.317	3.328	17.215	1.857	14.489

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

Table (7): Mean performance of the breeding methods of the F_5 lines for the five studied traits in the first cross.

Breeding methodology	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
Pedigree	143.700	20.087	72.527	47.431	61.041
Bulk	142.767	19.608	70.405	49.282	63.121
Single seed descent	144.833	19.088	71.311	49.915	54.848
LSD 5%	0.415	0.660	1.500	0.493	1.376
LSD 1%	0.548	0.872	1.982	0.651	1.819

selection and single seed descent were almost equally effective and both were superior than bulk selection.

Whan *et al.* (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 five traits 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 bulk method produced consistently more superior lines for grain yield compared to the best parent or the average population or Sids 13. The best lines were number 18 (95.378g), number 12 (94.350g), number 5 (82.418g) and number 2 (78.494g) in bulk method and number 13 (80.853g) in pedigree method. But single seed descent only number 15 (80.903g) produced consistently more superior lines compared to the best parent or the average population.

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 or average over lines with one line for each method.

Table (8): Mean squares of the breeding methods and both parents for the five studied traits in the first cross.

source of variation	Degrees of freedom	Days to maturity	No. spikes / plant	No. of grains/ spike	1000 G.W.	Grain yield/plant
Replicates	2	2.185	17.685**	88.435**	4.353	20.426
Lines	63	130.483**	42.389**	404.072**	51.228**	506.362**
Error	126	1.259	3.252	16.752	1.771	14.139

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

Table (9): Mean performance of the selected lines of breeding methods and two parents and tow check varieties in the first cross population.

Breeding methods	No. of lines	Days to maturity	No. of spikes/plant	No. of grains/spike	1000-grain weight	Grain yield/plant (g)
Pedigree	1	140.667	24.332	80.221	49.997	71.906
	2	135.333	15.112	57.443	47.995	59.050
	3	141.000	19.332	72.777	43.722	57.867
	4	148.667	14.111	65.443	51.486	59.504
	5	131.667	23.002	72.553	42.772	65.230
	6	151.333	20.111	78.999	39.704	49.283
	7	130.667	21.862	63.222	44.331	60.511
	8	134.000	17.668	57.111	50.756	60.483
	9	153.000	21.484	55.000	45.806	47.433
	10	150.333	22.666	64.332	40.510	45.160
	11	141.333	29.610	71.777	51.302	75.139
	12	144.667	19.889	83.778	47.027	70.751
	13	140.667	21.331	65.556	53.293	80.853
	14	151.333	20.444	63.554	52.192	52.889
	15	141.333	18.444	77.778	52.027	48.427
	16	144.000	18.111	68.444	45.622	73.661
	17	147.667	23.777	78.332	42.332	56.900
	18	147.333	18.334	80.777	47.999	63.993
	19	149.000	12.333	116.889	53.271	49.950
	20	150.000	19.778	76.556	46.474	71.830
Bulk	1	135.333	23.222	84.333	40.450	61.643
	2	141.000	22.333	78.110	44.846	78.494
	3	148.667	21.269	46.779	52.069	65.373
	4	135.333	20.000	67.666	48.404	75.800
	5	149.000	17.667	72.222	53.883	82.418
	6	136.333	15.889	65.888	51.110	46.810
	7	135.333	13.444	83.778	50.438	33.659
	8	149.000	19.777	80.777	42.086	55.572
	9	151.333	18.778	87.333	54.365	61.233
	10	141.333	15.777	86.223	44.686	59.850
	11	144.000	15.444	61.667	52.252	50.700
	12	148.667	24.333	65.556	57.312	94.350
	13	146.333	19.556	59.110	47.908	64.461
	14	141.000	11.777	81.554	45.899	50.211
	15	148.667	18.111	66.554	48.681	57.670
	16	131.667	22.444	45.222	52.277	47.866
	17	151.333	27.667	71.778	45.922	53.791
	18	138.000	18.889	71.999	49.267	95.378
	19	137.667	20.110	72.443	55.196	60.389
	20	145.333	25.667	59.111	48.590	66.743

Table (9): continued

Breeding methods	No. of lines	Days to maturity	No. of spikes/plant	No. of grains/spike	1000-grain weight	Grain yield/plant (g)
Single	1	141.000	23.999	68.779	54.849	72.617
	2	148.667	16.554	68.887	50.176	47.156
	3	131.667	22.889	65.002	49.543	52.033
	4	141.000	18.778	65.777	47.240	41.644
	5	148.667	18.779	82.890	47.324	52.418
	6	148.667	20.333	64.332	48.838	37.122
	7	131.667	17.667	76.333	46.704	62.694
	8	151.333	18.001	66.443	49.294	41.110
	9	134.000	19.666	67.443	44.843	57.194
	10	153.000	21.109	63.890	58.295	73.432
	11	153.000	16.888	87.888	52.358	56.037
	12	150.333	16.333	91.331	48.952	48.290
	13	141.333	27.554	76.889	50.554	45.982
	14	140.667	14.778	83.443	45.427	45.216
	15	149.000	23.554	66.334	46.370	80.903
	16	151.333	14.889	61.889	53.381	55.179
	17	141.333	22.778	88.333	46.800	71.516
	18	144.000	15.443	63.999	56.230	39.212
	19	148.667	13.443	63.223	50.485	61.478
	20	147.333	18.333	53.113	50.633	55.722
Parent 1		137.670	22.300	74.780	49.960	63.370
Parent 2		134.780	23.820	68.550	47.970	66.030
Over mean		143.523	19.706	71.423	48.879	59.832
Sids 12		134.780	18.220	73.960	46.460	60.860
Sids 13		139.000	22.960	63.920	43.180	71.970
LSD 5%		1.855	2.949	6.708	2.203	6.154
LSD 1%		2.452	3.898	8.866	2.912	8.134

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

Regarding to 1000-grain weight, five, six and three lines showed, significant higher than the best parent for SSD, bulk and pedigree methods, respectively. However, the heavier line was number 10 (58.295g) in1000-grain weight (g) than grand mean in single seed descent methods.

4.1.3.2. Direct and indirect selection:

Selection for yield and yield components deserves considerable interest. A crop breeding program aimed to increasing plant productivity requires consideration interest not only of yield but also of its components which have a direct and indirect bearing on yield. The present part was under taken to compare the efficiency of indirect selection for yield via yield components with direct selection for grain yield/plant.

Mean squares due to four selection criteria i.e. number of spikes/plant, 1000-grain weight and number of grains/spike (indirect selection), and high yield/plant (direct selection) were high significant (Table 10). For the five traits under study.

Generally, the selection of high number of grains/spike, gave the highest grain yield/plant, but without superiority of grain yield per plant and number of spikes/plant, followed by 1000-grain weight (Table 11).

Table (10): Mean squares for lines, four selection criteria and lines/selection criteria in the first cross.

Source of variation	Degrees of freedom	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
Replications	2	7.554**	82.077**	27.154	0.336	14.001
Lines	79	122.760**	33.968**	284.003**	163.976**	329.682**
Methods	3	86.089**	38.004**	389.019**	1217.838**	806.938**
Lines/Methods	76	124.208**	33.809**	279.858**	122.376**	310.842**
Error	158	0.921	3.858	20.086	2.566	18.131

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

Table (11): Mean values of the four selection criteria in the first cross.

Selection criteria	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
No. of spikes/plant	143.983	23.544	67.572	48.501	56.243
No. of grains/spike	142.050	21.689	65.249	49.475	57.053
1000- grain weight (g)	142.350	22.750	62.638	57.934	49.468
Grain yield/plant (g)	144.483	23.133	68.266	48.901	57.000
LSD 5%	0.347	0.710	1.620	0.579	1.539
LSD 1%	0.459	0.938	2.141	0.765	2.034

In 1999, Dokuyucu and A. Akkaya suggested that improvement of complex characters like yield may be accomplished through component breeding subsequently, many workers (Johanson et al. 1983; Sharma et al. 1995) suggested that selection for component traits can help to increase productivity. The present investigation expressed that the selection for high number of grains/spike was more efficiency as indirect selection for yield gave the best one.

With respect to the effect of selection criteria on 1000-grain weight, the results revealed that selection for 1000-grain weight gave significant heavier grain index followed by selection high number of grains/spike. However, selection of high number of spikes per plant gave the lowest one (Table 11).

Also, the selection criteria on number of spikes/plant, the results revealed that selection for number of spikes/plant and grain yield/plant gave significant higher values for this trait number followed by selection high criteria of 1000-grain weight. However, selection of high number of grains/spike gave the lowest one (Table 11).

For the selection criteria on number of grains/spike, the selection of high grain yield per plant gave significant highest value of number of grains/spike. However, the selection of number of spikes/plant gave the second of number of grains/spike. However, the selection criteria on number of grains/spike gave the third of number of grains/spike, but it was the first in grain yield/plant and earliest in maturity date.

Concerning grain yield/plant, the selection method of high number of grains/spike exhibited significantly higher value of this trait, followed by high number of spikes/plant and heavier grain index were detected revealing that the selection criteria differed among them (Table 11).

The results indicated that selection for number of grain per spike, number of spikes/plant and 1000-grain weights were more efficient in breeding forward superior yielding F5 lines.

It could be concluded that selection for number of grains/spike, for (indirect selection) three successive generations was successful in improving the mean grain yield in the F5 lines.

The mean values of selected F5 lines for maturity date, number of spikes/plant, 1000-grain weight, number of grains/spike and grain yield/plant were affected by selection criteria indirect selection i.e. (high number of grains/spike, heavier grain index and high number of spikes/plant) and direct selection (high grain yield/plant) are presented in Table (12).

For days to maturity two, one, two and zero lines in the F5 generation had significantly the earliest than the best parent for selected when selected was based on number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively.

This result is logically expected. The best lines were number 7 and 18 when selected with number of spikes/plant. However, number 13 when selected with number of grains/spike and number 5 and 7 when selected with 1000- grain weight.

For number of spikes/plant, two, three, four and four lines were significantly higher than the best parent with number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively (table 12). This result is logically expected. The best lines were number 17 when selected with number of spikes/plant. However, number 17 when selected with number of grains/spike also, number 4 when selected with 1000-grain weight and number 9 when selected with grain yield/plant.

For number of grains/spike, one, two, two and three lines were significantly higher than the best cultivar Sids 12 when selected with number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively.

This result is logically expected. The best lines were number 11 when selected with number of spikes/plant. However, number 6 when selected with number of grains/spike also, number 1 when selected with 1000- grain weight and number 6 when selected with grain yield/plant.

Table (12): Mean performance of the F_5 selected lines from direct and indirect selection two parents and check variety in the first cross for the studied characters.

Selection criteria	# of line	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
No. of spikes/plant	1	134.333	16.667	68.332	42.419	47.961
	2	149.333	23.556	62.668	47.782	58.186
	3	150.667	22.333	78.667	46.809	60.336
	4	146.000	22.999	51.664	41.440	58.033
	5	139.667	21.110	57.999	51.756	58.783
	6	151.000	27.110	63.111	52.530	68.087
	7	131.333	21.777	64.333	45.267	65.243
	8	150.000	24.777	62.557	49.552	56.983
	9	139.667	27.000	72.332	51.039	42.056
	10	150.333	22.221	77.443	47.339	66.013
	11	140.667	24.444	83.443	51.301	29.932
	12	148.333	27.000	75.333	39.011	48.283
	13	138.333	21.111	79.554	49.234	52.917
	14	150.667	22.999	55.443	53.321	68.677
	15	146.000	25.000	71.110	47.516	59.193
	16	135.000	24.556	67.777	49.366	42.994
	17	148.000	29.667	55.443	49.397	70.767
	18	132.667	22.222	62.111	55.994	41.113
	19	149.000	21.888	67.000	47.944	60.122
	20	148.667	22.443	75.111	51.003	69.189
No. of grains/spike	1	134.333	21.668	64.998	54.592	73.494
	2	134.333	26.778	49.553	40.508	65.096
	3	150.667	19.111	74.000	41.457	38.089
	4	136.000	16.666	70.110	47.103	58.386
	5	152.333	26.332	75.556	46.231	63.987
	6	136.667	21.333	91.111	46.441	58.078
	7	138.000	21.998	67.443	50.833	80.999
	8	142.000	20.109	72.997	54.748	50.153
	9	138.000	23.112	80.779	43.389	63.307
	10	140.000	21.889	55.222	49.164	71.790
	11	145.000	23.444	74.999	47.611	68.881
	12	139.000	20.777	72.331	49.456	59.198
	13	133.667	21.667	55.778	48.790	46.706
	14	148.333	19.444	53.109	42.039	55.346
	15	134.333	21.887	52.110	48.241	44.624
	16	150.000	20.000	53.776	45.963	34.511
	17	149.667	27.222	66.666	45.420	50.111
	18	140.667	20.890	48.221	52.810	45.852
	19	150.667	20.556	63.443	78.567	54.097
	20	147.333	18.889	62.777	56.128	58.358
Parent 1		143.33	20.06	62.81	47.27	54.53
Parent 2		134.92	21.06	67.56	50.34	61.39
Over mean		143.12	22.72	65.91	51.14	55.01
Sids 12		135.42	14.58	72.92	47.88	61.54
Sids 13		139.92	16.28	67.61	41.88	64.52
LSD 5%		1.552	3.175	7.245	2.590	6.884
LSD 1%		2.051	4.197	9.576	3.423	9.098

Table (12): continued

Selection criteria	# of line	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
1000- grain weight (g)	1	140.000	18.443	84.556	51.448	45.090
	2	136.000	22.111	53.778	55.170	43.774
	3	140.000	22.888	57.332	50.903	57.411
	4	148.000	28.221	66.443	61.149	64.568
	5	132.667	18.553	57.443	65.550	50.914
	6	151.000	24.556	53.999	60.090	60.377
	7	131.333	20.332	63.000	61.731	48.950
	8	134.000	24.889	53.553	51.794	57.390
	9	136.667	18.668	63.890	53.903	33.218
	10	150.333	19.778	67.778	51.317	36.191
	11	140.667	27.554	59.443	53.363	61.262
	12	148.333	22.332	66.333	63.010	37.460
	13	140.667	19.668	58.111	61.387	58.884
	14	151.333	26.002	53.110	50.272	43.931
	15	138.000	27.444	52.332	55.320	55.092
	16	135.000	19.223	63.332	61.295	45.382
	17	147.667	24.890	63.667	54.810	54.493
	18	147.333	21.336	83.889	62.030	37.114
	19	149.000	23.333	68.111	69.036	40.897
	20	149.000	24.777	62.666	65.103	56.963
Grain yield/plant (g)	1	141.333	16.999	67.442	44.899	52.167
	2	136.000	24.113	70.667	44.013	53.879
	3	141.000	24.666	65.667	43.434	63.330
	4	149.333	24.110	72.668	50.100	69.747
	5	136.000	23.109	65.110	49.652	63.867
	6	152.333	17.557	89.888	46.797	47.330
	7	136.667	23.443	68.443	62.030	68.740
	8	138.000	21.109	85.556	52.682	60.353
	9	153.000	35.556	61.223	45.340	55.906
	10	149.667	19.444	68.777	42.266	51.329
	11	141.333	29.999	64.666	44.449	62.488
	12	144.333	22.222	65.334	66.290	71.036
	13	141.000	28.333	64.443	41.807	55.653
	14	150.000	23.333	71.443	42.939	55.250
	15	141.333	26.221	82.889	52.649	55.754
	16	144.667	19.222	65.777	44.383	58.370
	17	147.333	19.221	62.999	44.603	48.749
	18	148.000	21.110	55.998	59.408	48.133
	19	149.333	22.889	55.888	52.096	46.782
	20	149.000	19.999	60.443	48.188	51.130
Parent 1		143.33	20.06	62.81	47.27	54.53
Parent 2		134.92	21.06	67.56	50.34	61.39
Over mean		143.12	22.72	65.91	51.14	55.01
Sids 12		135.42	14.58	72.92	47.88	61.54
Sids 13		139.92	16.28	67.61	41.88	64.52
LSD 5%		1.552	3.175	7.245	2.590	6.884
LSD 1%		2.051	4.197	9.576	3.423	9.098

For grain index, one, four, fourteen and three lines were significantly heavier than the best grand mean for selection high number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively. The best lines were number 18, 19, 19 and 12 when selected with number of spikes per plant, number of grains/spike and 1000- grain weight grain yield/plant, respectively. Regarding grain yield/plant the range of selected lines ranged from 29.932g to 70.767g; 34.511g to 80.999g; 33.218g to 64.569g and 46.782g to 71.036g when selection plants with number of spikes/ plant, number of grains/spike, 1000- grain weight and heavier grain yield/plant, respectively. Also, zero, two, zero and zero lines significantly surpassed higher grain yield/plant than the best cultivar Sids 13, in the same order.

In addition, the best lines were number 6, 10, 14, 17 and 20 when selecting plants with high number of spikes/plant, number 1, 2, 7, 10 and 11 when selected for number of grains/spike, number 4 when selected for 1000- grain weight and number 4, 5, 7 and 12 for selection grain yield/plant.It could be concluded that indirect selection for yield via number of grains per spike is more efficient than direct selection for yield.

The comparison of selection criteria revealed the efficiency of selecting for number of grains/spike and high grain yield/plant and then by number of spikes/plant and heavier grain index, in improving mean yield of F5 lines in this cross and also extracting a higher number of high yielding lines (selection for high number of grains/spike, number of spikes/plant and heavier grain index). It, also, appeared that indirect selection for yield via number of grains/spike was more efficient than direct effects of selection for yield.

4.2. Second cross:

4.2.1. F_3 generation:

The results indicated that F_3 families' mean squares were highly significant for all the five studied traits indicating wide differences between the F_3 families' (Table 13).

Mean performance of F_3 families as well as two parents' for the five traits under study are presented in Table (14).

For maturity date, there are not families from 80 families of F_3 showed earlier than the early patent P2 (Sids 4). While, the families' number 1, 14, 18, 34, 66, 71, 74 and 76 significantly surpassed the better parent for number of spikes/plant. On the other hand, the families' number 10, 24, 27, 29, 31, 32, 33, 35, 36, 37, 38, 39, 42, 44, 47, 53, 54, 59, 60, 61, 62, 66 and 67 exhibited significant higher number of grains/spike than the better parent. Regarding 1000-grain weight, the families' number 2, 9, 10, 16, 28, 35, 48 and 58 surpassed significantly the heavier parent. With respect to grain yield/plant all F_3 families none surpassed significantly higher than the best parent, except families' number 18, 32, 33 and 66 These results indicated the importance of selection in this material for these traits. The family number 66 gave the highest grain yield/plant followed by number 33 and 18.The genetic components of variation (Table 14) showed the high estimate of ΔG and $\Delta G\%$ values and G.C.V. for number of spikes/plant, number of grains/spike and grain yield/plant. However, moderate values were detected for maturity date and 1000-grains weight.

Table (13): Mean squares of the F_3 families for the five traits in the second cross.

Source of variation	Degrees of freedom	Days to maturity	No. spikes /plant	No. of grains / spike	1000 G.W.	Grain yield/plant
Replicates	2	0.199	2.616	54.487	5.573	50.447*
Lines	81	53.983**	65.488**	648.506**	116.562**	232.091**
Erorr	162	3.631	1.869	28.068	12.28	11.093

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

Table (14): Mean performances of the selected F_3 families, their parents and genetic parameters heritability, the predicted genetic advance under selection and genetic coefficient of variation.

F3 families	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
1	148.33	17.00	55.00	52.73	22.89
2	147.33	10.77	60.00	57.42	20.21
3	146.67	12.67	32.67	47.92	11.57
4	145.00	7.23	48.67	53.85	13.40
5	146.00	11.83	58.00	37.30	24.28
6	146.00	9.50	61.67	49.87	33.89
7	144.00	9.29	58.00	50.27	23.42
8	144.00	11.68	60.00	42.54	27.17
9	148.67	10.53	49.33	64.48	21.18
10	146.00	8.12	81.00	58.59	38.73
11	145.00	9.91	70.67	47.38	14.21
12	148.67	8.42	69.33	50.50	29.74
13	145.33	9.40	48.67	47.10	12.91
14	150.33	19.50	53.33	46.46	40.48
15	144.33	7.97	68.33	47.34	18.77
16	137.00	5.20	44.00	72.11	12.27
17	131.00	6.00	55.00	44.10	17.76
18	150.67	20.33	65.33	51.42	42.84
19	149.67	16.19	58.33	44.66	31.20
20	145.33	9.82	63.67	46.48	27.79
21	143.00	14.63	52.67	43.60	15.93
22	143.33	9.44	63.67	47.71	30.78
23	144.33	11.12	69.00	49.92	25.02
24	142.67	8.62	76.00	45.29	20.02
25	145.33	11.64	67.33	43.19	27.00
26	144.33	14.61	70.67	49.21	23.22
27	133.00	4.11	78.67	55.16	13.82
28	132.33	5.33	68.67	60.93	20.27
29	136.67	6.00	87.00	55.48	10.97
30	145.00	8.75	59.67	51.25	13.61
31	144.00	10.48	77.67	46.05	32.50
32	148.33	12.88	115.00	44.30	42.83
33	151.67	16.33	74.67	48.36	42.89
34	151.33	19.42	66.67	43.98	25.21
35	144.67	5.28	76.67	60.29	15.49
36	145.33	7.04	86.00	49.20	26.64
37	145.33	8.88	72.67	46.89	24.69
38	146.00	12.14	77.33	39.01	21.12
39	134.00	4.93	94.00	44.83	14.94
40	148.33	9.92	70.00	46.01	31.66
41	137.67	5.64	52.67	52.08	12.10
42	147.67	12.95	80.00	39.06	31.75
43	144.00	7.84	56.33	50.31	23.14
44	146.33	9.11	74.33	50.77	20.70

Table (14): continued

F3 families	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
45	142.67	13.01	60.67	54.85	20.52
46	135.67	4.01	65.33	50.85	11.55
47	143.67	5.00	80.33	45.17	10.56
48	145.00	6.83	55.00	61.04	18.33
49	144.33	7.63	47.50	48.42	16.34
50	145.67	9.94	61.33	42.66	19.87
51	144.33	5.92	55.67	49.56	14.79
52	144.00	3.78	63.00	50.17	11.95
53	143.33	5.80	74.50	51.56	23.04
54	145.67	6.00	76.33	51.49	14.36
55	147.33	6.33	61.83	47.56	19.39
56	142.67	6.04	53.33	38.86	9.27
57	148.67	7.54	46.00	55.12	19.01
58	144.33	7.45	53.00	67.86	25.97
59	141.33	3.29	87.00	54.79	14.35
60	142.00	4.06	77.50	52.47	15.95
61	144.33	6.08	104.50	53.67	34.32
62	144.00	4.36	86.67	54.91	19.19
63	144.67	4.35	71.00	55.70	14.34
64	145.00	12.20	69.33	39.42	23.35
65	145.33	9.41	59.00	47.49	22.13
66	150.00	22.98	81.67	54.08	44.40
67	146.00	10.98	79.50	51.05	33.56
68	142.00	5.94	47.50	49.36	13.75
69	145.67	11.26	69.50	45.18	25.36
70	146.00	9.49	64.50	42.07	12.60
71	147.33	18.94	57.50	47.72	39.96
72	145.67	9.03	59.50	44.88	21.11
73	145.67	16.41	62.67	50.63	31.18
74	144.67	17.77	43.33	48.70	24.33
75	145.00	13.09	46.50	49.13	22.30
76	149.67	25.00	38.50	44.64	28.26
77	147.00	16.41	44.00	45.34	28.96
78	145.33	12.38	41.83	56.18	24.28
79	146.67	11.71	41.33	44.26	20.65
80	149.00	11.86	60.00	47.53	32.75
Parent 1	140.00	14.33	62.67	49.81	35.83
Parent 2	133.00	9.33	60.33	50.70	30.03
Over mean	144.47	10.18	64.61	49.64	23.16
LSD 0.01	4.138	2.969	11.506	7.611	7.233
LSD 0.05	3.111	2.232	8.651	5.722	5.438
h^2	82.214	91.900	88.050	73.895	86.912
Δg	7.652	9.094	27.798	10.440	16.483
G.C.V	11.618	208.404	320.095	70.029	318.107
Δg%	5.296	89.369	43.051	21.033	71.178

The high heritability values in broad sense were detected for five traits under study.

The same trend was previously reported by **Pathak** and **Nema (1985); Chander *et al.* (1993) and Mohamed (2006)** for grain yield/plant, number of grains/spike and number of spikes/plant for genetic coefficient of variation (GCV), heritability and genetic advance.

4.2.2. F_4 generation:

The mean squares due to F_4 selected families were found to be highly significant for all studied traits (Table 15), indicating that the forty F_4.selected families behaved some what differently from each to other. For maturity date, none of the selected families of F_4 showed earlier than the early patent (Table 16).

As for number of spikes/plant, the range of the selected families varied from number 10 (4.53) to number 12 (19.67) spikes/plant. The selected families' number 12, 18, 19, 25, 33, 36 and 38 had significant superiority than the best parent. The family 12 followed by number 18 gave the highest number of spikes/plant. However, the family number 10 gave the lowest one (Table 16).

Regarding number of grains/spike, family's number 3, 14, 16, 24, 29, 31, 32, 34, 37 and 40 surpassed significantly the best parent. The mean values of selected families ranged from 44.67 to 119. On the other hand, family's number 3, 4, 10, 13, 14 and 37 had significantly from the best parent with 1000-grains weight.

Table (15): Mean squares of the F_4 families for the five studied traits in the second cross.

Source of variation	Degrees of freedom	Days to maturity	No. spikes /plant	No. of grains / spike	1000 G.W.	Grain yield/plant
Replicates	2	24**	10.862**	52.793	43.469**	2.134
Lines	41	85.774**	50.524**	815.315**	135.937**	228.692**
Error	82	3.056	1.324	19.257	4.711	4.966

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

Table (16): Mean performance of the selected F_4 families in the second cross, their parents and genetic parameters heritability, the predicted genetic advance under selection and genetic coefficient of variation.

F4 families	Days to maturity (days)	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
1	144.00	10.98	68.00	46.38	25.83
2	143.00	13.94	71.33	50.03	22.05
3	132.00	5.67	85.33	58.49	12.65
4	131.67	5.00	69.33	61.75	19.10
5	144.67	11.16	58.67	38.13	23.10
6	144.67	8.83	62.33	49.95	32.72
7	142.67	8.63	58.67	51.09	22.25
8	142.67	10.81	60.67	43.36	24.56
9	143.00	7.31	69.00	48.17	17.59
10	134.67	4.53	44.67	67.63	11.10
11	129.67	5.33	55.67	44.73	16.59
12	149.33	19.67	66.00	52.25	41.67
13	147.33	9.87	50.00	65.58	21.65
14	138.33	7.45	81.67	58.65	25.65
15	143.67	11.58	71.33	45.01	13.04
16	147.33	7.76	100.67	46.27	28.57
17	140.33	8.73	49.33	50.06	11.73
18	150.33	19.00	56.33	47.28	37.68
19	148.33	18.33	59.00	47.45	28.72
20	144.00	9.15	64.33	46.89	26.61

Table (16): continued

F4 families	Days to maturity (days)	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
21	141.67	13.96	53.33	44.42	14.76
22	142.00	8.77	64.33	45.66	26.40
23	143.00	10.45	69.67	52.83	23.84
24	141.33	11.67	76.67	46.11	18.84
25	147.67	17.00	54.67	51.74	21.72
26	145.67	10.10	62.33	53.31	19.84
27	143.33	12.00	59.33	49.49	11.07
28	143.67	6.56	49.33	55.03	12.99
29	135.33	6.33	103.33	53.31	12.62
30	143.67	8.08	60.33	52.07	12.44
31	143.67	9.81	78.33	46.87	31.32
32	147.00	12.21	115.67	45.12	39.59
33	150.33	15.67	75.33	48.56	42.90
34	132.67	4.26	119.00	54.73	13.77
35	146.67	9.25	74.33	44.15	30.49
36	150.00	18.75	67.33	44.81	24.04
37	143.33	4.61	77.33	67.45	14.32
38	144.00	14.67	54.00	50.03	27.22
39	144.00	8.21	73.33	45.36	25.31
40	144.67	11.47	78.00	38.64	19.94
Parent 1	139.33	12.33	64.33	50.38	36.40
Parent 2	131.33	8.33	67.67	54.88	31.32
Over mean	142.52	10.43	69.06	50.34	23.19
LSD 0.01	3.735	2.458	9.376	4.637	4.761
LSD 0.05	2.826	1.860	7.094	3.508	3.602
h^2	90.022	92.530	93.234	90.277	93.757
Δg	10.263	8.025	32.402	12.945	17.225
G.C.V	19.346	157.176	384.260	86.900	321.584
Δg%	7.200	76.908	46.921	25.717	74.278

With regard to grain yield/plant, none of the selected families of F_4 surpassed significantly than the better parent except families number 12 and 33 The range of selected families varied from 11.07 (family number 27) to 42.90 (family number 33).

From the previous mentioned data, it is observed that the pedigree method was more effective for selected superior families or lines. The estimates of genetic coefficient of variation, genetic gain % and heritability in broad sense are presented in Table (16).

Heritability in broad sense in the F_4 families for the five traits under study was estimated and the obtained values are presented in Table (16). The high heritability values in broad sense were detected for five traits under study, indicating the effectiveness of selection in these materials for these traits.

4.2.3. F_5 generation:

4.2.3.1. Comparison between breeding methods:

Mean squares due to breeding methods were significant for maturity date, yield and its components (Table 17). This result indicated the differences between breeding methods.

The pedigree method expressed significant desirable values for number of spikes/plant and grain yield/plant (Table 18). While the single seed descent method exhibited significantly earlier of maturity date, highest 1000-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

Table (17): Mean squares of the breeding methods for the five studies traits in the second cross.

Source of variation	Degrees of freedom	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
Replications	2	15.239**	51.891**	17.672	0.979	35.618
Lines	59	109.877**	47.745**	280.896**	43.295**	411.307**
Methods	2	161.006**	299.636**	331.112**	372.029**	236.769**
Lines/Methods	57	108.083**	38.907**	279.134**	31.761**	417.432**
Error	118	1.013	3.539	30.716	2.921	28.568

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

Table (18): Mean performances of the breeding methods for the five studied traits in the second cross.

Breeding methodology	Days to maturity	N. of spikes/plant	N. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
Pedigree	143.700	20.312	66.199	50.306	56.181
Bulk	144.967	16.767	62.705	48.532	54.024
Single seed descent	141.717	16.183	67.173	53.449	52.213
LSD 5%	0.364	0.680	2.003	0.618	1.932
LSD 1%	0.481	0.899	2.648	0.817	2.554

and grain yield/plant than those 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 **Pawar *et al.* (1985), Pawar *et al.* (1986), Pawar *et al.* (2001)** and **Arunachalam *et al.* (2002)** on self pollinated crops using two or more methods of breeding.

Whan *et al.* (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 lines of breeding methods as well as two parents were significant for the five traits under study (Table 19). 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 (20) show that the pedigree method produced consistently more superior lines for grain yield per plant compared to the best parent or the average population or check (Sids 13 or Sids 12). The best lines were number 4 (86.56g) in pedigree method, number 12 (89.946g) in bulk method and number 12 (69.400g) in SSD method.

For maturity date, two lines number 7 (130.667 days) and number 5 (131.667 days) in pedigree method had the earliest than the best parent. There aren't any lines significant earlier in bulk methods and single seed method than the best parent (Sids 4) in this cross.

Table (19): Mean squares of the breeding methods and their parents (F_5-lines) for the five studied traits in the second cross.

Source of variation	Degrees of freedom	Days to maturity	No. spikes/ plant	No. of grains/ spike	1000 G.W.	Grain yield
Replicates	2	15.504**	47.788**	8.651	0.916	55.476*
Lines	63	111.379**	48.221**	269.794**	43.743**	405.227**
Error	126	0.988	3.523	20.317	2.758	18.247

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

Table (20): Mean performances of the selected lines of breeding methods and their parents and two check varieties in the second cross.

Breeding methods	No. of lines	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight	Grain yield/plant (g)
pedigree	1	140.667	20.557	80.333	45.273	37.467
	2	135.333	22.778	68.667	47.215	67.156
	3	141.000	26.813	61.667	53.000	48.478
	4	148.667	24.443	63.000	50.377	86.056
	5	131.667	22.443	75.667	47.962	59.089
	6	151.333	15.636	65.000	47.872	47.584
	7	130.667	18.222	65.999	53.996	46.946
	8	134.000	20.221	72.442	50.413	68.640
	9	153.000	16.993	69.444	49.964	62.299
	10	150.333	16.777	72.332	50.000	39.056
	11	141.333	25.556	54.222	50.887	73.902
	12	144.667	20.000	69.888	49.933	56.944
	13	140.667	26.331	63.000	52.788	59.250
	14	151.333	19.444	53.999	51.394	62.097
	15	141.333	19.444	51.999	52.730	46.957
	16	144.000	13.889	61.221	47.890	53.344
	17	147.667	21.111	67.444	50.394	60.148
	18	147.333	16.033	77.333	49.184	53.513
	19	149.000	18.557	67.666	53.799	38.640
	20	150.000	20.999	62.666	51.043	56.053
bulk	1	147.667	13.221	72.667	52.804	37.078
	2	146.000	19.889	66.223	48.591	46.989
	3	143.667	20.332	42.444	40.647	50.247
	4	145.333	20.001	58.000	50.672	57.367
	5	140.667	22.999	71.443	53.590	75.291
	6	143.667	13.778	62.778	45.948	36.560
	7	148.667	17.222	68.222	47.632	65.933
	8	151.333	19.223	65.666	45.930	51.520
	9	148.667	15.777	66.554	43.947	48.789
	10	146.667	16.111	57.332	50.218	55.006
	11	150.667	11.889	46.110	47.644	48.737
	12	136.333	21.222	67.999	49.007	89.946
	13	146.333	10.889	53.332	46.255	42.167
	14	133.667	13.890	73.111	50.944	45.723
	15	148.333	14.444	58.667	50.497	50.757
	16	134.333	12.666	61.111	55.388	53.536
	17	150.000	19.444	66.668	51.213	62.326
	18	140.667	16.667	71.333	44.956	49.626
	19	150.667	13.777	61.890	45.403	48.867
	20	146.000	21.889	62.556	49.359	64.022

Table (20): continued

Breeding methods	No. of lines	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight	Grain yield/plant (g)
Single seed descent	1	134.333	21.444	68.000	44.718	52.408
	2	135.333	18.778	51.787	48.805	49.854
	3	149.000	10.667	80.999	50.404	47.111
	4	136.333	13.667	57.334	52.809	50.476
	5	148.333	14.443	71.111	50.970	55.264
	6	151.333	16.001	69.110	56.081	59.724
	7	143.000	14.889	79.221	54.791	52.553
	8	143.333	13.000	72.223	49.491	33.072
	9	138.000	17.444	64.778	58.971	45.697
	10	138.000	15.889	67.112	57.178	61.143
	11	145.000	14.889	63.666	53.884	58.296
	12	135.000	19.556	85.332	52.457	69.400
	13	145.000	16.333	57.777	52.944	69.129
	14	138.000	14.111	70.000	54.722	47.922
	15	137.667	15.332	53.890	56.600	32.594
	16	145.333	22.443	50.333	55.856	44.657
	17	134.333	21.223	53.888	59.351	66.022
	18	150.667	14.000	99.779	56.965	49.607
	19	139.000	9.332	65.554	50.966	41.164
	20	147.333	20.222	61.556	51.018	58.164
Parent 1		139.220	10.920	59.700	44.750	53.040
Parent 2		134.780	18.040	66.550	48.600	50.320
Over mean		143.253	17.648	65.287	50.630	54.060
Sids 12		134.780	13.070	69.780	47.600	63.140
Sids 13		139.000	14.780	65.040	46.250	69.190
LSD 5%		1.627	3.041	8.960	2.763	8.641
LSD 1%		2.151	4.020	11.842	3.652	11.421

For number of spikes/plant the results indicated that the pedigree method produced more superior lines followed by bulk and then by single seed descent compared to the best 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 best parent for pedigree breeding method. But bulk methods three lines showed significant higher spike number than the average of all lines or best parent. However, single seed, three lines from twenty lines showed significant higher.

Regarding to 1000-grain weight, ten, two and two lines showed, significant higher than the average of all lines for SSD, pedigree and bulk methods, respectively. However, the heavier line was number 17 (59.351g) in this trait than grand mean in single seed descent method.

For number of grains/spike, line number one showed significant higher grain number than the high number from the average of all lines or best parent or check for pedigree breeding method. The line number 1 in pedigree breeding method gave the highest number of grains/spike. But bulk methods zero lines showed significant higher grain number than the high number from the average of all lines or best parent or check. However, the third method in this cross is single seed descent, four lines showed significant higher grain number than the high number from the average of all lines or best parent or check (Sids 12).

4.2.3.2. Direct and indirect selection:

Selection for yield and yield components deserves considerable interest. A crop breeding program aimed to increasing plant productivity requires consideration interest not only of yield but also of its components which have a direct and indirect bearing for yield. The present part was undertaken to compare the efficiency of indirect selection for yield via yield components with direct selection for grain yield/plant.

Mean squares due to four selection criteria i.e. number of spikes/plant, 1000-grain weight and number of grains/spike (indirect selection), and high yield/plant (direct selection) were significant (Table 21). Significant differences between the five traits in number of spikes/plant, 1000-grain weight, number of grain/spike and maturity and high yield/plant.

Generally, the selection of high number of spikes/plant, gave the highest grain yield/plant and the second for number of grains/spike, grain yield/plant and 1000-grain weight (Table 22).

The present investigation expressed that the selection for high number of spikes/plant was more efficiency as indirect selection for yield gave the highest one.

With respect to the effect of selection criteria on 1000-grain weight, the results revealed that selection for 1000-grain weight gave significant heavier grain index followed by selection high number of spikes/plant, number of grains/spike and number of grains/spike. However, selection of high grain yield per plant gave the lowest one (Table 22).

Table (21): Mean squares of lines, four selection criteria and lines/selection criteria in the second cross.

Source of variation	Degrees of freedom	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
Rep	2	8.254**	4.954	4.516	7.204	108.651**
Lines	79	101.442**	88.296**	285.730**	89.310**	620.862**
Methods	3	66.233**	860.054**	2746.814**	520.197**	6560.208**
Lines/Methods	76	102.832**	57.832**	188.582**	72.302**	386.414**
Error	158	1.060	4.308	22.395	2.391	19.398

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

Table (22): Mean values of the four selection criteria for all the studied traits in the second cross.

Selection criteria	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
No. of spikes/plant	144.317	21.000	60.355	51.215	65.191
No. of grains/spike	143.650	13.727	73.699	50.149	55.953
1000- grain weight (g)	143.500	13.588	58.722	55.551	39.927
Grain yield/plant (g)	145.800	19.172	62.500	48.720	54.946
LSD 5%	0.372	0.750	1.711	0.559	1.592
LSD 1%	0.492	0.992	2.261	0.739	2.104

Also, the selection criteria on number of spikes/plant, the results revealed that selection for number of spikes/plant gave significant high grain yield per plant and number of spikes per plant followed by selection high number of grains per spike and grain yield/plant. However, selection of high 1000- grain weight gave the lowest one (Table 22).

Also, the selection criteria on number of grains/spike, the results revealed that selection for number of grains/spike gave significant high value for this trait followed by selection high criteria of grain yield/plant. However, selection of high 1000-grain weight gave the lowest one. But it was the second in grain yield/plant and earliest nearly in maturity date (Table 22).

Concerning grain yield/plant, the selection method of high number of spikes per plant exhibited significantly higher value of this trait, followed by high number of grains/spike and grain yield per plant were detected revealing that the selection criteria differed among them (Table 22).

The results indicated that selection for grain number, number of spikes/plant and 1000-grain weights were more efficient in breeding for word superior yielding F5 lines.

It could be concluded that selection for number of spikes/plant, number of grains/spike, for (indirect selection) three successive generations was successful in improving the mean grain yield in the F5 lines.

The mean values of selected F5 lines for maturity date, number of spikes/plant, 1000-grain weight, number of grains/spike and grain yield/plant were affected by selection criteria indirect selection i.e. (high number of grains/spike, heavier grain index and high number of spikes/plant) and direct selection (high grain yield/plant) are presented in Table (23).

For days to maturity there are no lines in the F5 generation had significantly the earliest than the best parent with all selection criteria under study.

For number of spikes/plant, nine, one, zero and three lines were significantly higher than the best parent when selected with number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively (table 23). This result is logically expected. The best lines were number 2 when selected with number of spikes/plant. However, number 8 when selected with number of grains/spike also, number 18 when selected with 1000- grain weight and number 12 when selected with grain yield/plant.

For number of grains/spike, one, six, zero and one lines were significantly higher than the best cultivar Sids 12 with number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively. This result is logically expected. The best lines were number 14 when selected with number of spikes/plant. However, number 12 when selected with number of grains/spike also, number 19 when selected with 1000- grain weight and number 17 when selected with grain yield/plant.

For 1000- grain weight, seven, four, ten and one lines were significantly heavier than the best grand mean for selection high number of spikes/plant, number of grains/spike, 1000- grain weight and grain yield/plant, respectively. The best line was number 5 when selected with number of spikes/plant, however, number 18 when selected with number of grains/spike also and number 1 when selected with 1000- grain weight and number 11 when selected with grain yield/plan

Table (23): Mean performance of the F_5 selected lines from direct and indirect selection criteria, parents and check variety in the second cross.

Selection criteria	# of line	Days to maturity	No. of spikes/plant	No. of grains/spike	1000-grain weight (g)	Grain yield/plant (g)
No. of spikes/plant	1	137.333	27.000	66.889	52.126	76.952
	2	148.333	28.889	69.887	44.690	91.900
	3	152.333	21.221	61.553	49.058	50.267
	4	136.000	23.333	59.000	52.763	60.570
	5	148.667	19.778	49.109	61.450	76.727
	6	131.667	22.222	53.221	57.623	60.850
	7	147.333	21.890	65.889	50.424	67.782
	8	148.000	26.333	53.667	59.145	61.762
	9	148.000	27.554	63.778	43.637	74.594
	10	149.333	22.888	67.888	55.483	88.887
	11	147.667	16.110	60.000	48.194	62.776
	12	148.333	16.667	55.663	57.840	59.097
	13	140.667	23.111	62.333	47.212	85.650
	14	135.333	18.554	83.887	49.359	52.719
	15	145.000	22.443	57.332	55.908	58.616
	16	135.667	18.568	58.443	45.462	60.210
	17	141.667	15.999	49.332	47.315	63.882
	18	149.000	20.110	53.554	49.053	54.403
	19	143.667	13.554	61.779	40.602	53.304
	20	152.333	13.777	53.890	56.960	42.879
No. of grains/spike	1	133.667	10.220	73.109	52.619	58.280
	2	148.333	8.222	81.444	46.410	45.509
	3	152.333	11.889	64.000	50.898	44.438
	4	136.000	11.777	67.556	49.100	64.233
	5	148.667	8.666	80.999	47.713	49.178
	6	131.667	15.333	84.889	45.215	77.453
	7	147.667	12.557	77.442	43.756	66.113
	8	147.333	22.553	73.110	51.353	62.754
	9	148.000	21.554	73.001	58.213	74.989
	10	149.333	20.223	75.333	51.461	65.872
	11	147.667	12.778	85.333	48.566	35.211
	12	146.000	9.444	90.887	45.987	43.819
	13	140.667	15.333	81.667	50.218	60.133
	14	135.333	13.333	77.666	47.522	36.333
	15	145.000	16.221	62.556	44.182	55.739
	16	135.667	11.221	49.888	46.473	43.583
	17	141.667	19.777	67.888	56.244	77.883
	18	149.000	14.890	73.887	62.513	62.822
	19	143.667	10.000	72.111	49.519	50.387
	20	145.333	8.556	61.221	55.023	44.320

Table (23): continued

Selection criteria	# of line	Days to maturity	No. of spikes/plant	No. of grains/spike	1000- grain weight (g)	Grain yield/plant (g)
1000- grain weight (g)	1	147.667	7.222	55.666	66.323	47.393
	2	147.333	11.553	46.778	51.143	45.140
	3	148.000	9.333	55.666	55.191	36.506
	4	149.333	7.554	50.333	51.974	40.511
	5	148.333	17.110	62.444	55.567	26.547
	6	151.000	7.554	59.554	60.450	30.244
	7	152.333	10.110	57.667	63.976	35.211
	8	136.000	14.888	64.442	49.550	31.870
	9	131.667	9.668	65.666	51.879	34.564
	10	141.333	10.888	53.222	55.892	33.600
	11	144.667	15.223	51.443	51.182	47.461
	12	140.667	10.443	57.556	61.257	33.794
	13	134.333	14.443	62.111	53.455	23.353
	14	145.000	21.554	61.556	47.808	53.457
	15	140.667	20.444	57.222	52.181	46.650
	16	150.667	19.888	58.000	63.509	45.600
	17	135.333	17.666	61.001	60.307	50.380
	18	141.000	21.667	64.778	51.871	48.753
	19	144.667	8.333	75.002	54.202	29.368
	20	140.000	16.220	54.333	53.298	58.131
Grain yield/plant (g)	1	147.333	13.221	62.167	51.818	46.680
	2	140.667	13.333	56.667	52.178	34.830
	3	143.667	18.221	61.500	47.554	47.611
	4	148.667	21.333	70.833	50.595	60.692
	5	151.333	20.779	64.667	48.064	65.800
	6	148.667	18.110	65.667	47.103	63.821
	7	146.667	18.556	56.888	51.830	56.727
	8	148.667	20.666	68.000	46.716	56.723
	9	146.667	19.001	55.220	43.945	56.487
	10	150.667	19.666	60.167	40.830	63.152
	11	136.333	21.222	51.722	54.678	61.646
	12	146.333	26.111	63.833	50.799	61.411
	13	133.667	24.556	65.167	50.746	60.050
	14	148.333	23.110	53.167	52.803	52.604
	15	153.000	13.554	63.000	47.085	44.541
	16	150.333	18.443	55.167	45.588	45.538
	17	141.333	13.777	83.667	45.069	59.564
	18	144.667	21.333	66.667	46.896	60.562
	19	140.667	20.889	62.167	51.421	41.830
	20	148.333	17.556	63.667	48.686	58.650
Parent 1		139.58	18.78	64.65	50.37	60.41
Parent 2		130.67	10.92	62.17	50.12	55.62
Over mean		144.09	16.82	63.81	51.38	54.10
Sids 12		134.75	14.06	70.57	47.71	58.05
Sids 13		139.42	16.11	69.72	44.09	57.13
LSD 5%		1.665	3.356	7.651	2.500	7.120
LSD 1%		2.200	4.435	10.112	3.304	9.411

Regarding grain yield/plant the range of selected lines ranged from 42.879g to 91.900g; 35.211g to 77.883g; 23.353g to 58.131g and 34.830g to 65.800g when selection plants with number of spikes/plant, number of grains/spike, 1000-grain weight and grain yield/plant, respectively. Also, seven, three, zero and zero lines significantly surpassed higher grain yield per plant than the best parent, in the same order.

In addition, the best lines were number1, 2, 5, 7, 9, 10 and 13 when selecting plants with high number of spikes/plant, number 6, 9, and 17 when selected for number of grains/spike.

It could be concluded that indirect selection for yield via number of spikes/plant is more efficient than direct selection for yield.

The comparison of selection criteria revealed the efficiency of selecting for number of spikes/plant followed by number of grains/spike and then by grain yield/plant and heavier grain index, in improving mean yield of F5 lines in this cross and also extracting a higher number of high yielding lines (selection for high number of grains/spike, number of spikes/plant and heavier grain index). It, also, appeared that indirect selection for yield via number of spikes/plant was more efficient than direct effects of selection for yield.

SUMMARY

V. SUMMARY

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), bulk method (BM) and single seed descent method (SSDM) on two hexaploid bread wheat (*Triticum aestivum vulgare., L.*) populations (2n = 42 chromosomes) chosen from wheat research program on the basis of their genetic diversity and performance under field conditions. Also, direct and indirect selection for increasing grain yield was carried out. The selection intensity of 10% approximately was used with direct selection and with indirect selection using yield component in wheat, *i.e*, number of spikes/plant, number of grains/spike and 1000-grains weight in gm.

Two F_2 populations derived from the two crosses; the first cross (I) (WEAVER/WL3926//SW893064/5/Desconocido#6/4/Bl1133/3/ Cmh 79A.955*2/ Cno 79//Cmh 79A.955/Bow's') and the second cross (II) (LFN/1158.57//PRL/3/HAHN/4/KAUZ/5/KAUZ/6/Sids 4) were used.

The obtained results could be summarized as follow:

A- The first cross:

A-1- F_3 and F_4 generations:

1- The mean squares associated with F_3 families were found to be significant for all the studied traits. High estimates of heritability in broad-sense in the F_3 families were detected for all the studied traits.

2- In the F_3, genetic gain was rather higher for number of spikes/plant, number of grains/spike and grain yield/plant. However, low to moderate genetic gain from selection was obtained for maturity date and 1000-grain weight (g). Also, high G.C.V%. was detected for number of spikes/plant, grain yield/plant and number of grains/spike. However, low to moderate G.C.V%. was obtained for other traits.From the previous mentioned data, it is observed that the pedigree method was more effective for selected superior families or lines.

3- In the F_4 high heritability values were detected for number of spikes/plant, number of grains/spike and maturity date indicating the effectiveness of selection in this material for these traits. However, moderate values were obtained for 1000-grain weight and grain yield/plant. The values of expected gain (ΔG) and ΔG % reported the possible gain from selection as percent increase in the F_5 over the F_4 are selected. Also, genetic gain was rather higher for grains/spike and grain yield/plant. However, low gain was found for maturity date.

A-2- F_5 generation:

A-2-a- Breeding methods:

1- The mean squares due to breeding methods were significant for maturity date, yield and its components.

2- The bulk method was considered the best breeding method for grain yield/plant and maturity date. While the single seed descent (SSD) method exhibited significant 1000- grain weight. While, pedigree method gave the highest value for number of spikes/plant and number of grains/spike.

3- The best lines of grain yield/plant were number 18 (95.378g), number 12 (94.350g), number 5 (82.418g), number 2 (78.494g) and number 4 (75.800g) in bulk method and number 13 (80.853g), number 11(75.139g) and number 16 (73.661g) in pedigree method. But number 15 (80.903g), number 10 (73.432g) and number 1 (72.617g) in single seed descent.

A-2-b- selection criteria:

1- Mean squares due to four selection criteria *i.e.* number of spikes/plant, 1000-grain weight and number of grains/spike (indirect selection), and high yield/plant (direct selection) were high significant. For the five traits under study.

2- The present investigation expressed the selection for high spikes/plant, 1000-grain weight, number of grains/spike and days to maturity and high yield/plant. With respect to the effect of selection criteria on 1000-grain weight, the results revealed that selection for 1000-grain weight gave significant heavier seed index followed by selection high number of grains/spike. However, selection of high number of spikes per plant gave the lowest one.

3- The comparison of selection criteria revealed the efficiency of selecting for number of grains/spike and high grain yield/plant and then by number of spikes/plant and heavier grain index, in improving mean yield of F5 lines in this cross and also extracting a higher number of high yielding lines (selection for high number of grains/spike, number of spikes/plant and heavier grain index). It, also, appeared that indirect selection for yield via number of grains/spike was more efficient than direct effects of selection for yield.

B- The second cross:

B-1- F_3 and F_4 generation:

1- Significant F_3 mean squares were detected for all the five studied traits indicating wide differences between the F_3 families'

2- For maturity date, there are not families from 80 families of F_3 showed earlier than the early patent (Sids 4).

3- The families' number 1, 14, 18, 34, 66, 71, 74 and 76 significantly surpassed the better parent for number of spikes/plant.

4- The families' number 10, 24, 27, 29, 31, 32, 33, 35, 36, 37, 38, 39, 42, 44, 47, 53, 54, 59, 60, 61, 62, 66 and 67 exhibited significant higher number of grains /spike than the better parent.

5- Regarding 1000-grain weight, the families' number 2, 9, 10, 16, 28, 35, 48 and 58 surpassed significantly the heavier parent.

6- The genetic components of variation showed the high estimates of ΔG and ΔG% and G.C.V% for number of spikes/plant, number of grains/spike and grain yield/plant. However, moderate values were detected for maturity date and 1000-grain weight. The high heritability values in broad sense were detected for the five traits under study.

7- The mean squares due to F_4 selected families were found to be highly significant for all studied traits.

8- For maturity date, none of the selected families of F_4 showed earlier than the early patent.

9- As for number of spikes/plant, the range of the selected families varied from number 10 (4.53) to number 12 (19.67) spikes/plant for this trait.

10- Regarding number of grains/spike, family's number 3, 14, 16, 24, 29, 31, 32, 34, 37 and 40 surpassed significantly the best parent.

11- With regard to grain yield/plant, none of the selected families of F_4 showed surpassed significantly than the better parent except family's number 12 and 33.

12- High heritability values in broad sense were detected for the five traits under study, indicating the effectiveness of selection in these materials for these traits.

B-2- F_5 generation:

B-2-a- Breeding methods:

1- Mean squares due to breeding methods were significant for maturity date, yield and its components.

2- The pedigree method expressed significant desirable values for spikes/plant and grain yield/plant. While the single seed descent method exhibited significantly earlier of maturity date, 1000-grain weight and high number of grains/spike.

3- The pedigree method produced consistently more superior lines compared to the best parent or the average population or check (Sids 13 or Sids 12). The best lines were number 4 (86.56g) and number 11 (73.902g) in pedigree method number 12 (89.946g) and number 5 (75.291g) in bulk method and number 12 (69.400g) in SSD method.

4- For maturity date, two lines number 7 (130.667 days) and number 5 (131.667 days) in pedigree method had the earliest than the best parent. There aren't any lines significant earlier in bulk methods and single seed method than the best parent (Sids 4) in this cross.

5- For number of spikes/plant the results indicated that the pedigree method produced more superior lines followed by bulk and then by single seed descent compared to the best 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 best parent for pedigree breeding method. But bulk methods three lines showed significant higher spike number than the average of all lines or best parent. However, single seed, three lines from twenty lines showed significant higher.

6 Regarding to 1000-grain weight, ten, two and two lines showed, significant higher than the average of all lines for SSD, pedigree and bulk methods, respectively. However, the heavier line was number 17 (59.351g) in this trait than grand mean in single seed descent method.

7- For number of grains/spike, line number one showed significant higher grain number than the high number from the average of all lines or best parent or check for pedigree breeding method. The line number 1 in pedigree breeding method gave the highest number of grains/spike. But bulk methods zero lines showed significant higher grain number than the high number from the average of all lines or best parent or check. However, the third method in this cross is single seed descent, four lines showed significant higher grain number than the high number from the average of all lines or best parent or check (Sids 12).

B-2-b- selection criteria:

1- Mean squares due to four selection criteria *i.e.* number of spikes/plant, 1000-grain weight and number of grains/spike and high yield/plant were significant.

2- Generally, the selection of high number of spikes/plant, gave the highest grain yield/plant and the second for number of grains/spike, grain yield/plant and 1000-grain weight.

3- Selection criteria on number of spikes/plant, the results revealed that selection for number of spikes/plant gave significant high grain yield per plant and number of spikes per plant followed by selection high number of grains per spike and grain yield/plant. However, selection of high 1000-grain weight gave the lowest one.

4- For days to maturity there are no lines in the F5 generation had significantly the earliest than the best parent

5- For number of spikes/plant, nine, one, zero and three lines were significantly higher than the best parent when selected with number of spikes/plant, number of grains/spike, 1000-grain weight and grain yield/plant, respectively. This result is logically expected. The best lines were number 2 when selected with number of spikes/plant. However, number 8 when selected with number of grains/spike also, number 18 when selected with 1000- grain weight and number 12 when selected with grain yield/plant.

6- The comparison of selection criteria revealed the efficiency of selecting for number of spikes/plant followed by number of grains/spike and then by grain yield/plant and heavier grain index, in improving mean yield of F5 lines in this cross and also extracting a higher number of high yielding lines (selection for high number of grains/spike, number of spikes/plant and heavier grain index). It, also, appeared that indirect selection for yield via number of spikes/plant was more efficient than direct effects of selection for yield.

REFERENCES

VI. REFERENCES

Abdel-Ghani, A.M.; A.A. Gomaa; A.M. Abd EL-Shafi; Enayat H. Ghanem; O.S. Khalil; R.A. Abo el Enien and Eissa A.M (1994). Deffierential developments of wheat wheat production in Egypt out of recognition yield transformation. Assiut J. Agric. Sci 25(2):39-58.

Allard R.W (1960). Principles of Plant Breeding John Wiley and Sons, Ins., New York. 485pp.

Allard, R.W. and J. Harding (1963). Early generation analysis and prediction of gain under selection in derivatives of wheat hybrid. Crop Sci., 3 : 454-456.

Amin, M.R.; N.C.D. Barma and **M.A. Razzaque (1992).** Variability, heritability, genetic advance and correlation study in some quantitative characters in durum wheat. Rachis, 11 : 1-2, 30-32.

Arunachalam A.; K.P. Viswantha; K.K. Chakravarthy A. Manjunathe and M.K. Jayashree (2002). Efficiency of breeding methods in early segregating generations in cowpea (*Vigna unguiculata* L.) Walp. Ind. J.Genet., 62(3): 228-231.

Bangar N.D.; G.D. Mukhekar; D.B. Lad and D.G. Mukhekar (2003). Genetic variability, correlation and regression studies in soybean. Journal of Maharashtra Agricultural Universities, College of Agriculture, Pune, India. 28: 3, 320-321 (C.F. summaries of monograph, Accession Number 20043014173 CAB Abstract).

Baser, I; O. Bilgin; A.Y. Bilgin and T.Genctan, (2000). Relationship between characters related to tillering and grain yield in bread wheat (*Triticum turgidum* L.). Acta Agronomica Hungarica. 2000, 48 (3): 251-256 [C.F.Computer Res, International Agric. Cent. For Information Service].

Briggs, K. G. and **L.H. Shebeski (1970).** Visual selection for yielding ability of F_3 lines in a hard red spring wheat breeding program. Crop Sci., 10 : 400-402.

Chander, S. ; R.B. Srivastava and **M.D. Yunus (1993).** Impact of intermating on population mean and genetic advance in wheat (*Triticum aestivum* L. em Thell). Cereal Res., Commun., 21 : 2-3 , 201-206.

Chen, C.S. and **C. Chen (1987).** A rapid generation advance single seed descent method in wheat. II. The performance of single seed descent population and the effects of environmental pressure. (C. F. Plant Breeding Abst., 58 : 7, 5620).

Chettri M.; S. Mondal and R. Nath (2005). Studies on genetic variability in soybean, *Glycine max* (L.) Merril in the mid hills of Darjeeling District. Journal of Inter Academicia. Journal of Interacademicia, Nadia, India. 9: 2, 175-178.

Deghais, M. and **Auriau, P. (1993).** Comparison between pedigree, modified bulk and single seed descent methods of selection on grain yield in wheat under semi arid conditions. (BIBLIOGRAPHIC CITATION): Annales-de-1, Institute-National-de-La Recherche-Agronomique-de-Tunisie., 66 : 1-2, 1-17.

Dev Vart; J.S. Hooda and B.P.S. Malik (2005). Variability and association studies in soybean [*Glycine max* (L.) Merril]. Crop Research (Hisar). Agricultural Research Information Centre, Hisar, India. 29: 2, 247-251.

Dhonde, S.R.; N.S.Kute; D.G. Kanawade and N.D. Sarode (2000). Variability and characters association in wheat (*Triticum aestivum* 1.). Agric. Sci. Digest., 20 (2): 99-101.

Dixit SS; K.S. Pawar; Y.S. Rawat and Jagdish Singh (2002). Genetic variability in soybean [*Glycine max* (L.) Merril]. Research on Crops. Gaurav Society of Agricultural Research Information Centre, Hisar, India. 3, (1) 195-196.

Dokuyucu, T. and A. Akkaya (1999): Path coefficient analysis and correlation of grain yield and yield components of wheat (*Triticum aestivum* L.) genotypes. Rachis. 8 (2): 17-20.

Ehdaie, B. and J.G. Waines (1989). Genetic variation, heritability, and path-analysis in landraces of bread wheat from South Western Iran. Euphytica, 41 : 183-190.

El-Hosary A.A. and M. EL. M EL-Badawy (2003). Evaluation of breeding methods and direct and indirect selection to increase seed yield in faba bean (*Vicia faba* L.) Proc. 10^{th} Conf. Agron. Sues Canal Univ. Fac. Environ., Agric., Sci., El-Arish, Egypt. 820 - 837.

Enayat H. Ghanem, (1993). Present status and future prospective of wheat improvement in Egypt with emphasis on heat tolerance program. In the international conference, wheat in hot dry irrigated environments. Wad Medani, Sudan, 1-4 feb. 1993. Saunders, D.A and G.P. Hettel, Editors.

Gohil V.N.; H.M. Pandya and D.R. Mehta (2006). Genetic variability for seed yield and its component traits in soybean Agricultural Science Digest. Agricultural Research Communication Centre, Karnal, India 26: 1, 73-74.

Grafius J.E. (1964). A geometry of plant breeding. Crop Sci. 4: 241-246.

Gupta A.K. and H. Punetha (2007). Genetic variability studied for quantitative traits in soybean {*Glycine max* (L.) Merril}. Agricultural Science Digest. Agricultural Research Communication Centre, Karnal, India. 27: 2, 140-141.

Ismail, A.A. (1995). Pedigree selection for grain yield, grain weight and earliness in two segregating populations of spring wheat. (BIBLIOGRAPHIC CITATION): Assiut Jour. of Agric. Sci., 26 : 4, 59-72.

Johanson H.W.; H.F. Robinson and R.E. Comstock (1955). Estimation of genetic and environmental variability in soybean. Agron. J. 47: 314-318.

Johanson S.K.; D.B. Helsel and J. Frey (1983). Direct and indirect selection for grain yield oats (*Avena sativa* L). Euphytica 32: 407-413.

Knott, D.R. (1979). Selection for yield in wheat breeding. Euphytica, 28: 37-40.

Lungu, D.M., P.J. Kaltikes and E.N. Larter, (1990). Intra and intcrgcne-ration relationships among yield, its components and other related characteristics in spring wheat. Euphytica, 45:139-153.

Malik M.F.A.; A.S. Qureshi; M. Ashraf and Abdul Ghafoor (2006). Genetic variability of the main yield related characters in soybean Intern. J. of Agric. and Biology. Friends Science Publishers, Faisalabad, Pakistan 8: 6, 815-819 (C.F. summaries of monograph, Accession Number 20073025362 CAB Abstract).

Martynov, S.P.; V.A. Krupnov; A.I. Sfdiovskii and **Dobrotvorskaya, T. V. (1983).** Modification of the pedigree method in breeding wheat. (C. F. Plant Breeding Abst., 26 : 2, 805).

Masood, M.S. and **A.R. Chaudhary (1987).** Heritability estimates and genetic advance values of some agronomic characters involving exotic and indigenous wheat varieties. Pak. J. Agric. Res., 8: 7-11. [C.F. Wheat, Barley and Triticale Abst. 1988].

McNeal, F.M., C.O. Qualset, D.E. Baldridge and V.R. Stewert, (1978). Selection for yield and yield components in wheat. Crop Sci., 18:795-799.

Merril P.A.; J.C. Williams; H.F. Robinson and R.E. Comstock (1958). Estimates of genotypic and environmental variances and covariance in upLand cotton and their implications in selection. Agron. J. 50: 126-131.

Mitchell, J.W. ; R.J. Baker and **D.R. Knott (1982).** Evaluation of honeycomb selection for single plant yield in durum wheat. Crop Sci., 22 : 840-843.

Mohamed, M.S. (2006). Breeding for drought tolerance in bread wheat under new land conditions in Upper Egypt. Ph. D. Thesis, Agron. Dep., Fac. Agric., Minia Univ., Egypt.

Moshref, M.K. (1996). Genetical and statistical studies in wheat. Ph. D. Thesis, Agron. Dep., Fac. Agric., Al-Azhar Univ., Egypt.

Natarajan C.K.; Thiyagrajan and R. Rathnaswamy (1988). Association and genetic diversity studies in green gram Madras Agric. J. 76 (7-8): 238-245.

Nass, H.G., (1973). Determination of characters for yield selection in spring wheat. Can. J. PI. Sci., 53:755-762.

Pande, M.K. ; S.B. Atale; M.C. Patel; S.R. Golhar and **P.D. Peshattiwar (1998).** Comparison of single seed descent and pedigree selection method in durum wheat (*Triticum durum*). (BIBLIOGRAPHIC CITATION): Annuals-of-Plant-Physiology, 12: 2, 153-155.

Pathak, N.N. and **D.P. Nema (1985).** Genetic advance in landraces of wheat. Indian Jour. Agric. Sci., 55 : 478-479.

Pawar, I.S. ; R.S. Paroda and **S. Singh (1986).** A comparison of pedigree selection, single seed descent and bulk methods in two wheat (*Triticum aestivum* L. em Thell.) crosses. Crop-Improvement., 13: 1, 34-37.

Pawar, I.S. ; R.S. Paroda and **S. Singh (1989).** Study of heritability and genetic advance in three wheat populations. (BIBLIOGRAPHIC CITATION): Bangladesh- J. of Agric. Res., 14: 1, 24-26.

Pawar, I. S. ; R.S. Paroda; M. Yunus and **S. Singh (1985).** A comparison of three selection methods in two wheat crosses.(C. F. Plant Breeding Abst., 57 : 8, 4617).

Pawar, I.S.; A.S. Redhu; S. Iqbal and **M. Yunus (2001).** Effectiveness of selection procedures in wheat. (BIBLIOGRAPHIC CITATION): Haryana- Agric. Univ. J. of Res., 31 : 3-4, 119-121.

Pawar, I. S. ; M. Yunus; S. Singh and **V.P. Singh (1995).** A comparison of genetic variability generated by five selection procedures in wheat. (C. F. Plant Breeding Abst., 65 : 8, 8232).

Perovic, D. (1997). Inheritance of stem height and grain yield components in F_4 and F_5 generations of winter wheat hybrids. (BIBLIOGRAPHIC CITATION): Review- of- Research- work- at- the- faculty- of- Agriculture- Belgrade., 42 : 1, 145-156.

Picard, E. ; J.C. Dusautoir; S. Gregoire ; J. P. Meunier and **E. Verly (1986).** Comparison of methods of producing homozygous lines in wheat: preliminary data. (BIBLIOGRAPHIC CITATION): Bulletin- de- la-Societe- Botanique- de- France- Actualities- Botaniques., 133 : 4, 73.

Raut, S.K.; J.G. Manjaya and P.W. Khorgade, (1995). Selection criteria in wheat (Triticum aestivum L.). P.K.V. Res. J. 19 (1):17-20.

Salmeron, J.J. and **W. E. Kronstad (1986).** Response of grain yield, plant height and kernel weight in winter wheat to different selection methods. (BIBLIOGRAPHIC CITATION): Special- Publication- Agronomy- Society-of- New- Zealand., 5 : 37-41.

Salmon, D.F. ; E.N. Larter and **J.P. Gustafson (1978).** A comparison of early generation (F_3) yield testing and pedigree selection methods in Triticale. Crop Sci., 18 : 673-676.

Shalaby F.H.; Sabah M. Attia; H.M. Ibrahim; S.R. Saleeb; Kh.A. Al-Assily and Sohir A. Mokhtar (2001). Evaluation of some breeding methodology in faba bean (*Vicia faba* L.) J. Agric. Sci. Mansoura Univ., 26(9): 5205-5215.

Shoba-Immadi; Kajjidoni; S.T. and P.M. Salimath (2004). Comparative performance of three breeding methods in three way and double cross populations for improving productivity in black gram (*Vigna mungo* L). National-Journal-of Plant Improvement. 6(1): 31-34.

Sharma, S.K.; K.P. Singh and I. Singh, (1995). Selection responses for grain weight in some mass selected and intermitted populations of wheat (*Triticum aestivum L.*). Indian J. Genet. Pl. Breeding., 55(4):365-373.

Shukla R.S.; Y. Mishra and C.B. Singh, (2000). Variability and association in bread wheat under rainfed condition. Crop Res. Hisar., 19(3):512-515.

Singh, K. H. and **T. B. Singh, (1997).** Random bulk versus individual plant selection in F_2 generation of bread wheat. (BIBLIOGRAPHIC CITATION): Cereal- Research-Communications., 25 : 1, 51-53.

Srivastava, R.B. ; R.S. Paroda; S.C. Sharma and **M.D.Yunus (1989).** Genetic variability and advance under four selection procedures in wheat pedigree breeding program. (BIBLIOGRAPHIC CITATION): Theoretical- and-Applied- Genetics., 77: 4, 516-520.

Sultana S.; L. Rahman and S.H. Habib (2005). Genetic variability, correlation and path analysis in soybean (*Glycine max* L. Merril). International J. of Sustainable Agric. Techn. Gurpukur Res. Institute, Gurpukar, Bangladesh. 1: 5, 16-20 (C.F. summaries of monograph, Accession Number 20073227513 CAB Abstract).

Tammam, A.M. (2004). The efficiency of four selection methods for grain yield improvement in some bread wheat crosses. Egypt. J.. Appl. Sci., 19 , (11): 199-214.

Tee, T. S. and **C.O. Qualset, (1975).** Bulk populations in wheat breading : comparison of single seed descent and random bulk methods. Euphytica., 24 : 393-405.

Tejbir Singh and H.S.Balyan (2003). Relative efficiency of various single plant selection criteria and F3 generation yield testing in wheat (*Triticum aestivum L.*). Indian J. genet. 63(1): 24-29.

Wells, W.C. and K.D. Kofoid (1986). Selection indices to improve an intonating population of spring wheat. Crop Sci. 26: 1104-1109.

Whan B.R.; R. Knight and A.J. Rathjen (1982). Response to selection for grain yield and harvest index in F_2, F_3 and F_4 derived lines of two wheat crosses. Euphytica 31: 139-150.

Yadav R.K. (2007). Genetic variability and coheritability estimates in soybean (*Glycine max.* L.). International Journal of Plant Sci. (Muzaffarnagar). Hind Agri-Horticultural Society, Muzaffarnagar, India 2: 1, 9-11 (C.F. summaries of monograph, Accession Number 20073112616 CAB Abstract).

ARABIC SUMMARY

الملخص العربي

الانتخاب للتبكير و المحصول و مكوناتة في قمح الخبز

أقيمت هذه الدراسة في مركز البحوث الزراعية بمحطةبحوث سدس في مواسم: ٢٠٠٧/ ٢٠٠٨، ٢٠٠٨/ ٢٠٠٩، ٢٠٠٩/ ٢٠١٠ بهدف تقييم ثلاث طرق تربية مختلفة وهى: النسب والتجميع وطريقة ألانحدار عن بذره واحدة/نبات وأيضا تقدير كفاءة الانتخاب المباشر والغير مباشر للمحصول وكانت شدة الانتخاب هي ١٠ %. وقد تم استخدام عشيرتين (هجينين) في الجيل الثاني الهجين الأول هو

WEAVER/WL3926//SW893064/5/Desconocido#6/4/Bl 1133/3/Cmh 79A.955*2/ Cno 79//Cmh 79A.955/Bow's' والهجين الثاني هو

LFN/1158.57//PRL/3/HAHN/4/KAUZ/5/KAUZ/6/Sids4

وتتلخص أهم النتائج المتحصل عليها فيما يلي:-

كانت قيم نسبة التوريث بمعناها الواسع والتحسين الوراثي والتحسين الوراثي كنسبة مئوية ومعامل الاختلاف الوراثي عالية إلى متوسطة لمعظم الصفات تحت الدراسة في الجيل الثالث والرابع.

وفى الجيل الخامس أظهرت طريقة التجميع قيما عالية في النضج ومحصول النبات في الهجين الأول بينما أظهرت طريقة النسب قيما أعلى في كل من عدد السنابل بالنبات وعدد حبوب السنبلة. وهذا يعنى أن طريقة التجميع أفضل لكل من محصول النبات والنضج وطريقة الانحدار عن بذرة واحدة في وزن الالف حبة، بينما في الهجين الثاني أعطت طريقة النسب قيما أعلى لكل من عدد السنابل فى النبات ومحصول النبات وأعطت طريقة الانحدار عن بذرة /نبات قيما أعلى في باقى الصفات. أعطى الانتخاب لعدد الحبوب فى السنبلة

أعلى محصول للنبات في الهجين الأول، بينما أعطى الانتخاب لعدد السنابل فى النبات أعلى محصول للنبات فى الهجين الثاني.

*** بالنسبة للهجين الأول :**

أ- الجيل الثالث والرابع:

١- كانت النتائج معنوية لكل الصفات المدروسة في الجيلين الثالث والرابع.

٢- كان هناك ارتفاع وتحسين وراثي بالنسبة لصفات عدد السنابل بالنبات، عدد حبوب السنبلة ومحصول الحبوب/نبات، كما وجد انخفاض في التحسين الوراثي عند الانتخاب لصفات ميعاد النضج وزن الالف حبة على الترتيب وكذلك ارتفاع في نسبة معامل الاختلاف الوراثي لصفات التفريع، عدد حبوب السنبلة ومحصول الحبوب/نبات و عدد حبوب السنبلة وكانت النسبة متوسطة إلى منخفضة للقيم في باقي الصفات.

٣- أوضحت النتائج زيادة نسبة التراكيب الوراثية المنتخبة والتي تفوقت في محصولها على الأب الأفضل.

٤- أشارت القيم المرتفعة لنسبة التوريث في صفات ميعاد النضج، عدد الحبوب بالسنبلة و عدد السنابل بالنبات إلى فاعلية الانتخاب بالنسبة لهذه الصفات وكانت القيم متوسطة لصفات وزن الالف حبة ومحصول الحبوب، وأشارت القيم المتوقعة للتحسين الوراثي إلى إمكانية زيادة هذه النسبة في النباتات المنتخبة للجيلين الرابع والخامس. وكذلك كان التحسين الوراثي مرتفع لصفات عدد الحبوب بالسنبلة والمحصول. وقد لوحظ انخفاض لصفتي ميعاد النضج.

ب- الجيل الخامس:

*** طرق التربية:**

١- أشارت المتوسطات الى أن هناك معنوية لكل طرق التربية بالنسبة لصفات ميعاد النضج والمحصول ومكوناته والنتائج توضح الفروق بين طرق التربية المختلفة.

٢- كانت طريقة التجميع هي أفضل طرق التربية المستخدمة بالنسبة لصفات محصول الحبوب/نبات والنضج. بينما طريقة الانحدار عن بذرة واحدة كانت الافضل فى صفة وزن الالف حبة وكذلك طريقة تسجيل النسب كانت الالفضل فى التفريع و عدد حبوب السنبلة.

٣- كانت أفضل السلالات لصفة محصول البذور للنبات هي السلالة رقم ١٨ وأعطت ٩٥,٣٧٨جم و رقم ١٢ وأعطت ٩٤,٣٥٠جم و رقم٥ وأعطت ٨٢,٤١٨جم و رقم ٢ وأعطت ٧٨,٤٩٤جم رقم ٤ وأعطت ٧٥,٨٠٠جم حبوب للنبات وذلك في طريقة التجميع والسلالة رقم ١٣ وأعطت ٨٠,٨٥٣جم رقم ١١ وأعطت ٧٥,١٣٩جم رقم ١٦ وأعطت ٧٣,٦٦١جم حبوب للنبات وذلك في طريقة النسب. بينما طريقة الانحدار عن بذرة واحدة السلالة رقم ١٥ اعطت ٨٠,٩٠٣جم و السلالة رقم ١٠ اعطت ٧٣,٤٣٢جم وأيرا السلالة رقم ١ أعطت ٧٢,٦١٧جم حبوب للنبات.

*** الصفات التي تم الانتخاب لها:**

١- أشارت متوسطات الصفات المنتخب لها إلى معنوية صفات عدد السنابل بالنبات و عدد الحبوب بالسنبلة و وزن الالف حبة (انتخاب غير مباشر) ومحصول الحبوب المرتفع (انتخاب مباشر) وكانت هناك فروق معنوية.

٢- أظهرت النتائج أن الانتخاب لوزن الالف حبة أعطى زيادة معنوية لدليل المحصول.

٣- أوضحت المقارنة كفاءة الانتخاب لصفة عدد الحبوب بالسنبلة ويليه عدد السنابل بالنبات ثم وزن الالف حبة مما أدى إلى تحسين المتوسط العام للمحصول في سلالات الجيل الخامس لهذا الهجين وأيضا اختيار اكبر عدد من السلالات عالية المحصول.

* **بالنسبة للهجين الثاني:**

أ- في الجيل الثالث والرابع:

١- أوضحت النتائج إلى وجود معنوية عالية للتراكيب الوراثية لعائلات الجيل الثالث للصفات المدروسة مما يشير إلى وجود اختلافات معنوية بين هذه العائلات.

٢- بالنسبة لعدد الايام حتي النضج لا يوجد عائلات من الثمانين أعطي معنوية فى الجيل الثالث من أبكر الاباء وهو سدس ٤.

٣- العائلات رقم ١، ١٤ ، ١٨، ٣٤، ٦٦، ٧١، ٧٤، و٧٦ كانت افضل من أحسن الأبوين فى صفة عدد السنابل بالنبات.

٤- العائلات رقم ١٠ ، ٢٧، ٢٩، ٣١، ٣٢، ٣٣، ٣٥، ٣٦، ٣٧، ٣٨، ٣٩، ٤٢، ٤٤، ٤٧، ٥٣، ٥٤، ٥٩، ٦٠، ٦١، ٦٢، ٦٦، و ٦٧ كانت افضل من أحسن الأبوين فى صفة عدد حبوب السنبلة بالنبات.

٥- العائلات رقم ٢، ٩، ١٠، ١٦، ٢٨، ٣٥، و ٥٨ كانت افضل من أحسن الأبوين فى صفة وزن الالف حبة.

٦- أظهرت مكونات التباين الوراثي زيادة في قيم التحسين الوراثي ومعامل الاختلاف الوراثي لصفات عدد السنابل بالنبات وعدد الحبوب بالسنبلة ومحصول النبات في حين كانت القيم متوسطة بالنسبة لصفات ميعاد النضج ووزن الالف حبة مع ارتفاع درجة التوريث بمعناها العريض لجميع الصفات المدروسة.

٧- أوضحت المتوسطات معنوية جميع الصفات المدروسة في عائلات الجيل الرابع التي تم انتخابها.

٨- بالنسبة لعدد الايام حتي النضج لا يوجد عائلات من الثمانين أعطي معنوية فى الجيل الرابع من أبكر الاباء وهو سدس ٤.

٩- بالنسبة لصفة عدد السنابل فى النبات تباينت العائلات وتراوح المدى ما بين ٤,٥٣ للعائلة ١٠ إلى١٩,٦٧ للعائلة رقم ١٢.

١٠- سجلت العائلات رقم٣ ،١٤، ١٦، ٢٤، ٢٩، ٣١، ٣٢، ٣٧، ٣٤ و ٤٠ كانت افضل من أحسن الأبوين فى صفة عدد حبوب السنبلة بالنبات.

١١- بالنسبة لمحصول الحبوب بالنبات لا توجد عائلات تفوقت على أحسن الأبوين ماعدا رقم١٢ و ٣٣.

١٢- أوضحت النتائج ارتفاع قيم درجات التوريث في عائلات الجيل الرابع لكل الصفات مما يدل على كفاءة الانتخاب فى هذه العائلات لتلك الصفات.

ب- الجيل الخامس:

*** طرق التربية:**

١- أشارت المتوسطات إلى معنوية كل طرق التربية لصفات: ميعاد النضج والمحصول ومكوناته.

٢- تعتبر طريقة النسب أفضل طريقة تربية بالنسبة عدد السنابل بالنبات و المحصول العالي للنبات، بينما طريقة الانحدار عن بذرة واحدة أفضل فى باقى الصفات.

٣- كانت أفضل التراكيب الوراثية في طريقة النسب السلالة رقم ٤ (٨٦. ٥٦ جم) والسلالة رقم ١١ (٧٣,٩٠٢ جم) بالنسبة لطريقة تسجيل النسب. بينما السلالات رقم ١٢ (٨٩,٩٤٦ جم) و رقم ٥ (٧٥,٢٩١ جم) بالنسبة للتجميع فى حين كانت السلالات رقم ١٢ (٦٩,٤٠٠ جم)بالنسبة الى طريقة الانحدار عن بذرة واحدة.

٤- بالنسبة لميعاد النضج سلالاتين هم رقم ٧ (١٣٠,٦٦٧يوم) و رقم ٥ (١٣١,٦٦٧ يوم) فى طريقة تسجيل النسب بينما فى طريقة التجميع و طريقة الانحدار عن بذرة واحدة لا يوجد اى سلالات.

٥- بالنسبة لصفة عدد السنابل بالنبات دلت ىالنتائج على ان طريقة تسجيل النسب كانت أفضل من التجميع و طريقة الانحدار عن بذرة واحدة مقارنة بأفضل الاباء. أثنى عشر سلالة من العشرون أظهرت معنوية فى طريقة

تسجيل النسب. لكن ثلاثة فى طريقة التجميع بينما ثلاثة فى طريقة الانحدار عن بذرة واحدة.

٦- بالنسبة لصفة وزن الالف حبة ١٠ ،٢ و ٢ سلالة أظهرت معنوية أعلى من أحسن ألابوين فى طريقة الانحدار عن بذرة واحدة و طريقة تسجيل النسب و أخيرا طريقة التجميع على الترتيب. بينما كانت اعلى قيمة فى هذه الصفة هى السلالة رقم ١٧ (٥٩,٣٥١ جم) مقارنة بالمتوسط العام فى طريقة الانحدار عن بذرة واحدة.

٧- بالنسبة لصفة عدد الحبوب بالنبات أظهرت ستة سلالات معنوية عالية بالنسبة لصفة عدد الحبوب بالنبات مقارنة بالمتوسط العام وكذلك بالأب الأعلى في طريقة النسب. السلالات رقم ١ و أعطت أعلى عدد فى طريقة تسجيل النسب. لكنلا يوجد سلالات أظهرت معنوية عالية بالنسبة لصفة عدد الحبوب بالنبات مقارنة بالمتوسط العام وكذلك بالأب الأعلى في طريقة التجميع. بينما كانت أفضل طريقة فى هذه العشيرة كانت طريقة الانحدار عن بذرة واحدة حيث كان هناك أربعة سلالات أظهرت معنوية عالية بالنسبة لصفة عدد الحبوب بالنبات مقارنة بالمتوسط العام وكذلك بالأب الأعلى وايضا الصنف المقارن سدس ١٢ .

*** الصفات التي تم الانتخاب لها:**

١- أشارت متوسطات الصفات المنتخب لها إلى معنوية صفات عدد السنابل بالنبات و عدد الحبوب بالسنبلة و وزن الالف حبة (انتخاب غير مباشر) ومحصول الحبوب المرتفع (انتخاب مباشر) وكانت هناك فروق معنوية.

٢- جاء الانتخاب للعدد السنابل بالنبات أولا والتي أعطت أعلى محصول حبوب للنبات ثم عدد الحبوب بالسنبلة.

٣- أفاد الانتخاب لصفات عدد السنابل بالنبات وعدد الحبوب بالسنبلة في الثلاثة أجيال الانعزالية في تحسين متوسط محصول الحبوب لسلالات الجيل الخامس.

٤- بالنسبة لعدد الايام حتي النضج لا يوجد سلالات فى الجيل الخامس كانت أبكر من افضل الاباء.

٥- بالنسبة الى عدد السنابل النبات ٨ ،١ ،صفر و ٣ سلالة كانت عالية المعنوية من افضل الأباء مع عدد السنابل بالنبات ثم عدد الحبوب بالسنبلة ثم وزن الالف حبة ثم المحصول على الترتيب. هذه النتائج كانت متوقعة و منطقية. أفضل سلالة كانت رقم ٢ والسنابل فى النبات بينما رقم ٨ عندما كان الانتخاب لصفة عدد الحبوب فى السنبلة ايضا رقم ١٨ عندما كان الانتخاب لصفة وزن الالف حبة ورقم ١٢ عندما كان الانتخاب لصفة المحصول.

٦- أظهرت المقارنة كفاءة الانتخاب لصفة عدد السنابل بالنبات ثم عدد الحبوب بالسنبلة في تحسين متوسط المحصول في سلالات الجيل الخامس لهذا الهجين وكذلك الكشف عن اكبر عدد من السلالات عالية المحصول عند الانتخاب للعدد السنابل بالنبات والتي أظهرت أيضا أن الانتخاب غير المباشر للمحصول. وايضا عدد السنابل بالنبات كان أكثر فاعلية عن الانتخاب المباشر للمحصول.


بِسْمِ اللَّهِ الرَّحْمَٰنِ الرَّحِيمِ
مَّثَلُ الَّذِينَ يُنفِقُونَ أَمْوَالَهُمْ فِي سَبِيلِ اللَّهِ كَمَثَلِ حَبَّةٍ
أَنبَتَتْ سَبْعَ سَنَابِلَ فِي كُلِّ سُنبُلَةٍ مِّائَةُ حَبَّةٍ ۗ وَاللَّهُ يُضَاعِفُ
لِمَن يَشَاءُ ۗ وَاللَّهُ وَاسِعٌ عَلِيمٌ ﴿٢٦١﴾
صدق الله العظيم

الانتخاب للتبكير و المحصول و مكونـاتة في قمح الخبز

رسالة علمية مقدمة من

محمد مرعي محمد حموده

بكالوريوس العلوم الزراعية – كلية الزراعة – جامعة المنيا ٢٠٠٢

ماجستير في العلوم الزراعية (محاصيل) – كلية الزراعة – جامعة المنيا ٢٠٠٧

للحصول علي

درجة دكتوراه الفلسفة في العلوم الزراعية

محاصيــــل (تربية المحاصيل)

و قد تمت مناقشة الرسالة و الموافقة عليها.

لجنة الفحص و المناقشة:

ا.د/ السيد محمد حسن شكر ....

أستاذ تربية المحاصيل المتفرغ بكلية الزراعة – جامعة بنها.

ا.د/ محمود سليمان سلطان ....

أستاذ المحاصيل المتفرغ – كلية الزراعة – جامعة المنصورة.

ا.د/ على عبد المقصود الحصرى ....

أستاذ تربية المحاصيل – كلية الزراعة – جامعة بنها.

ا.د/ محمد السيد رياض جمعه ....

أستاذ المحاصيل – كلية الزراعة – جامعة بنها.

د/ محمود الزعبلاوى البدوى ....

أستاذ تربية المحاصيل المساعد بكلية الزراعة – جامعة بنها.

تاريخ الموافقة: ٢٠١٢/٢/٢٢

الانتخاب للتبكير و المحصول و مكوناتة في قمح الخبز

رسالة علمية مقدمة من

محمد مرعي محمد حموده

بكالوريوس العلوم الزراعية – كلية الزراعة – جامعة المنيا ٢٠٠٢

ماجستير في العلوم الزراعية (محاصيل) – كلية الزراعة – جامعة المنيا ٢٠٠٧

للحصول علي

درجة دكتوراه الفلسفة في العلوم الزراعية

محاصيـــــل (تربية المحاصيل)

لجنة الإشراف:

أ.د/ على عبد القصود الحصرى ....

أستاذ تربية المحاصيل بكلية الزراعة – جامعة بنها.

أ.د/ السيد محمد حسن شكر ....

أستاذ تربية المحاصيل بكلية الزراعة – جامعة بنها.

أ.د/ محمد السيد رياض جمعه ....

أستاذ المحاصيل بكلية الزراعة – جامعة بنها.

أ.د/ محروس عبد الغنى أبو شريف ....

رئيس بحوث متفرغ – مركز البحوث الزراعية.

٢٠١٢

الانتخاب للتبكير و المحصول ومكوناته
في قمح الخبز

رسالة علمية مقدمة من

محمد مرعي محمد حموده

بكالوريوس العلوم الزراعية – كلية الزراعة – جامعة المنيا ٢٠٠٢
ماجستير في العلوم الزراعية (محاصيل) – كلية الزراعة – جامعة المنيا ٢٠٠٧

للحصول علي

درجة دكتوراه الفلسفة في العلوم الزراعية

محاصيــــل (تربية المحاصيل)

قسم المحاصيل

كليـة الزراعـة

جامعة بنهــا

٢٠١٢