RESULTS AND DISCUSSION

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The analysis of variance for each experiment and the combined analysis for all studied traits are presented in Table (6).

Results indicated that nitrogen levels mean squares were significant for all the studied traits, indicating an overall differences between the three levels of nitrogen.

Results in Table (7) indicate the effect of nitrogen fertilizer levels on the studied traits. It is clear that all traits increased significantly with increasing nitrogen levels up to 40 kg/ fed. except oil percentage where the highest mean value was detected by plant received 20 kg/ fed. This result might be attributed to the pronounced improvement of growth, yield and yield components by increasing N level, which in turn increased the yield of sunflower.

It is obvious from Table (7) that seed yield and oil percentage followed opposite direction in their response to nitrogen levels. While seed yield and yield components increased with increasing nitrogen levels, oil percentage decreased. Therefore, the minimum oil and maximum seed yield were obtained by high level of nitrogen (40 kg/ fed.) and vice versa in low nitrogen level (20 kg N/ fed.). This result may be due to the metabolism and commutative of oil content was determined and not increased by increasing nitrogen levels, whereas, the other seed contents increased by increasing nitrogen levels. This statement might provide an explanation to the previous findings. in this connection, the high seed yield and low oil content was expected by increasing nitrogen level.

These results are in harmony with those obtained by Montti (1975), Tomov (1976), Shabana (1978), Sanford *et al.* (1979), Zubriski *et al.* (1979), El- Ahmmer *et al.* (1980), Pirani (1983), El- Emam (1984) and Attia (1985).

Highly significant genotypes mean squares were obtained for all the studied traits at the three nitrogen levels as well as the combined analysis (Table 6), indicating the wide diversity between the parental materials used in the present study. Insignificant genotypes x nitrogen levels mean squares were obtained for all the studied traits except number of seeds per head, revealing that the genotypes responded in a similar manner to the nitrogen fertilizer levels. On the contrary, for the exceptional trait (number of seeds per head) which showed significant genotypes by nitrogen fertilizer levels interaction, it indicated that the performance of genotypes differed from one nitrogen level to another.

Results also showed that mean squares due to parents were highly significant for all cases. Insignificant mean squares due to interaction between parental inbred lines and nitrogen levels were obtained for all traits. This result, therefore, might reveal the high repeatability of the tested parental inbred lines under different nitrogen levels.

The mean performance of the tested parental inbred lines at each nitrogen fertilizer levels as well as the combined data are presented in Table (8). The parental inbred lines (P5), (P6) and (P7) gave the lowest values of number of days to flowering in the three nitrogen levels and the combined data. However, the parental inbred line (P1) gave the latest with regard to number of days to flowering. For plant height, the parental inbred line (P1) gave the highest values for the first, second and third nitrogen levels as well as the combined data. However, the parental inbred line (P5) had the lowest one.

For number of leaves per plant, the parental inbred line (P1) and (P2) had the highest values, over the three nitrogen levels or each level. While, the parental inbred line (P5) gave the lowest values followed by parental line P4 (Table 8).

For seed yield and yield components, the inbred lines (P1) and (P2) had the highest values for seed yield per plant, husk percentage, 1000 seed weight, 100 seed size and head diameter in the first, second and third nitrogen levels as well as the combined data. However, the parental inbred line (P5) had the lowest value for these traits. Meanwhile, it produced the highest significant values for number of seeds per head when compared with the other parental inbred lines. It is interesting to note that the superiority of the two parental inbred lines (P1) and (P2) in seed yield per plant resulted from 1000- seed weight, 100- seed size, head diameter and husk percentage.

With respect to oil percentage, the parental inbred line (P5) gave the highest values of oil percentage at the first, second and third nitrogen levels as well as the combined data.

Data presented in Table (6) showed that crosses mean squares were highly significant for all the studied traits in the separate nitrogen fertilizer levels as well as the combined data except number of leaves per plant at the third nitrogen level. Mean squares due to interaction between F_1 hybrids and nitrogen fertilization levels was significant for oil percentage, indicating that F_1 hybrids behaved some what differently from one nitrogen fertilizer level to another. On the contrary, insignificant mean squares due to interaction between F_1 hybrids and nitrogen fertilizer levels were detected for all the other traits. This result, therefore, might reveal the high repeatability of the tested crosses under different nitrogen fertilizer levels.

The mean performances of the tested 21 crosses at each nitrogen fertilizer levels as well as the combined data are presented in Table (8). The cross (P5 x P6) was the best for number of days to flowering. Also, it had the lowest value of plant height, number of seeds per head, and seed yield per plant and it was moderate for the other traits. Meanwhile, the cross (P5 x P6) had the earliest for number of days to flowering but without significant superiority over those of crosses (P1 x P6), (P2 x P3), (P2 x P6), (P2 x P7), (P3 x P6), (P4 x P6) and (P5 x P7). Moreover, the cross (P4 x P5) gave the latest with regard to number of days to flowering.

The cross (P3 x P5) had the lowest value for plant height, but without superiority over the crosses (P2 x P5), (P4 x P5) and (P5 x P6) at the combined analysis. The values of plant height increased by increasing nitrogen fertilizer levels in all crosses. The cross (P1 x P2) gave the highest value for plant height at the combined analysis.

For number of leaves per plant, none of the hybrids surpassed the highest parent. Also, hybrids were within the range of parental lines. The cross (P1 x P2) showed the highest value for this trait, but without significant superiority over the crosses between parental (P7) and each of the other parents, and both crosses (P5 x P6) and (P6 x P7). On the contrary, the crosses (P3 x P6) in the first nitrogen level (20 kg N/ fed.), (P3 x P5) in the second nitrogen level (30 kg N/ fed.), (P2 x P6) in the third nitrogen level (40 kg N/ fed.) and (P3 x P5) at the combined analysis gave the lowest ones.

The hybrids were within the range of parental genotypes for head diameter. The crosses (P1 x P4), (P1 x P6), (P1 x P7) and (P1 x P6) showed the highest values for head diameter at the first , second, third nitrogen levels as well as the combined data, respectively. However, the cross (P4 x P6) gave the lowest ones at the three levels of nitrogen and the combined analysis.

The crosses (P2 x P3) and (P1 x P2) had the highest values for 100-seed size and 1000 seed weight, respectively, in the three levels of nitrogen and the combined analysis. On the contrary, the cross (P3 x P4) gave the lowest ones for both traits. None of the hybrids surpassed the highest parent for husk percentage. The cross (P2 x P5) had the highest value for husk percentage at the combined analysis, but without significant superiority over the crosses (P1 x P4), (P1 x P5), (P1 x P6) and (P2 x P4) in the combined analysis. Also, the hybrids were within the range of parental genotypes for oil percentage. The cross (P4 x P5) had the highest oil percentage in the combined analysis followed by cross (P3 x P4). On the other hand, the cross (P1 x P3) gave the lowest ones.

With regard to seed yield per plant, the cross (P1 x P4) had the highest seed yield per plant in the three nitrogen levels and the combined analysis, followed by crosses (P1 x P2) and (P1 x P7). The high seed yield per plant in the three crosses could be attributed to its high number of seeds per head and 1000 seed weight. It can be concluded that these crosses would be efficient and prospective in sunflower breeding program for seed and oil yields per plant. Also, these crosses had the highest oil percentage.

The cross (P1 x P3) in the first, second nitrogen levels and the combined analysis, and the cross (P1 x P4)in the third nitrogen level gave the highest number of seeds per head. However, the cross (P2 x P5) had the lowest ones in the first, second, third nitrogen levels and the combined analysis.

Correlation coefficient values between mid- parent and F_1 hybrids mean values in each of the studied trait are presented in Table (8).

Significant positive correlation coefficient values were detected for plant height, 100 seed size and 1000 seed weight in the three nitrogen levels as well as the combined analysis. Such results clarified good agreement between mid- parent values and F_1 performance. Consequently the best performance of F_1 combination could be achieved by crossing between parental inbred lines of high values.

Insignificant correlation coefficient values, meanwhile, were detected for the rest traits indicated that certain high and low parental inbred lines may produce outstanding F_1 hybrids in this concern.

Heterosis :

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses was of appreciable magnitude in the three fertilizer levels as well as their combined for all investigated traits except seed yield per plant in the three nitrogen levels and the combined data, number of leaves per plant at the third levels (40 kg/ fed.) and husk percentage at the second, third nitrogen levels as well as the combined data (Table 6). Insignificant mean squares due to interaction between parents vs. crosses and nitrogen fertilizer levels were detected for all the studied traits. These results indicated that the heterotic effects were not affected by the nitrogen fertilizer levels under study. The results agreed with the results reported by Zielinska and Zielinska (1979), Zaffaroni and Schnieter (1991).

F_1 mean performances were significantly higher than parental means for head diameter, 1000 seed weight and oil percentage at the first, second, and third nitrogen levels as well as the combined analysis., number of leaves per plant at the first , second nitrogen levels as well as the combined data and husk percentage at the first nitrogen level. However, the plant height, number of days to flowering, number of seeds per head and 100- seed size at the three nitrogen levels as well as the combined data, the parental mean performances were significantly higher than F_1 means.

Heterosis expressed as the percentage deviation of F1 mean performance from its mid parent and better parent average values for all the studied traits at the three nitrogen levels and an average over the three nitrogen levels, are presented in Table (9).

With regard to number of days to flowering, five, two, three and four crosses manifested significant negative heterotic effects in the first, second, third nitrogen levels as well as the combined data over mid-parent, respectively. Meanwhile, the cross (P2 x P3) expressed significant negative heterotic effects relative to better parent at the first, third nitrogen levels as well as the combined data. The other crosses were either equal to or significantly surpassed the mid- parent or better parent. The significant of this character lies in the fact that negative heterosis should to a proportional earliness in the crosses that possess this heterotic effect. Putt (1966) and Chaudhary and Anand (1986) obtained negative estimates. Seetharam (1977) however, found positive estimates for this character.

For plant height, four, four, three and two combinations gave significant negative heterotic effects relative to mid- parent in the first, second and third nitrogen levels as well as the combined data, respectively. Also, the cross (P2 x P3) of the previous crosses had significant negative heterotic effects relative to better parent in the first and second nitrogen levels. Negative heterosis for plant height was recorded before by Putt (1966), and Kovacik and Skaloud (1990).

However, two, two, three and two combinations significantly exceeded the mid- parents in the first, second, third nitrogen levels and the combined analysis, respectively. While, ten, eight, fourteen, and ten hybrids showed positive heterotic effects relative to better parent in the same order. Significantly positive heterotic effect for plant height over mid- parents and/ or better parent were recorded by Stoyanova (1971), Gorbachenko (1980) Chaudhary and Anand (1986) and Taha (1994).

Concerning number of leaves per plant, two, four, one and two crosses expressed significant positive heterotic effects relative to mid- parents in the first, second, third nitrogen levels as well as the combined data, respectively. However, all hybrids were either equal or significant negative heterotic effects relative to better parent in the three nitrogen levels as well as the combined analysis. These results are in harmony with those recorded by Niklyaev (1976) and Pirani (1983).

For head diameter, six, five, four and six combinations exhibited significant positive heterotic effects relative to mid- parents in the first, second, third nitrogen levels as well as the combined analysis, respectively. Also, the cross (P5 x P6) of the previous crosses significantly surpassed the better parent at the three nitrogen levels as well as the combined analysis. Significant positive heterotic effects for head diameter over mid- parents and/ or over better parent were recorded by Putt (1966), Seetharam (1977), Ge (1982), Shrinivasa (1983) as well as Chaudhary and Anand (1986).

For 100- seed size, all hybrids were either equal to or significant negative heterotic effects relative to mid and/ or better parents.

For number of seeds per head, two, two, four and three combinations significantly exceeded the mid parents in the first, second, third levels of nitrogen as well as the combined analysis, respectively. Also, the cross (P1 x P3) in the three nitrogen levels and the combined data as well as the cross (P1 x P4) in the second, third nitrogen levels and the combined analysis, significantly surpassed the better parent. The other hybrids, either were equal to or significant and negative relative to the mid parents or better parent. In this concern, Putt (1966) and Ge (1982) found an increase of 47 % in this character.

Also, from Table 9, it could be noticed that 1000- seed weight, in the three crosses (P1 x P4), (P1 x P5) and (P4 x P5) showed significant positive heterotic effects relative to mid- parents in the nitrogen levels as well as the combined data. All hybrids, either were equal to or significant negative heterotic effects relative to the better parent in the three nitrogen levels as well as the combined analysis. Putt (1966), Shrinivasa (1983) and Chaudhary and Anand (1986) obtained heterosis values over the better parent for this trait.

With respect to husk percentage, three, two, three and three combinations showed significant negative heterotic effects relative to mid parents in the first, second, third nitrogen levels as well as the combined data, respectively. Also, the cross (P4 x P6) in the first nitrogen level and the cross (P1 x P3) in the first, third nitrogen levels as well as combined data expressed significant negative heterotic effects relative to the better parent. Significant heterotic effects for husk percentage were recorded before by Kukosk (1986).

Concerning seed yield per plant, three crosses in the three nitrogen levels and four crosses in the combined analysis surpassed the mid-parents. The cross (P1 x P4) had the highest values for heterosis relative to mid- parents or the better parent in the three nitrogen levels as well as the combined analysis. Also, both crosses (P1 x P2) and (P1 x P7) exhibited significant positive heterotic effects relative to the better parent in the first and second nitrogen levels, respectively. The other hybrids were either equal to or significantly negative to mid and/ or better parent. Putt (1966), Niklyaev (1976), Putt and Dorell (1977), Seetharam (1977), Gorbachenko (1980), Nuthan (1981), Toit (1981), Ge (1982), Vranceanu (1983), Chaudhary and Anand (1986) and Sheriff and Appadurai (1987) obtained significant positive heterotic effects for seed yield per plant.

With respect to oil percentage, nine, eleven, ten and ten combinations significantly exceeded the mid- parents in the first, second, third nitrogen levels as well as the combined analysis, respectively. Also, both crosses (P1 x P2) and (P1 x P7) significantly surpassed the better parent in the three nitrogen levels as well as the combined analysis. Significant positive heterotic effects for oil percentage were recorded by Stoyanova (1971), Seetharam (1977), Skoric (1981), Shvestova (1982) and Chaudhary and Anand (1986).

The cross (P1 x P4) expressed significant high mean values when compared with each of the three check hybrids Hysun 354, G 101 and Vidoc for seed yield per plant (Table 9). The cross (P1 x P4) significantly outyielded the three hybrid varieties Hysun 354, G 101 and Vidoc by 57.03, 30.30 and 41.54 %, respectively over the three nitrogen levels.

Also, the both crosses (P1 x P2) and (P1 x P7) significantly outyielded the check hybrid Hysun 354 by 40.45 and 28.28 % at the first nitrogen level, 34.79 and 37.56 at the second nitrogen level, 38.00 and 41.11 at the third nitrogen level and 37.72 and 35.9 % at the combined analysis, respectively. Also, both crosses (P1 x P3), (P1 x P7) appreciably outyielded the check hybrid G 101 by 14.28 and 12.77 %, respectively in the combined data. Also, it surpassed the Vidoc hybrid by 24.13 and 22.49 % in the combined analysis, respectively.

It could be concluded that the previous three F_1 hybrids offer possibility for improving seed yield of sunflower. This finding revealed that a hybrid program based on this material will be effective.

Combining ability :

Analysis of variance for combining ability as outlined by Griffing's (1956) method 2 model 1 in each nitrogen fertilizer level as well as their combined for all the growth, yield, yield components and oil percentage is shown in Table (6). Variances of general and specific combining abilities have been determined and related to the possible types of gene action involved (Sprague and Tatum, 1942).

The mean squares associated with general and specific combining abilities were significant for all traits except for number of leaves/ plant at the 40 kg N/ fed. which showed an insignificant S.C.A. It is evident that additive and additive by additive types of gene action were the more important part of the total genetic variability for this exceptional case. For other traits, both additive and nonadditive gene effects were involved in determining the performance of single cross progeny. Also, results showed that all other cases exhibited high G.C.A/ S.C.A ratios which exceeded the unity indicating the predominance of additive and additive by additive gene action in the inheritance of such cases.

These results were along the same line of those reported by Putt (1966) for 1000- seed weight and head diameter traits, Dua and Yadava (1985), Jukic (1990) and Taha (1993) where they found that both additive and non additive gene effects are important in controlling most of sunflower characters. Moreover, Putt (1966), Dua (1979) , Tuberosa *et al.* (1983), Pathak *et al.* (1987), Singh *et al.* (1989), Rudranaik *et al.* (1990) and Marinkovic (1993) pointed out that the non additive variation was the only predominant type of gene action for most characters.

On the other hand, the preponderance of additive gene effects for sunflower yield and its components was recorded by Putt (1966) for number of days to flowering and oil content traits, Dua (1979), Rudranaik *et al.* (1990) for 100- seed weight trait, Marinkovic (1993) for number of seeds per plant and Taha (1993) for most traits.

The mean squares of interaction between nitrogen levels and both types of combining ability were non significant for all traits indicating that additive and non- additive types of gene action were not influenced by the environmental conditions (Nitrogen levels). This result may be due to the narrow range among different levels of nitrogen, this trend was obtained by Zubriski *et al.*,(1979).

Estimates of general combining ability effects ($\hat{g}_i$) for individual parental lines in each trait at each nitrogen level as well as the combined data are presented in Table (10). Theoretically an estimate of ($\hat{g}i$) effects of the inbred line is not an absolute value. It actually depends upon the group of inbred lines with which this particular inbred line was crossed in the diallel crossing system. If the inbred line is exactly average in its ($\hat{g}i$), the expected estimate ($\hat{g}i$) would be zero. Significant departure from zero, wherever the direction, would indicate that the inbred line is much better or much poorer than overall average of the parental inbred lines involved in the test. High positive values would be of interest under all traits in question except flowering date, plant height and husk percentage where high negative values would be useful from the breeder point of view.

The parental inbred line (P1) expressed significant positive ($\hat{g}i$) effects for number of leaves per plant, head diameter, 100- seed size, number of seeds/ head, 1000- seed weight and seed yield per plant. However, it gave undesirable ($\hat{g}i$) effects for number of days to flowering, plant height, husk percentage, and oil percentage. The parental inbred line (P2) exhibited significant desirable ($\hat{g}i$) effects for number of days to flowering, head diameter, 100- seed size, 1000 seed weight, seed yield per plant in the combined data, but it gave undesirable ($\hat{g}i$) effects for other traits. The parental inbred line (P3) expressed significant desirable ($\hat{g}i$) effects for number of seeds per head, oil percentage and husk percentage, but was average in the other traits. The parental inbred line (P4) had undesirable ($\hat{g}i$) effects for all traits except plant height and oil percentage. The parental inbred line (P5) expressed significant undesirable ($\hat{g}i$) effects for all traits except plant height, husk percentage and oil percentage where it gave the desirable ($\hat{g}i$) effects. The parental inbred line (P6) appeared to be the best general combiner for number of days to flowering, plant height and oil percentage. On the contrary, inbred line (P6) was considered as a poor general combiner for other traits. The parental inbred line (P7) appeared to be a good combiner for number of days to flowering, plant height, head diameter, number of seeds per head and husk percentage.

The parental inbred lines P6, P5, P1, P1, P2, P1, P2, P5, P1 and P4 appeared to be the best general combiners for number of days to flowering, plant height, number of leaves per plant, head diameter, 100-seed size, number of seeds per head, 1000- seed weight, husk percentage, seed yield per plant and oil percentage, respectively. These results suggest that improving opportunity by selection would be possible for earliness, oil percentage, yield and its components.

It is worthy mentioning that an excellent agreement between the parental performances and its (ĝi) effects was obtained for all studied traits in the three nitrogen levels as well as combined analysis except number of seeds per head. Therefore, it could be concluded that high performing hybrids could not be reached except when crossing is carried out between parental inbred lines characterized by high mean performances. Such agreement might add another proof for the preponderance of additive genetic variance governing these traits, and coincides with the finding reached above (Table 6). A similar trend was previously reported by Putt (1966), Dua and Yadava (1985), Pathak *et al.* (1987), Jukic (1990) and Taha (1993).

The estimates of specific combining ability effects in twenty one crosses for the studied attributes at 20, 30 and 40 kg N/ fed. as well as the combined analysis are presented in Table (11).

For number of days to flowering, six, seven, seven and seven crosses showed significant negative S.C.A effects at 20, 30, 40 kg N/ fed. and the combined analysis, respectively. On the same order, however, five, six, five and four crosses had significant positive S.C.A effects. Insignificant S.C.A effects were detected in the other crosses. The cross (P5 x P6) followed by crosses (P3 x P4), (P2 x P3) and (P1 x P2) had highly significant negative values of S.C.A effect in the combined analysis and two of nitrogen levels for earliness and these crosses could be considered as the best ones for earliness.

Regarding plant height, five crosses in each three nitrogen levels and six crosses at the combined analysis gave significant negative S.C.A. effects. However, four, seven. six and three crosses showed significant positive S.C.A. effects at 20, 30, 40 kg N/ fed. and the combined analysis, respectively. Insignificant S.C.A effects were detected in the rest cases. Both crosses (P1 x P3) and (P2 x P5) showed significant negative S.C.A effects in the three nitrogen levels as well as the combined data. However, the three crosses (P1 x P5), (P5 x P7) and (P4 x P6) had significant positive S.C.A effects in the three levels of nitrogen as well as the combined analysis for this trait. The cross (P1 x P3) gave the highest desirable S.C.A effect followed by cross (P2 x P5) for this trait.

For number of leaves per plant, six, seven, one and six parental combinations had significant positive S.C.A effects at 20, 30 and 40 kg N/

fed. as well as the combined analysis, respectively. The other cases showed either insignificant or significant negative S.C.A effects.

Considering head diameter, seven, seven, seven, and seven crosses had significant positive S.C.A effects at each of 20, 30, 40 kg N/ fed as well as the combined between them. The cross (P5 x P6) had the highest desirable S.C.A effect for this trait and this cross could be considered as the best one for increasing head diameter. On the other side, most other crosses gave insignificant S.C.A effects for this trait.

With respect to 100- seed size, three, three, four and four crosses had significant positive S.C.A effects at 20, 30, 40 kg N/ fed and the combined analysis, respectively. Also, the cross (P2 x P3) followed by cross (P5 x P6) gave the highest desirable S.C.A effects in the three nitrogen fertilizer levels and the combined analysis. The cross (P1 x P2), (P1 x P4) and (P3 x P4) showed significant positive S.C.A effects for number of seeds per head in each nitrogen level as well as the combined analysis. Also, the cross (P1 x P3) in the first, third nitrogen levels as well as the combined, the cross (P3 x P6) in the third nitrogen level and the cross (P5 x P7) in the second nitrogen level had significant positive S.C.A effects for this trait. The other crosses gave either insignificant or significant negative S.C.A effects.

Results of eight, ten, eight and seven crosses showed significant positive S.C.A effects for 1000- seed weight at 20, 30, and 40 kg N/ fed. as well as the combined analysis, respectively.

For the husk percentage, seven, seven, five, and seven combinations showed significant negative S.C.A effects at 20, 30 and 40 kg N/ fed. as well as the combined analysis, respectively. The cross (P1 x P3) produced the highest desirable S.C.A effect followed by the cross (P4 x P6) for this trait at the three nitrogen levels as well as the combined analysis.

For oil percentage, nine, ten, nine and ten combinations showed significant positive S.C.A effects at the first, second and third nitrogen levels as well as the combined analysis, respectively. Generally, the cross (P1 x P7) had the highest S.C.A effect for oil percentage followed by both crosses (P1 x P6) and (P1 x P2).

Regarding seed yield per plant, six, four, four, and four combinations showed significant positive S.C.A effects at 20, 30 and 40 kg N/ fed. as well as the combined data, respectively. In conclusion, the best combinations were (P1 x P4) and (P1 x P7). These crosses gave the highest useful heterosis (Table 9).

In most traits, the values of S.C.A effect were not affected from one nitrogen level to another. This finding coincided with that reached above for insignificant S.C.A by nitrogen level mean squares (Table 6).

Genetic components analysis :

Having established differences in genotypes for trait, the data were then analyzed for genetic components by the method for diallel analysis devised by Hayman (1954 b). It should be noted that the diallel analysis was performed on data which did not necessarily completely fulfill the assumptions made for the analysis. These assumptions are :

1- Diploid segregation : sunflower is diploid and a segregation in a diploid manner logically took place,

2- Homozygous parents : the parental inbred lines were assumed to be homozygous,

3- No genotypic by environment interaction are detected in this study,

4- No reciprocal differences,

5- No epistasis,

6- No multiple allels, and

7- Uncorrelated gene distribution.

Failure of any one or any combination of the assumptions invalidates to some degree the conclusion obtained by means of the analysis.

To test the validity of these assumptions, two general tests were employed. The first of all was t^2 value. This value was expected to be insignificant if all assumptions were valid. The value of t^2 is presented in Table (12). With the exception of flowering date and seed yield per plant in the three levels of nitrogen and 1000 seed weight in the first nitrogen level, insignificant t^2's were detected, for all traits revealing the validity of all assumptions were obtained for these traits.

The second employed test was the analysis (Wr, Vr) regression. In this test, the regression coefficient is expected to be significantly different from zero but not from unity if all assumptions are satisfied (Jinks and Hayman, 1953). Significant regression lines were obtained for 100- seed size, husk percentage and oil percentage in the three levels of nitrogen, number of days to flowering in the second and third nitrogen levels, plant height in the first and third nitrogen levels. While, the slope of the regression lines did not deviate significantly from unity for plant height, head diameter, husk percentage and oil percentage in the three levels of nitrogen, number of leaves per plant in the second and third nitrogen levels, number of seeds per head in the third nitrogen levels and 1000-seed weight in the first and second nitrogen levels.

For the other cases where regression coefficients of less than unity were obtained, the assumptions of no genetic interaction was not satisfied. However, the estimation of population parameters, could be possible with such partial fulfillment (Hayman, 1954- b). These estimations, however, would be less reliable than those traits which completely satisfied this assumption.

Data were further subjected to the diallel analysis proposed by Hayman (1954- b) to obtain more information about the genetic behavior for the traits under test. The computed parameters for all traits are presented in Table (12). Appreciable values for both additive (D) and dominance (H_1) components were obtained in all cases except number of leaves per plant in the first nitrogen level. Number of leaves at 20 kg N/ fed. showed insignificant (H_1). This finding is in agreement with that reached in Table (6).

Fourteen out of thirty cases, the (D) component was found to express the higher magnitude relative to the corresponding (H_1) ones

Table (12). This finding is in harmony with that reached above in Table (6).

For the other cases, the values of $(\hat{D})$ were smaller in magnitude than the respective $(\hat{D})$ ones. This result revealed that non additive of gene action was more prevalent in sixteen out of thirty studied cases. For these cases, which exhibited high GCA/ SCA ratios which exceeded the unity from combining ability analysis contradicted with that obtained from Hayman analysis. This contradiction between both types of analysis might be a logical result because of the presence of complementary type of non allelic interaction which inflated the ratios of $(\hat{H})$ to $(\hat{D})$. Hayman (1954 b) and Mather and Jinks (1971). Also, dominance may has a role in GCA estimates as emphasized by Jinks (1955).

The various size of $(\hat{D})$ and estimated as (H1/ D)½ can be used as a weighted measure of the average of dominance at each locus, showed the presence of over dominance for; flowering date, number of leaves per plant, number of seeds per head and seed yield per plant in the three nitrogen levels as well as the combined analysis. This result is in agreement with previously reached by Unrau (1947) and Rao and Anand (1981) for flowering date, Manjunath (1978), Dua (1979) and Miller *et al.* (1981) for seed yield/ plant, and Taha (1994) for other characters. On the other hand, Marinkovic (1993) found that partial dominance for seed yield / plant.

The values of $\left(\hat{H}1/\hat{D}\right)^{1/2}$ were equal unity for head diameter, and oil percentage in the three levels of nitrogen and husk percentage in the first and third nitrogen levels indicated that complete dominance was present. The same results were obtained by Dua and Yadava (1982) for several traits, Pathak *et al.* (1987) for head diameter, oil content and husk percentage, Jukic (1990), Kovacik and Skaloud (1990) and Marinkovic (1993) for oil percentage and Taha (1993) for head diameter and oil content.

In other cases, the values of $(\hat{H}1 / \hat{D})^{1/2}$ were less than the unity, revealing that a partial dominance was detected. Similar results were obtained by Unra (1947), Clement (1968), Velkov (1970), Dua (1979) and Kongchuensin and Marinkovic (1984) for plant height and Dua (1979), and Rao (1981) for 1000- seed weight. On the other hand, Kovacik and Skaloud (1972) found dominance and overdominance for these traits.

The average frequency of negative vs. positive alleles in parental populations was detected by computing the ratio $(\hat{H}2 / 4\hat{H}1)$. Values largely deviating from one quarter were obtained for all traits except 100- seed size, revealing that negative and positive alleles were unequally distributed among the parents.

The relative frequencies of dominant and recessive alleles in the parental population could be also tested by computing the $(\hat{F})$ component. Significant $(\hat{F})$ values were detected in all traits except 100- seed size, in the three nitrogen levels, indicating a symmetry of gene frequency among the parental population, with an excess of recessive allels for seed yield per plant in the second and third levels of nitrogen. For 100- seed size insignificant $(\hat{F})$ values were detected, indicating that dominance and recessive alleles of loci exhibiting dominance were equally distributed among the parents. This finding again confirms the results reached above for $(\hat{H}2/4\hat{H}1)$ estimate. The same conclusion could also be drawn from the corresponding proportion $[(4\hat{D}\hat{H}1)^{1/2} + \hat{F}]/ [(4\hat{D}\hat{H}1)^{1/2} - \hat{F}]$. Unequality of dominant and recessive allele distribution among the tested parental inbred lines was also previously recorded for oil content and seed yield by Marinkovic (1993) and Taha (1994) for 100- seed weight, flowering date and head diameter.

The overall dominance effects of heterozygous loci symbolized as $(\hat{h}^2)$ were computed for all the studied traits. Significant $(\hat{h}^2)$ values were reached herein for head diameter, 100- seed size, 1000- seed weight, and oil percentage in the nitrogen levels indicating that dominance was unidirectional in these traits. On the contrary, insignificant $(\hat{h}^2)$ estimates were obtained for the other traits, suggesting a considerable amount of canceling of dominant effects in the present material. This finding confirms the results shown above by parent vs. crosses presented in Table (6).

Appreciable heterotic effect was previously reported for head diameter by Shrinivasa (1983) and Taha (1994), Enn (1959) and Clement (1968) for plant height. In addition, for 10- seed size the same results were obtained by Heikal (1976). For 1000- seed weight, similar results were obtained by Manjunath (1978), and Rao (1981). Moreover, for oil percentage, similar results were obtained by Jukic (1990), Marinkovic (1993) and Taha (1993).

Heritability estimates in both broad and narrow senses for the studied traits were computed according to Mather and Jinks (1971). High to moderate values for heritability in broad sense were obtained for all traits in the three nitrogen levels, revealing that most of the phenotypic variability in each case was due to genetic cases. For number of days to flowering, number of leaves per plant, head diameter and number of seeds per head in the three nitrogen levels and 100- seed size in the first nitrogen level, heritability estimates in narrow sense were much lower than those of broad one indicating that the most part of the genetic variance was due to non additive effects. Therefore, breeding programs towards inbred selections might be recommended for such traits. For other cases, high heritability values in broad sense along with moderate ones in narrow sense were detected, indicating that the genetic variance associated with these traits was mostly attributed to additive effects of genes. These findings supported those data mentioned before in Table (6). Therefore, a pedigree selection program for these traits might be quite promising.

High values for heritability in broad sense were recorded for all the studied traits except for number of leaves per plant in the third level of nitrogen and number of seeds per head in the first level of nitrogen level where moderate to low values were detected. Similar results were obtained by Shabana (1974) for plant height, Shabana (1974) and Lakshmanalah (1981) for flowering date, Shabana (1974) for head diameter, Vol'F and Dumacheva (1973), Fick (1978) and Soltani and Arshi (1990) for 1000- seed weight, Miller *et al.* (1981) and Singh *et al.* (1989) for seed yield, Vol'F and Dumacheva (1973) and Soltani and Arshi (1990) for oil content. On the other hand, low heritability values in broad sense were obtained by Rao (1981) and Rao and Anand (1981) for yield and 100- seed weight.

Heritability in narrow sense was previously found to be high in magnitude for head diameter and oil content traits by Shrinivasa (1983).

Graphical analysis :

The data obtained herein were also subjected to genetic analysis by means of diallel cross graphs as constructed by Jinks (1954). According to this analysis, the parabola marks limits within which the variance-covariance points (Wr- Vr) should lie. If the regression coefficient (b) of (Wr, Vr) is not differed from unity the genetic system can be deduced to be additive without the complication of non allelic interaction. Complementary type of epistatsis generally decreases the covariance disportionally more than the variance causing the slope of the regression line to be less than unity. If dominance is complete, the regression line would pass through the origin. Overdominance cause the regression line to intersect the (Wr) axis below the origin, while partial dominance causes the regression line to intersect the (Wr) axis above the origin. The closeness of the regression line or (Wr, Vr) points to the limiting parabola indicates little dominance. The position of the array points along the regression lines depends on the relative proportion of dominant and recessive alleles present in the common parent of each array. Parents with preponderance of dominant alleles will have a low array variance and covariance, and will lie near the origin. Highly recessive parents will have a large array variance and covariance and lie at the opposite end of the regression line. If the dominance effects of the genes are unequal, the position of an array point will be weighted in favor of genes with large dominance effects.

The regression of parent- offspring covariance (Wr) on parental array variances (Vr) and their limiting parabola of the seven parental (inbred lines) diallel crosses for all the studied traits at the three nitrogen levels are illustrated in Fig 1- 30.

With the exception of flowering date and seed yield per plant in the three nitrogen levels, number of seeds per head in the first, second nitrogen levels, number of leaves per plant in the first nitrogen level, 100- seed size in the second nitrogen level and 1000- seed weight in the third nitrogen level, the slope of the regression lines did not deviate significantly from unity. This result might reveal that the genetic system could be deduced to be additive without the complication of non allelic interaction. For exceptional cases, regression slops were differed from unity, indicating that complementary type of epistasis was involved.

The regression lines were found to intersect the (Wr) axis above the origin for plant height, head diameter, 100- seed size, number of seeds/ head, 1000- seed weight and seed yield per plant in the three nitrogen levels, flowering date in the first nitrogen level, number of leaves per plant in the first and third nitrogen levels, husk percentage in the second nitrogen level, and oil percentage in the first and second nitrogen levels, suggesting partial dominance. Similar results were obtained by Unrau (1947), Clement (1968), Velkov (1970) and Marinkovic (1993) for plant height, Manjunath (1978), Dua (1979), and Rao (1981) for 1000- seed weight, Dua and Yadava (1982), Pathak *et al.* (1987) and Taha

(1993) for head diameter, Pathak *et al.* (1987), Jukic (1990), Marinkovic (1993) and Taha (1993) for oil content, Manjunath (1978), Dua (1979), Miller *et al.* (1981), Marinkovic (1993) and Taha (1994) for yield/ plant and Unrau (1947), Manjunath (1978), Rao and Anand (1981) and Taha (1994) for flowering date.

For flowering date in the second and third nitrogen levels, husk percentage in the first and third nitrogen levels and oil percentage in the third nitrogen level, the regression lines passed through the origin revealing the complete dominance for these cases. similar results were obtained by Pathak *et al.* (1987).

The position of the actual regression lines was shifted to the right of unit slope line and below the origin for number of leaves per plant in the second level of nitrogen, indicating a case of overdominance in the inheritance of this trait. The same result was obtained by Taha (1994).

For flowering date, number of leaves per plant, number of seeds per head and seed yield per plant, significantly positive intercept was obtained in these traits suggesting partial dominance. Presence of over dominance for these traits, however, was the conclusion drawn from computing the ratio of ($\hat{H}1$) to ($\hat{D}$) as presented in Table (12). This contradiction between both types of analysis might be a logical result of the presence of complementary type of non allelic interaction which influenced the ratios of ($\hat{H}1$) to ($\hat{D}$) and distorted the (Vr, Wr) graphs (Hayman, 1954b and Mather and Jinks, 1971).

The array points were significantly scattered along the regression line for all the studied traits, revealing genetic diversity among the parents and corroborating with the results obtained herein for degree of dominance presented in Table (12).

The correlation coefficient values between parental mean (Yr) and (Wr + Vr) for each array were significant negative values for head diameter in the first and second nitrogen levels and husk percentage in the third nitrogen levels and appreciable negative values for both traits in the other levels of nitrogen and oil percentage in the nitrogen levels, revealing that increaser genes were dominant over decreasers. However, appreciable positive correlation coefficient values were detected for number of seeds per head, 1000- seed weight and seed yield per plant in the three nitrogen levels and 100- seed size in the first and third nitrogen levels, indicating that decreaser genes were dominant over increasers. For the other cases, low correlation values which could not be fruitful in getting any idea about the direction of dominance were obtained. Such low values might be due to the presence of epistasis and to additively of most genes involving the system in these traits. also, it might reveal that high performance for such traits was controlled by dominant genes and recessive genes.

Dominance in generally towards the higher parent or towards the lower parent was obtained by Unrau (1947), Clement (1968), Velkov (1970), Dua (1979), Kongchuensin and Marinkovic (1984), Kovacik and Skaloud (1990) and Taha (1994) for plant height trait, Manjunath (1978), and Rao (1981) for 100- seed weight, Pathak *et al.* (1987), Jukic (1990) and Marinkovic (1993) for oil content, Pathak *et al.* (1987) for head diameter, Unrau (1947), Manjunath (1978) and Rao and Anand (1981) for flowering date and Dua (1979), Miller *et al.* (1981) and Marinkovic (1993) for yield.

The parental lines (P6) and (P7) for flowering date and plant height in the three nitrogen levels, (P1) for number of leaves per plant in the three nitrogen levels and 100- seed size in the second nitrogen level, (P7) for husk and oil percentage in the three levels of nitrogen, (P5) for seed yield in the three nitrogen levels, and 1000- seed weight in the second and third nitrogen levels, (P6) for 100 seed size, number of seeds per head and 1000- seed weight in the first nitrogen level, (P1) and (P6) for head diameter in the first and second nitrogen levels, (P5), (P6) and (P1) for 100- seed size in the third nitrogen level and (P3) for head diameter in the third nitrogen level and (P2) for number of seeds per head in the second and third nitrogen levels seemed to carry most of dominant genes responsible for these traits. However, (P5) for flowering date, number of leaves per plant, husk percentage, and head diameter in the three nitrogen levels, and number of seeds per head in the second and third nitrogen levels, (P2) and (P4) for seed yield per plant, (P2) for 1000- seed weight, (P1) for oil percentage in three nitrogen levels, (P2) for number of seeds per head in the first nitrogen level, and (P2) and (P3) for 100- seed size in the three nitrogen levels possessed more recessive genes for the previous traits.

It could be concluded that, the present genetic material could be utilized as follows :

a) Releasing superior single crosses as commercial cultivars, however, such proposal may sucessfull the economic point of view for producing cheap high yielding single crossing, for example the three crosses (P1 x P4), (P1 x P2) and (P1 x P7).

b) The good crosses which exhibited significant SCA effects for a particular trait and having at least one parent involved which exhibited a good general combiner for this trait may be recommended for practising selection between and among plants of head to row lines through inbreeding generation to isolate superior inbred lines. The crosses showed significant Sij effects for any character may be interest in breeding programs towards inbred line as most of them involve at least one good combiner for the trait in view.

c) For synthetic varieties, Wright (1922) and Stephens and Finker (1953) equations could be made for predicting superior synthetic varieties. Also, the results indicated the possibility of selection for 1000 seed index, or number of seeds per head and/ or head diameter.

Simple phenotypic correlation:

The simple correlation coefficients between each two traits under study were calculated within each nitrogen levels. Study the associations between seed yield and main yield components and some growth characters gives very useful information for the plant breeder who wants to incorporate desirable characters.

Table (13) shows significant positive phenotypic correlation values between seed yield per plant and each of other traits except flowering date and oil percentage in each of separate levels of nitrogen. Therefore, selection for each of higher number of seeds per head, number of leaves/ plant, heavy 1000- seed weight, increasing of plant height, 100- seed size or husk percentage is more effective for obtaining new higher yielding inbred lines. The present results are in agreement with those obtained by Putt (1943), Serry (1964), Natali and Shaikh (1970), Kovacik and Skaloudı (1972), Singh et al., (1977) Zali *et al.*, (1977), Omran et al., (1979), Sheriff *et al.*, (1986) and Chaudhary and Anand (1993).

Significant negative correlation coefficient values were found between oil percentage and each of plant height and 100- seed size in the three levels of nitrogen, 1000- seed weight in the first and second nitrogen levels (20 and 30 kg N/ fed.), and 100- seed size and husk percentage at the first and second levels, respectively. High oil percentage might be accompained by lower values of the previous traits. Significant negative correlation cofficient values between oil percentage and each of flowering date, plant height, number of leaves per plant, head diameter, 100- seed size, number of seeds per head, 1000- seed weight, husk percentage and seed yield per plant were previously obtained by Kurnik and Varsanyi (1963), Heikal (1976), Zali *et al.*, (1977) and Moursi *et al.*, (1980).

Significant positive correlation values were detected between husk percentage and each of plant height, head diameter, 100- seed size, and 1000- seed weight at the three nitrogen levels and number of leaves per plant at the second and third nitrogen levels (30 and 40 kg N/ fed.).

These results might indicate that selection for lower number of leaves per plant and decreasing plant height or head diameter or 1000- seed weight are more effective for obtaining new lower husk percentage varieties. The same results were obtained by Attia (1980).

Significant positive correlation values were found between 1000-seed weight and each of plant height, number of leaves per plant, head diameter and 100- seed size at the three nitrogen levels. Also, significant positive correlation values were detected between 100- seed size and each of plant height, number of leaves per plant and head diameter. These results might indicate that selection for high values of the five characters are more effective for increasing 1000- seed weight. These results agrred with those reported by Serry (1964) Natali and Shaikh (1970) and Singh *et al.* (1977).

Highly significant positive correlation values were found between head diameter and each of plant height and number of leaves per plant. The present results are in agreement with those obtained by Ross (1939), Serry (1964), Burns (1970), Khanna (1972), Singh *et al.*, (1977), Varshney and Singh (1977), Attia (1980), Ahmed *et al.*, (1991) and Taha (1994).

Significant positive correlation values were detected between number of leaves per plant and plant height. Height may be accompained by higher number of leaves per plant, that is logic.

Path coefficient analysis:

To calculate path coefficient, simple correlation coefficient were made between all possible pairs of seed yield, head diameter, number of seeds per head and 1000- seed weight. The nature of the interrelated variables system used in connection with seed yield per plant is presented diagramatically in Figur (31).

	↗ Py3	(3) Head diameter		
		↕ r 3.4		↑
	↗ Py4	(4) Number of seeds per head		r 3.5
Seed yield per plant		↕ r 4.5		↓
	↘ Py5	(5) 1000- seed weight		
	↘ Pyo	(0) Residual factors.		

Figure (19): A path diagram and coefficient of factors influencing individual seed yield per plant.

p = Path coefficient

r = Simple correlation coefficient.

Py3, Py4 ... etc = path coefficient of head diameter (x3), number of seeds per head (x4) ... etc on individual seed yield (y).

r 3.4 = Simple correlation between head diameter (x3) and unmber of seeds per head (x4).

Partitioning of simple correlation coefficient between seed yield and head diameter, number of seeds per head and 1000- seed weight in the three nitrogen levels is presented in Table (14).

1000- seed weight had the most direct effect on seed yield by values 0.692, 0.672 and 0.569 at 20, 30 and 40 kg N/ fed.respectively. Also, its indirect effects are important through head diameter at the three nitrogen levels.

Number of seeds per head had a second large and positive effect on yield by 0.573, 0.545 and 0.353 at 20, 30 and 40 kg N/ fed., respectively.

head diameter had a high positive direct effect on seed yield by values 0.245, 0.195 and 0.308 at 20, 30 and 40 kg N/ fed., respectively. Also, the highest indirect effects were found through 1000- seed weight by values 0.467, 0.478 and 0.431 at 20, 30, 40 kg N/ fed., respectively.

The coefficients of determination were calculated for the direct and indirect effects of the three yield factors studied and transformed into percentages in order to evaluate these factors as to their importance as source of variation in plant yield. The component in percent for seed yield variation in the three nitrogen levels are presented in Table (15). From this Table it could be concluded that the most important sources of variation in plant yield are:

1- The direct effect of 1000- seed weight followed by direct effect of number of seeds per head and then by indirect effect of head diameter x number of seeds per head at 20, 30 kg N/ fed.

2- The direct effect of 1000- seed weight followed by indirect effect of head diameter x number of seeds per head and then by direct effect of number of seeds per head at 40 kg N/ fed.

The direct effect for both yield components (1000- seed weight and number of seeds per head) were 80.6, 74.96 and 44. 78 % at 20, 30 and 40 kg N/ fed., respectively, of seed yield/ plant variation. Other important sources of seed yield were indirect effects of head diameter x number of seeds per head at the three nitrogen levels. Other sources in variation are negligable as shown in Table (15). In this connection, Chaudhary and Anand (1993) found that the most important sources of variation in plant yield were the direct effect of 1000- seed weight and number of seeds per head. Also, Ahmed *et al.*, (1991) indicated that yield components had direct effects on seed yield.

Table (6): Observed mean squares from ordinary analysis and combining ability analysis for all the studied traits.

S.O.V	d.f		No. of days to flowering				Plant height (Cm)				No. of leaves/ plant			
	Single	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
Nitrogen		2				126.42**				2400.37**				126.97**
Blocks in Nitrogen	2	4	0.64	8.15	6.76	7.85**	601.18**	977.80**	501.51**	1307.28**	16.78	59.02**	18.48	28.83
Genotypes	27	27	23.84**	37.26**	40.194**	95.82**	2210.83**	2601.68**	2683.31**	7344.06**	33.72**	26.32**	24.40*	72.57**
Parents	6	6	15.81**	33.57**	39.32**	84.35**	5233.50**	5703.18**	5973.29**	16857.17**	34.00**	52.53**	47.31**	125.62**
Crosses	20	20	27.05**	40.00**	42.42**	103.47**	1403.98**	5999.08**	1829.19**	4846.56**	35.07**	19.77**	18.47	60.28**
Parents vs. Crosses	1	1	7.78	4.69	0.86	11.54	211.66	31.80	27.47	215.58	5.15	0.06	5.42	0.01
Genotypes x Nitrogen		54				2.74				75.91				5.94
Parents x Nitrogen		12				2.18				26.40				4.11
Crosses x Nitrogen		40				2.99				93.17				6.52
Parents vs Crosses x Nitrogen		2				1.79				27.67				5.31
General combining ability	6	6	43.51**	77.07**	86.48**	199.05**	8632.67**	10468.25**	11217.26**	30176.67**	39.37**	43.53**	33.01**	105.22**
Specific combining ability	21	21	18.22**	25.89**	26.97**	66.32**	376.02**	354.09**	245.11**	820.46**	32.11**	21.41**	21.41	63.24**
G.C.A x Nitrogen		12				4.01				70.75				5.35
S.C.A x Nitrogen		42				2.38				77.38				6.11
Error	54	162	3.82	6.62	5.85	5.43	170.60	146.40	102.85	139.95	11.14	8.38	15.03	11.52
G.C.A/ S.C.A			2.39	2.98	3.21	3.00	22.96	29.56	45.76	36.78	1.23	2.03	--	1.66

* and ** Significant at 0.05 and 0.01 levels of probability,respectively.

N1 = refers to 20 kg N/ fed.
N2 = " " 30 kg N/ fed.
N3 = " " 40 kg N/ fed.

Comb. = refers to combined analysis
GCA = " " general combining ability
SCA = " " specific combining ability

Table (6): Cont..

S.O.V	d.f		Head diameter				100- seed size				No. of seeds/ head			
	Single	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
Nitrogen		2				96.86**				53.30**				260019.75**
Blocks in Nitrogen	2	4	9.57	1.41	9.00	7.79	7.71*	1.31	1.22	2.77	1076.86	27611.36*	34518.14	21068.79**
Genotypes	27	27	26.68**	28.27**	38.62**	89.16**	16.81**	18.14**	26.55*	59.13**	72685.2**	78674.15**	98640.97**	230030.96**
Parents	6	6	66.59**	68.01**	87.03**	215.01**	36.02**	31.58**	54.47**	117.22**	57865.9**	53717.39**	117478.0**	187050.48**
Crosses	20	20	14.22**	15.49**	23.60**	48.98**	10.71**	14.43**	18.38**	41.83**	72797.3**	84707.90**	97495.89**	243224.40**
Parents vs. Crosses	1	1	36.47**	53.64**	48.55**	137.78**	23.59**	11.83**	22.50**	56.68**	159357.9**	107739.88**	8520.29	224044.86**
Genotypes x Nitrogen		54				2.35				1.19				9984.66*
Parents x Nitrogen		12				3.31				2.43				21005.40
Crosses x Nitrogen		40				2.16				0.84				5888.34
Parents vs Crosses x Nitrogen		2				0.44				0.62				25786.64
General combining ability	6	6	54.55**	53.33**	99.91**	212.66**	60.98**	62.52**	94.84**	214.02**	123735.49**	152422.64**	182261.40**	437632.73**
Specific combining ability	21	21	5.66**	18.07**	21.11**	53.88**	4.19**	5.47**	7.04**	14.88**	58099.34**	57603.16**	74749.41**	170716.16**
G.C.A x Nitrogen		12				3.56				2.16				10393.39
S.C.A x Nitrogen		42				2.01				0.91				9867.88
Error	54	162	5.66	7.29	8.04	6.99	1.88	1.91	2.42	2.07	20128.003	17972.668	15039.75	17713.50
G.C.A/ S.C.A			9.64	3.62	4.73	3.95	14.56	11.40	13.46	14.39	2.13	2.65	2.44	2.56

* and ** Significant differences from zero at 5% and 1%

Table (6): Cont.

S.O.V	d.f Single	d.f Comb.	1000 seed weight (g) N1	N2	N3	Comb.	Husk prcentage N1	N2	N3	Comb.	Yield/ plant (g) N1	N2	N3	Comb.	Oil percentage N1	N2	N3	Comb.
Nitrogen		2				1577.92**				237.13**				2266.51**				21.51**
Blocks in Nitrogen	2	4	118.95	121.37**	55.87	98.73**	84.00**	121.93**	113.79**	106.49**	102.91	73.83	290.62	161.68**	0.32	1.22	0.12	0.30
Genotypes	27	27	1092.83**	1145.04**	1200.69**	3369.81**	124.23**	145.31**	132.04**	386.04**	755.61**	1013.51**	1286.78**	2970.07**	20.20**	21.20**	19.17*	59.62**
Parents	6	6	2673.80**	2765.33**	2870.15**	8222.80**	304.14**	381.49**	327.40**	984.99**	745.79**	907.28**	1035.69**	2649.26**	51.56**	56.78**	48.21**	55.23**
Crosses	20	20	654.38**	676.39**	730.92**	1996.76**	75.078**	81.48**	79.62**	223.87**	795.26**	1095.15**	1426.44**	3213.39**	11.25**	10.23**	10.03	30.74**
Parents vs. Crosses	1	1	375.96**	796.44**	579.37**	1712.72**	28.00**	4.83	8.21**	35.75	21.41	17.94	0.1678	28.66	11.02**	27.27**	27.80**	63.41**
Genotypes x Nitrogen		54				34.38				7.77				42.91				0.48
Parents x Nitrogen		12				43.24				14.02				19.75				0.66
Crosses x Nitrogen		40				32.46				6.15				51.73				1.64**
Parents vs Crosses x Nitrogen		2				39.05				5.30				5.43				1.34
General combining ability	6	6	3835.52**	4078.31**	4147.63**	11981.83**	316.37**	429.57**	335.92**	1050.65**	2290.65**	3056.82**	3813.88**	4038.40**	53.14**	52.30**	45.95**	149.95**
Specific combining ability	21	21	309.20**	306.97**	358.71**	909.22**	69.33**	64.09**	73.79**	196.15*	317.02**	429.70**	564.75**	1236.26*	10.79**	12.43**	11.52**	33.81**
G.C.A x Nitrogen		12				39.82				14.98				61.47				0.72
S.C.A x Nitrogen		42				32.83				5.71				37.61				0.46
Error	54	162	53.38	61.50	71.40	62.09	9.97	11.87	18.44	13.43	88.98	113.44	138.67	113.69	0.64	0.40	0.37	0.47
G.C.A/ S.C.A			12.40	13.29	11.56	13.18	4.56	6.70	4.55	5.36	7.23	7.11	6.75	3.27	4.93	4.21	1.14	4.44

* and ** Significant differences from zero at 5% and 1%

Table (7): The mean values for all the studied characters of sunflower as affected by nitrogen levels.

N levels kg/ fed.	No. of days to flowering	Plant height (cm)	No. of leaves/ plant	Head diameter (cm)	100 seed size (ml)	No. of seeds/ head	1000 seed weight (g)	Husk percentage	Yield per plant (g)	Oil percentage
20	52.96 c	117.24 c	26.11 b	15.49 c	9.75 c	835.34 c	62.59 c	25.28 c	48.96 b	37.41 a
30	54.60 b	124.18 b	27.67 a	16.57 b	10.61 b	785.93 b	66.14 b	27.17 b	52.29 b	36.96 b
40	55.54 a	128.21 a	28.45 a	17.67 a	11.35 a	867.49 a	71.31 a	28.55 a	58.76 a	36.42 c

Table (8): Genotypes mean performance for agronomic attributes at the three nitrogen fertilizer levels as well as the combined data.

Characters	No. of days to flowering				Plant height				No. of leaves/ plant			
Genotypes	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1	57.47 b	60.27 b	61.00 bc	59.58 b	195.00 a	202.33 a	210.67 b	202.67 a	26.76 a-d	31.33 ab	32.00 ab	30.00 a-d
2	54.27 b-f	57.87 c-f	54.90 d-h	54.68 d-e	141.67 c-e	150.33 b-f	151.67 cd	147.89 cd	29.67 ab	32.00 a	33.67 a	31.78 a
3	53.27 c-h	54.27 c-f	55.30 d-g	54.28 d-g	132.oo c-f	137.33 d-f	140.00 de	136.44 ef	24.67 a-f	27.67 a-c	31.00 ab	27.78 b-i
4	55.40 b-d	59.13 bc	60.27 bc	58.27 bc	104.00 g-j	104.33 kl	107.67 g-i	105.33 jk	23.33 b-f	23.67 c-f	25.33 b-d	24.11 i-k
5	52.00 d-j	52.83 d-f	53.30 e-h	52.71 e-h	62.33 k	64.33 m	69.00 j	65.22 m	19.33 f	20.33 f	22.67 cd	20.78 k
6	51.23 e-j	52.40 d-f	52.53 f-h	52.05 f-i	96.00 h- j	107.33 l-j	111.33 f-i	104.89 jk	25.33 a-f	29.67 ab	30.33 a-c	28.44 a-h
7	51.40 e-j	51.77 f	52.07 f-h	51.75 g-i	111.00 f-j	111.33 i-l	113.33 f-i	111.89 ik	27.67 a-c	27.33 a-d	27.67 a-d	27.56 b-i
1 x 2	53.23 c-h	53.00 d-f	53.40 e-h	53.21 e-h	169.67 b	171.00 b	173.67 a	171.45 b	28.00 ab	28.00 a-c	29.67 a-d	28.56 a-g
x 3	51. 83 d-j	54.50 c-f	56.77 c-f	54.37 d-f	135.00 c-f	146.67 c-f	153.33 cd	145.00 de	30.67 a	30.67 ab	31.33 ab	30.89 ab
x 4	56.10 bc	60.20 b	60.30 bc	58.87 b	146.00 c-d	154.00 b-d	165.33 c	156.11 c	29.00 ab	29.67 ab	31.00 ab	29.89 a-d
x 5	54.87 b-e	57.17 b-d	57.40 c-e	56.48 cd	151.76 bc	153.00 b-e	153.00 cd	152.56 cd	30.67 a	31.00 ab	30.33 a-c	30.67 a-c
x 6	50.93 f-j	52.30 d-f	52.53 f-h	51.92 f-i	126.00 d-g	166.67 b-c	169.67 c	154.11 cd	30.67 a	30.67 ab	29.33 a-d	30.22 a-d
x 7	53.67 c-g	53.83 d-f	54.73 d-h	54.08 d-g	140.67 c-e	145.33 c-g	156.00 cd	147.33 cd	28.00 ab	29.00 a-c	30.00 a-d	29.00 a-g
2 x 3	50.00 g-j	51.33 f	51.53 gh	50.95 hi	110.00 f-j	124.33 g-k	128.67 ef	121.00 g-i	25.00 a-f	27.00 a-d	28.33 a-d	26.00 e-i
x 4	54.37 b-f	54.93 c-f	58.63 b-d	55.98 cd	117.67 e-h	117.67 h-k	129.67 ef	121.67 g-i	25.33 a-f	26.00 a-e	26.67 a-d	26.78 d-i
x 5	53.67 c-g	57.00 b-3	58.67 b-d	56.45 cd	92.67 h-j	91.33 l	96.67 hi	93.56 l	25.67 a-f	26.33 a-e	29.00 a-d	27.00 c-i
x 6	51.10 e-j	52.33 d-f	53.63 e-h	52.35 e-i	110.33 f-j	112.67 i-l	115.00 f-h	112.67 ij	21.00 d-f	22.00 d-f	22.33 d	21.78 jk
x 7	51.53 e-j	52.00 ef	52.87 e-h	52.13 e-i	117.67 e-h	133.00 e0i	139.67 de	130.11 fg	26.33 a-e	27.67 a-c	28.67 a-d	27.56 b-i
3 x 4	52.17 d-j	52.43 d-f	54.93 d-h	53.18 e-h	114.67 f-i	128.33 f-j	128.67 ef	123.89 gh	30.00 ab	30.33 ab	28.33 a-d	29.55 a-f
x 5	55.47 b-d	60.17 b	62.17 ab	59.27 b	88.67 j	90. 00 l	94.33 i	91.00 l	20.00 ef	21.33 ef	23.00 cd	21.44 jk
x 6	49.73 h-j	51.87 ef	52.07 f-h	51.22 hi	106.00 g-j	112.33 i-l	116.00 f-h	111.44 ij	19.33 f	26.33 a-e	28.33 a-d	24.06 h-j
x 7	53.47 c-h	52.53 d-f	52.97 e-h	52.99 e-h	110.67 f-j	117.33 h-k	118.00 fg	115.33 h-j	21.33 c-f	26.33 a-e	29.33 a-d	25.66 g-i
4 x 5	62.63 a	65.43 a	85.97 a	64.68 a	89.00 ij	105.67 g-l	105.67 g-i	100.11 kl	27.00 a-d	29.00 a-c	30.00 a-d	28.67 a-g
x 6	48.93 j	52.70 d-f	54.03 d-h	51.89 f-i	117.33 e-h	119.33 h-k	124.33 eg	120.33 g-i	26.33 a-e	26.67 a-e	24.33 b-d	25.78 f-i
x 7	53.43 c-h	54.10 d-f	55.07 d-h	54.20 d-g	103.67 g-j	105.00 j-l	111.67 f-i	106.78 jk	26.33 a-e	26.33 a-e	26.67 a-d	26.44 d-i
5 x 6	49.33 ij	50.00 f	50.43 h	49.92 i	92.87 h-j	93.00 l	95.00 i	93.56 l	28.00 ab	28.33 a-c	29.00 a-d	28.44 a-h
x 7	50.77 fj	52.77 d-f	53.00 e-h	52.18 e-i	105.33 g-j	106.67 j-l	107.00 gi	106.33 jk	24.67 a-f	28.67 a-c	29.67 a-d	27.67 b-i
6 x 7	52.87 c-i	54.33 c-f	55.07 d-h	54.09 d-g	106.00 g-j	107.33 j-l	108.00 g-i	107.11 jk	28.00 ab	30.67 a-b	30.33 a-c	29.67 a-e
r	0.31	0.34	0.37	0.35	0.70*	0.83**	0.91**	0.89**	-0.06	-0.05	0.02	-0.03

N1 , N2, N3 refers to 20, 30, and 40 kg N/ fed., respectively.

Table (8): Cont.

Characters	Head diameter (cm)				100 seed size (ml)				No. of seeds/ head			
Genotypes	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1	17.40 a-d	19.37 a-e	22.97 a-c	19.91 ab	13.97 b	14.73 ab	15.03 b	14.58 b	783.00 b-i	783.30 c-i	873.00 c-h	783.11 e-h
2	17.17 a-e	18.03 a-g	18.45 b-f	17.87 b-d	16.30 a	15.53 a	20.27 a	17.37 a	587.00 g-i	674.70 g-j	745.00 f-i	668.89 h-k
3	17.10 a-e	17.83 a-g	18.23 b-f	17.72 b-d	11.00 d-f	11.73 c-h	12.20 b-f	11.64 c-f	911.70 a-e	941.00 a-f	882.00 c-h	911.56 cd
4	13.40 d-f	14.63 c-g	16.10 ef	14.71 e-g	10.03 d-g	10.10 c-j	10.27 e-j	10.13 f-i	830.30 b-h	839.70 b-h	786.00 d-h	818.67 d-g
5	4.60 g	4.90 h	5.67 g	5.06 h	5.80 j	6.00 l	6.93 k	6.24 m	1043.67 ab	995.30 a-d	1281.00 a	1106.56 a
6	12.33 f	14.10 e-g	12.27 ef	13.90 fg	10.07 d-g	11.93 c-g	11.80 c-g	11.27 d-g	842.00 b-g	787.00 c-i	687.70 g-i	772.22 e-i
7	17.27 a-d	16.90 a-g	16.80 ef	16.99 c-e	8.43 f-i	9.47 f-k	10.10 f-g	9.33 h-k	883.30 b-f	1047.33 ab	986.70 b-f	972.44 c
1 x 2	17.07 a-e	17.50 a-g	18.17 b-f	17.58 b-d	12.07 b-d	12.67 bc	14.50 bc	13.80 c	885.70 b-f	904.00 b-g	1003.00 b-d	930.78 cd
x 3	16.60 a-f	17.10 a-g	18.27 b-f	17.32 cd	10.80 d-g	11.57 c-h	12.20 b-f	11.52 c-f	1152.00 a	1158.00 a	1183.00 ab	1164.22 a
x 4	19.83 a	19.57 a-d	23.93 a	21.11 a	12.27 b-d	12.33 b-e	13.53 b-d	12.71 cd	963.30 a-c	1024.00 a-c	1282.00 a	1089.89 ab
x 5	15.80 a-f	15.77 b-g	15.37 ef	15.65 d-g	8.73 e-i	10.8 c-i	10.33 e-j	9.95 c-j	786.30 b-i	797.70 b-i	915.70 c-g	833.22 d-f
x 6	18.20 a-c	21.70 a	22.47 ad	20.79 a	10.67 d-g	12.53 b-d	13.33 b-e	12.18 c-e	766.7 c-i	901.30 b-g	982.7 b-f	883.56 c-e
x 7	18.40 ab	20.37 ab	23.47 ab	20.75 a	11.40 c-e	12.13 c-f	12.67 b-f	12.07 c-e	926.70 a-d	984.30 a-e	1047.00 bc	986.11 bc
2 x 3	18.43 ab	19.90 a-c	19.83 a-e	19.39 a-c	13.67 bc	16.47 a	18.00 a	16.05 a	557.00 i	652.30 g-j	749.00 f-i	652.78 i-k
x 4	16.33 a-f	16.87 a-g	19.00 a-f	17.40 cd	10.10 d-g	11.07 c-h	11.40 d-h	10.86 e-h	623.2 f-i	659.30 g-j	720.00 g-i	667.50 h-k
x 5	12.17 f	13.70 g	13.83 f	13.23 g	8.53 f-i	9.93 d-j	10.33 e-j	9.60 h-k	578.00 g-i	515.30 j	541.70 i	545.00 k
x 6	15.60 a-f	16.37 a-g	16.77 ef	16.25 d-f	11.00 d-f	11.67 c-h	12.27 b-f	11.65 c-f	609.30 g-i	616.00 h-j	675.70 g-i	633.67 jk
x 7	15.47 a-f	17.13 a-g	18.27 b-f	16.96 c-e	10.80 d-g	12.00 c-g	12.80 b-f	11.87 c-e	662.30 d-i	701.7 f-j	730.30 g-i	698.11 g-j
3 x 4	14.63 b-f	17.17 a-g	17.03 d-f	16.28 d-f	8.93 e-i	9.60 f-k	10.33 e-j	9.62 h-k	898.00 b-f	736.70 e-j	984.00 b-f	872.89 c-e
x 5	13.37 d-f	13.47 g	14.83 ef	13.89 fg	6.47 ij	7.07 kl	7.53 jk	7.02 lm	645.70 e-i	746.30 d-j	778.3 d-i	723.44 f-j
x 6	13.50 c-f	14.33 d-g	16.27 ef	14.70 e-g	8.27 g-j	9.33 g-k	10.73 d-i	9.44 h-k	761.70 c-i	751.30 d-j	908.00 c-g	807.00 d-g
x 7	14.30 b-f	15.30 b-g	16.87 d-f	15.49 d-g	9.00 e-i	9.67 e-k	10.47 e-j	9.71 h-j	674.30 d-i	798.00 b-i	818.70 c-h	763.67 e-i
4 x 5	14.70 b-f	14.93 c-g	17.07 d-f	15.57 d-g	7.33 h-j	7.53 j-l	7.87 i-k	7.58 lm	732.00 c-i	755.30 d-j	818.30 c-h	768.55 e-i
x 6	12.50 ef	13.90 f-g	13.33 f	13.24 g	8.47 f-i	9.07 h-k	10.00 f-j	9.18 i-k	598.00 g-i	581.70 ij	655.30 hi	611.67 jk
x 7	15.83 a-f	16.43 a-g	17.47 c-f	16.58 de	8.27 g-j	8.33 i-l	8.67 h-k	8.42 j-l	564.30 hi	565.00 ij	753.70 e-i	627.67 jk
5 x 6	18.60 ab	19.17 a-f	19.63 a-e	19.13 a-c	9.33 e-h	9.67 e-k	10.20 f-j	9.73 h-j	610.30 g-i	623.00 h-j	709.70 g-i	647.64 ik
x 7	15.67 a-f	16.43 a-g	16.93 d-f	16.39 d-f	6.87 h-j	9.07 h-k	9.13 g-k	8.36 j-l	796.70 b-i	943.00 a-f	997.00 b-e	912.23 cd
6 x 7	12.93 d-f	16.00 bg	17.50 c-f	15.48 d-g	8.13 g-j	7.80 j-l	8.40 h-k	8.11 kl	733.70 c-i	806.30 b-i	880.00 c-h	806.67 d-c
r	0.27	0.41	0.52	0.43	0.80**	0.62*	0.81**	0.83**	-0.22	0.16	-0.09	0.07

Table (8): Cont.

Characters	1000- seed weight (g)				Husk percentage			
Genotypes	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1	82.00 bc	85.53 bc	90.67 bc	86.07 cd	38.27 a	39.80 a	39.07 a	39.05 a
2	109.00 a	111.30 a	112.30 a	110.89 a	29.83 b-e	38.40 ab	33.57 a-e	33.93 bc
3	59.33 f-h	58.67 e-i	74.33 d-f	64.11 fg	28.43 c-g	28.37 a-h	31.93 a-h	29.58 d-j
4	46.33 h-j	49.67 hi	55.67 gh	50.56 jk	24.27 e-j	27.63 e-j	32.20 a-g	28.03 a-i
5	17.33 k	21.00 k	22.33 j	20.22 m	6.23 l	6.50 m	6.60 k	6.44 o
6	39.00 j	35.67 j	36.33 i	37.00 l	23.97 e-k	25.97 f-k	27.3 c-g	25.75 j-l
7	55.67 f-i	58.67 e-i	71.33 d-g	61.89 gh	17.97 k	20.20 kl	24.87 f-j	21.01 ml
1 x 2	94.33 b	95.67 b	100.00 ab	96.67 b	30.10 b-e	36.83 a-c	35.50 a-c	34.14 bc
x 3	54.00 f-i	55.00 f-i	55.17 gh	54.72 h-k	22.67 f-k	21.93 h-l	22.97 i-g	22.52 l-n
x 4	87.33 bc	91.00 b	99.00 ab	92.44 bc	30.67 b-o	35.50 a-d	36.40 a	24.19 bc
x 5	55.00 f-i	57.33 e-i	60.00 f-h	57.44 gk	30.63 b-d	31.23 c-f	32.37 a-f	31.41 b-e
x 6	80.67 c	81.67 b-d	91.33 bc	84.56 cd	30.73 b-d	32.87 b-f	32.17 a-g	31.92 b-d
x 7	75.00 c-e	83.67 b-d	90.00 bc	82.89 d	26.43 d-h	27.90 e-j	31.60 a-h	28.84 d-h
2 x 3	86.00 bc	90.67 b	93.00 b	89.89 bd	28.67 b-f	29.43 d-g	33.83 a-d	30.64 c-f
x 4	63.00 d-f	70.00 d-f	84.33 b-e	72.44 e	34.60 ab	33.30 be	36.00 ab	34.63 b
x 5	56.67 f-h	62.33 e-h	64.67 f-h	61.22 gh	34.17 a-c	35.27 a-d	35.70 a-c	35.05 e
x 6	64.33 d-f	71.67 c-e	46.00 c-f	70.67 ef	26.13 d-h	27.46 e-j	27.90 b-i	27.16 f-k
x 7	76.33 cd	83.67 b-d	85.67 d-e	81.89 d	22.67 f-k	24.50 j-l	27.43 c-i	24.87 h-m
3 x 4	61.67 e-g	54.33 e-h	69.00 e-g	65.00 eg	19.77 l-k	24.14 j-l	25.70 d-j	23.12 k-m
x 5	48.00 g-j	46.33 hi	50.67 h	49.33 k	18.33 jk	18.80 l	18.97 j	18.70 n
x 6	57.00 f-h	58.33 e-i	60.00 f-h	58.44 gj	26.57 d-h	27.37 a-j	27.07 d-j	27.00 f-k
x 7	45.00 ij	52.67 g-i	67.67 fg	55.11 h-k	21.53 h-k	21.07 j-l	24.00 f-j	22.20 l-n
4 x 5	44.33 ij	51.67 g-i	60.00 f-h	52.00 i-k	25.20 d-i	25.70 f-k	31.43 a-h	27.44 f-j
x 6	63.33 ef	65.67 a-g	68.00 fg	65.67 e-g	18.77 jk	23.13 g-l	23.03 a-g	21.84 l-n
x 7	58.00 f-i	61.33 a-i	60.67 f-h	60.00 g-i	19.27 i-k	21.33 i-l	23.70 g-j	21.93 mn
5 x 6	51.00 f-j	55.00 f-i	56.33 gh	54.11 h-k	24.07 i-k	23.87 j-l	23.87 f-j	23.94 j-m
x 7	44.67 ij	45.33 ig	57.67 gh	49.22 k	21.43 h-k	26.07 f-k	25.27 e-j	24.26 i-m
6 x 7	63.33 d-f	64.00 e-h	66.00 f-h	64.44 e-g	22.40 g-k	24.50 j-l	26.27 d-j	24.39 i-m
r	0.76**	0.76**	0.63*	0.72**	0.35	0.27	0.33	0.40

Table (8): Cont

Characters Genotypes	Seed yield/ plant (g)				Oil percentage			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1	63.10 bc	67.20 c-g	79.07 bc	69.79 cd	28.83 j	27.67 k	27.70 l	28.07 l
2	63.03 bc	70.63 b-d	79.23 bc	70.96 c	34.27 hi	32.97 j	32.97 k	33.40 k
3	53.33 c-f	54.70 d-j	64.83 c-e	57.62 e-g	38.97 b-d	38.13 c-e	36.13 hi	37.74 de
4	38.03 f-h	38.97 h-l	43.67 e-g	40.22 i-l	39.97 a-c	38.83 b-c	37.7 c-g	38.83 b
5	18.03 i	20.27 l	18.50 h	18.93 m	40.53 a	39.93 a	39.6 a	40.02 a
6	48.83 c-h	46.40 f-k	53.23 d-g	49.49 f-i	38.63 b-d	38.37 c-e	38.10 b-e	38.37 b-d
7	51.33 c-g	58.90 d-h	64.17 c-f	58.13 e-g	35.67 f-h	34.77 i	34.87 j	35.10 j
1 x 2	83.43 a	86.13 a-c	91.67 b	87.08 b	36.80 ef	36.23 gh	35.90 h-j	36.31 gh
x 3	61.93 b-d	63.43 d-f	65.80 c-f	63.72 c-e	33.30 j	33.33 j	32.70 k	33.11 k
x 4	88.23 a	97.43 a	112.2 a	99.29 a	37.97 de	37.43 ef	36.60 gh	37.33 ef
x 5	44.33 d-h	48.37 e-k	52.50 d-g	48.40 f-j	36.00 fg	35.40 hi	35.30 ij	35.57 ig
x 6	58.43 c-e	72.70 b-d	89.57 b	73.57 c	37.90 de	37.80 c-f	37.30 e-g	37.67 de
x 7	76.20 ab	87.90 ab	93.70 ab	85.93 b	37.97 de	37.87 c-f	37.67 c-g	37.84 ge
2 x 3	48.20 c-h	54.50 d-j	63.93 c-f	55.54 e-h	38.77 b-d	38.30 c-e	37.97 b-e	38.35 b-d
x 4	43.47 e-h	46.03 f-k	54.57 d-g	48.02 g-j	38.70 b-d	38.77 b-d	38.77 a-c	38.75 b
x 5	32.83 g-i	32.07 kl	35.27 gh	33.39 l	39.10 b-d	38.40 c-e	38.07 b-e	38.52 bc
x 6	42.07 e-h	42.17 g-k	41.37 fg	41.87 i-l	35.13 g-i	35.03 i	34.93 j	35.03j
x 7	50.57 c-h	61.50 d-g	67.13 cd	59.73 d-f	33.83 i	33.73 j	33.33 k	33.63 k
3 x 4	55.37 c-f	55.73 d-i	67.47 cd	59.52 d-f	40.07 ab	39.73 ab	38.73 a-d	39.51 a
x 5	33.83 g-i	36.97 i-l	39.20 gh	36.67 j-l	38.47 cd	37.70 c-e	37.57 d-g	37.91 c-e
x 6	46.27 c-h	45.50 f-k	49.67 d-g	47.15 g-k	38.43 cd	37.57 d-f	37.40 e-g	37.80 c-e
x 7	38.63 f-h	38.73 h-l	43.93 e-g	40.43 i-l	38.53 b-d	38.20 c-e	35.73 h-j	37.49 ef
4 x 5	38.77 f-h	39.27 h-l	45.37 d-g	41.14 i-l	40.73 a	40.23 a	38.90 ab	39.95 a
x 6	37.77 f-h	37.87 h-l	43.03 e-g	39.56 i-l	38.67 b-d	37.67 c-e	37.73 c-g	38.02 c-e
x 7	32.33 hi	33.77 j-l	45.93 d-g	37.34 g-l	36.90 ef	36.90 fg	36.70 f-h	36.83 fg
5 x 6	33.37 g-i	34.30 j-l	38.93 gh	35.53 kl	38.80 b-d	38.60 c-e	37.80 b-f	38.40 b-d
x 7	42.63 e-h	44.33 f-k	44.50 d-g	43.82 i-l	35.27 gh	35.10 i	34.77 j	35.50 ig
6 x 7	42.93 e-h	43.93 f-k	47.53 d-g	44.80 h-l	36.70 ef	36.23 jh	34.83 j	35.92 hi
r	0.60	0.62	0.60	0.60	0.50	0.46	0.42	047

Table (9): Percentage of heterosis over both mid parent (M.P) and better parent (B.P) at the three levels of nitrogen and the combined analysis for all the studied traits and over the three check hybrids for seed yield.

Crosses	No. of days to flowering								Plant height (cm)							
	M.P				B.P				M.P				B.P			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	-4.79*	-7.93*	-7.83**	-6.86*	-2.28	-3.40	-2.71	2.69	0.86	-3.74	-4.30	-2.18	19.71*	12.87	15.50*	14.93*
x 3	6.38**	-4.83	-2.38	-4.50	-2.70	0.43	2.65	0.16	-17.41**	-20.47**	-12.57**	-14.47**	2.19	-1.60	9.66	6.32
x 4	-0.56	0.85	-0.55	-0.08	1.32	1.83	0.06	1.06	-2.36	-4.87	3.91	1.35	40.36**	39.82**	53.71**	48.20**
x 5	0.26	1.09	0.43	0.59	5.52*	8.20*	7.69*	7.14	18.20*	13.99*	9.59	14.08*	144.09**	136.60**	122.50**	134.66**
x 6	-6.28**	-7.16*	-6.78*	-6.75*	-0.58	-0.19	0.74	-0.008	-13.17*	-18.44**	-4.52	-1.14	31.43**	17.60	46.83**	44.85**
x 7	-1.40	-3.90	-3.18	-2.84	4.41	3.99	5.12	4.51	-8.12	-10.32	-3.85	-6.36	26.49**	26.49**	37.48**	31.67**
2 x 3	-7.01**	-5.93	-6.47*	-6.47*	-6.14*	-1.72	-6.13*	-6.42*	-19.68**	-23.50**	-11.66*	-14.89*	-16.73*	-19.83**	-7.97	-11.29
x 4	-0.85	-3.36	-3.97	-2.84	0.15	0.12	0.73	0.34	-4.19	-7.58	0.01	-3.92	13.28	12.85	20.37**	15.51
x 5	0.99	5.85	8.43**	5.11	3.20	7.89*	10.05**	7.07*	-10.99	-15.38	-12.28	-13.25	45.91**	41.43**	40.30**	41.94**
x 6	-3.15	-2.43	-0.16	-1.90	-0.28	-0.13	2.09	0.57	-7.19	-14.35*	-12.54*	-10.91	14.88	2.79	3.17	7.29
x 7	-2.46	-2.09	-1.14	-1.90	0.26	0.84	1.56	0.88	-6.94	-10.00	5.32	0.12	5.91	5.91	23.02**	16.26
3 x 4	-3.96	-7.51	-4.93	-5.49	-2.07	-3.38	-0.66	-2.03	-2.97	-5.18	-3.99	2.50	10.20	9.78	19.50*	17.62
x 5	5.38*	12.36**	14.48**	10.79**	6.67*	13.89**	16.61**	12.43**	-13.67	-11.96	-9.77	-9.72	42.47*	38.10**	36.66**	39.72**
x 6	-4.82*	-2.75	-3.43	-3.66	-2.92	-1.02	-0.89	1,60	-7.25	-13.47	-9.24	-7.67	10.12	-1.46	4.06	6.13
x 7	2.16	-0.91	-1.34	-0.04	4.02	1.48	1.73	0.46	-8.99	-10.87	-6.79	-7.07	-0.40	0.40	4.06	3.12
4 x 5	16.67**	16.86**	16.16**	16.56**	20.45**	23.82**	23.74**	22.68**	-40.31**	5.64	19.76*	17.49	43.02*	38.63*	53.45**	53.50**
x 6	-8.18**	-5.49	-4.20	-5.92*	-4.47	0.57	2.86	-0.32	17.33	10.85	13.56*	14.47	22.09	12.49	15.57*	14.65
x 7	0.88	-2.42	-1.96	-1.45	3.95	4.51	5.76	4.75	-3.57	-3.75	1.02	-1.81	-0.23	-0.61	3.71	1.23
5 x 6	-4.1	4.97	-4.71	-4.61	-3.38	-4.58	-4.00	-4.00	17.05	7.99	5.34	9.95	48.90**	44.33**	37.89**	43.65**
x 7	-1.81	0.86	0.59	0.11	-1.23	1.90	1.79	0.83	21.47*	20.10*	17.39*	20.17*	69.52**	63.97**	55.30**	63.33**
6 x 7	3.02	3.88	5.26	4.21	3.19	4.94	5.74	4.52	1.99	-3.29	-4.08	-1.35	9.95	-1.62	-3.25	1.87

* and ** Significant at 0.05 and 0.01 levels of probability, respectively.
N1 = refers to 20 kg N/ fed.
N2 = " " 30 kg N/ fed.
N3 = " " 40 kg N/ fed.

Table (9): Cont.

Crosses	No. of leaves/ plant								Head diameter (cm)							
	M.P				B.P				M.P				B.P			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	-0.36	-10.97	-9.91	-7.49	-5.19	-12.03	-12.22	-10.0	-1.24	-4.68	-12.16	-6.38	-1.90	-6.42	-20.90	-10.72
x 3	12.04	2.95	-0.75	4.94	9.22	-1.57	-2.40	3.54	-3.71	-6.38	-11.41	-7.41	-4.60	-8.56	-20.55	-12.05
x 4	16.23	8.23	-3.98	9.28	8.74	-4.78	-3.55	-1.57	25.75**	17.43	22.51*	22.75*	13.96	4.65	4.15	7.19
x 5	32.12**	19.75*	11.14	19.88*	14.36	-1.16	-5.15	1.10	43.57**	33.59*	8.48	26.94	-9.19	-15.67	-33.17	-20.57
x 6	17.44	-0.07	-1.88	0.82	14.36	-2.12	-4.58	-1.60	22.43*	32.19**	17.49	23.72*	4.60	15.93	-2.18	5.55
x 7	3.67	-1.42	0.15	0.71	2.11	-7.48	-6.67	-3.40	5.99	15.39	17.93	13.33	5.75	8.82	2.09	5.29
2 x 3	-12.97	-10.77	-12.74	-14.36	-14.88	-15.86*	-16.36	-17.77*	7.62	10.91	8.27	8.95	7.34	10.2	-7.21	8.52
x 4	-3.92	-6.21	-9.55	-6.67	-13.96	-18.83*	-21.09	-17.96*	6.84	3.34	10.21	6.82	-4.95	-6.38	3.26	-2.63
x 5	5.05	0.88	3.88	3.71	-12.60	-17.51	-13.22	-14.45	11.75	19.49	16.56	16.00	-29.12	-23.97*	-24.84*	-25.92*
x 6	-22.51**	-28.15**	-30.33	-27.27	-27.92**	30.45**	-33.93	-30.89**	-10.29	-0.95	3.81	2.26	-9.14	-9.16	-8.86	-9.07
x 7	-7.61	-6.60	-6.76	-7.07	-10.55	-13.31	-15.18	-13.13	-3.94	5.79	-0.73	0.43	-10.68	-4.94	-0.71	-5.10
3 x 4	17.21	16.72	0.87	11.30	7.09	6.96	-8.61	1.47	-3.94	5.79	-0.73	0.43	-14.34	-3.70	-6.58	-8.12
x 5	-15.64	-13.06	-14.29	-13.43	-28.52	-25.51**	-25.81	-26.60**	23.10	18.29	25.89	22.45	-21.83	-24.56	-18.65	-21.67
x 6	-27.39	-14.98*	-7.57	-14.56	-31.02	-12.08	-8.61	-15.50	-8.40	-10.24	3.01	-7.12	-21.13	-19.63	-10.86	-17.11
x 7	-23.82	-11.12	-0.27	-9.72	-24.61	-11.88	-5.58	-12.27	16.98	-11.05	-3.68	-10.53	-17.55	-14.19	-7.46	-12.60
4 x 5	11.54	23.64*	25.84	25.83	2.58	14.79	17.12	16.82	63.42**	52.82**	59.46**	58.43**	9.87	2.05	6.16	0.59
x 6	8.17	-0.93	-12.28	-1.92	3.80	-10.48	-19.70	-9.67	-2.76	-3.24	-14.99	-7.47	-6.58	-4.99	-17.10	-9.90
x 7	3.41	3.65	0.89	2.52	-4.62	-3.29	-3.72	-3.99	3.13	5.32	6.69	4.83	-8.60	-0.84	3.69	1.98
5 x 6	25.53*	13.56	9.50	16.19	11.20	-4.69	-4.29	0.74	119.59**	101.68**	90.49**	102.94**	50.85**	35.96*	28.47	37.60*
x 7	6.81	19.72*	17.81	14.80	-8.73	4.28	7.11	0.33	42.91**	52.98*	52.91**	49.59**	-9.52	-0.85	0.72	-3.29
6 x 7	6.42	6.03	5.07	5.73	2.11	1.51	0.56	3.86	-12.85	4.34	9.10	0.48	-25.40*	-3.44	4.17	-8.42

* and ** Significant at 0.05 and 0.01 levels of probability, respectively.

Table (9): Cont.

Crosses	100 seed size (ml)								No. of seeds/ head							
	M.P				B.P				M.P				B.P			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	-20.25**	-16.16*	-17.85**	-18.12**	-25.95**	-18.32*	-28.46**	-24.70**	29.42*	24.13	24.01*	25.71*	-13.22	15.51	14.92	14.56
x 3	-13.49	-12.42	-10.39	-12.13	-22.69**	-25.42**	-18.83*	-20.97**	35.90*	34.44**	34.85**	35.06**	26.31*	28.11**	34.18**	27.77*
x 4	2.38	-0.56	6.72	2.88	-12.17	-20.45**	-10.18	-12.80	19.56	28.12*	54.62**	34.29**	16.12	25.55*	46.94**	34.11**
x 5	-11.68	4.35	-5.92	-4.38	-37.51**	-30.32**	-31.27**	-31.71**	-13.89	-10.26	-14.91	-13.15	-24.60*	-19.82	-28.45**	-24.66**
x 6	-11.19	-5.79	-0.63	-5.76	-23.62**	-19.16**	-11.31	-16.46*	-5.57	14.86	25.97*	11.52	-8.88	14.58	12.59	8.72
x 7	1.92	0.41	0.84	0.94	-18.39*	-21.74**	-15.70	-17.23*	11.29	7.59	12.73	10.52	4.98	-5.97	6.24	1.47
2 x 3	0.15	8.90	10.87	10.61	2.15	6.26	-11.19	-7.61*	-25.62*	-19.18	7.84	-17.32	-38.86	-30.62**	-14.99	-28.33*
x 4	-23.19**	-13.59	-25.34**	-21.05**	-38.03**	-28.64**	-43.76**	-37.49**	-11.91	-11.51	-5.83	-9.68	-24.81	-19.18	-8.30	-17.58
x 5	-22.80**	7.63	-24.04**	-18.68*	-47.67**	-35.93**	-10.33**	-44.72**	-29.10*	-38.24**	-46.27**	-38.49**	-44.59**	-48.19**	-57.50**	-50.66**
x 6	-16.54*	-14.89**	-23.48**	-18.69**	-32.51**	-24.77**	-39.46**	-32.97**	-15.12	-15.62	-5.59	-12.13	-27.98*	-21.65	-9.24	-18.01
x 7	-12.55	-3.85	-15.71	-11.10	-33.74**	-22.58**	-36.85**	-31.67**	-9.86	-18.46	-7.91	12.18	-24.97*	-32.97**	-19.19	-25.89*
3 x 4	-14.95	-42.68**	-8.06	-11.63	-18.81	-17.95	-15.32	-17.37	3.15	2.90	18.06	7.88	-1.46	-3.93	11.66	1.92
x 5	-22.97	-20.11	-21.27	-21.49	-41.18**	-39.57**	-38.28**	-39.69**	-33.94**	22.89*	-27.99**	-28.28**	-38.09	-25.00*	-39.20**	-34.60**
x 6	-21.46*	-21.19**	-10.58	-17.56*	-24.82*	-21.85*	-8.19	-18.89	-13.12	-13.02	18.32	-3.32	-16.44	-20.14	5.28	-10.71
x 7	-7.22	-8.60	-6.10	-0.07	18.18	-14.13*	-14.18	-16.60	-22.67*	-19.37*	-12.31	-18.87	-26.00*	-23.75*	-16.97	-21.41*
4 x 5	-7.21	-6.46	-8.49	-7.47	-26.70*	-25.44*	-23.37*	-25.22*	-21.84*	-16.53	-20.73*	-19.77*	-29.80**	-24.06*	-36.03**	-30.49**
x 6	-15.55	-17.54	-9.38	-14.23	-15.80	-12.93*	-15.25	-18.54	-28.42*	-27.38*	11.02	-22.67	-28.92*	-28.67*	-16.61	-24.51
x 7	-10.11	-14.83	-14.87	-13.48	-0.17	-17.52	-15.58	-16.91	-32.09**	-39.30**	-14.93	-29.55**	-36.05**	-46.00**	-23.57*	-35.40**
5 x 6	17.24	12.07	8.92	12.70	-7.26	-18.74*	-13.56	-13.61	-35.23**	-30.04	-27.87**	-32.24**	-41.46**	-37.36**	-44.57**	-41.44**
x 7	-3.24	17.33	6.87	7.29	-18.21	-4.12	-22.88*	-10.45	-15.06	-7.62	-11.99	-12.19	-23.59	-9.91	-22.10**	-17.51
6 x 7	-11.92	-26.97**	-23.29*	-21.25*	-19.18	-34.45**	-28.81**	-28.01**	-12.36	-12.06	5.20	-7.47	-12.82	-22.98*	-10.74	-16.99

* and ** Significant at 0.05 and 0.01 levels of probability, respectively.

Table (9): Cont.

Crosses	1000 seed weight (g)								Husk percentage							
	M.P				B.P				M.P				B.P			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	6.77	5.95	7.51	6.75	-0.39	0.39	4.90	1.64	-11.60	-5.81	-2.26	-6.41	1.01	4.09	5.75	0.62
x 3	-23.58**	-23.63**	-32.50**	-26.87**	-34.15**	-35.54**	-38.59**	-36.18**	-31.93**	-35.66**	-35.29**	-34.35**	-20.07*	-22.70	-28.06*	-23.86*
x 4	36.10**	34.78**	35.25**	35.39**	6.50	6.64	9.15	7.49	-2.01	5.29	2.15	1.96	26.21*	28.48**	13.04	21.96*
x 5	44.37**	51.79**	47.45**	47.90**	-12.56	-5.53	-8.12	-8.66	37.77**	34.90**	41.76**	38.16**	394.03**	380.46**	390.45**	387.73**
x 6	11.83	9.18	7.01	9.18	1.58	-4.25	0.69	-1.68	-1.35	0.05	-3.06	-1.44	28.04*	25.57*	17.84	24.01
x 7	8.93	16.25*	11.09	12.10	-8.54	1.91	-0.77	-3.62	-6.11	-7.00	-1.16	-4.60	46.83**	38.12**	27.06	36.32*
2 x 3	11.67	17.64**	9.63	12.91	-9.19	-4.96	-2.44	-5.49	-1.48	-11.85	3.30	-3.51	0.95	3.74	5.95	3.59
x 4	-5.93	8.02	21.043*	8.17	-29.96**	-17.83**	-3.81	-17.17*	26.32**	0.86	9.47	11.78	42.39**	20.52*	11.80	23.53*
x 5	1.22	7.16	9.98	6.17	-40.13**	-34.61**	-32.13	-35.63**	89.83**	57.10**	77.74*	73.59**	451.13**	442.62**	440.91**	444.09**
x 6	-18.07*	-10.18	-13.31	-13.82	-32.07**	-24.78**	-20.27**	-25.70**	-2.86	-14.65	-8.33	-8.95	8.89	5.78	2.20	5.54
x 7	2.00	8.70	2.84	4.32	-19.01*	-12.20	-10.10	-13.90	-5.15	-58.19**	-6.13	-9.42	25.94	21.29	10.29	18.35
3 x 4	16.71	18.69*	6.13	13.38	3.93	9.59	-7.17	1.39	-24.97**	-13.68	-19.85*	-19.42*	-18.64	-12.52	-19.51	-17.20
x 5	52.23	23.79	4.90	17.00	19.09	-15.96	-31.79**	-23.05	5.95	7.83	1.53	3.84	195.65**	489.23**	187.42**	190.37**
x 6	-15.01	0.79	-4.97	-6.27	-17.05	-3.62	-8.34	-9.52	1.41	0.74	-8.59	-2.38	10.71	5.39	-0.84	4.50
x 7	-21.73*	-10.20	-7.04	-12.52	-24.15*	-10.22	-8.29	-14.04	-7.20	-13.24	-15.49	-12.23	19.60	4.31	-3.5	5.66
4 x 5	39.27*	46.25**	53.79**	46.95*	-4.32	4.02	7.72	2.87	65.25**	50.60**	62.01**	59.20**	306.45**	295.38**	376.21**	326.06**
x 6	4.36	1.73	-5.67	-0.28	-9.03	-9.84	-20.00	-13.55	-22.28*	13.69	-20.57*	-18.77*	-21.79*	-10.94	-13.44	-15.15
x 7	13.69	13.19	-4.43	6.72	4.13	4.53	-14.90	-3.05	-8.89	10.81	-16.49	-12.61	7.06	5.59	-4.70	1.99
5 x 6	28.04	28.91*	10.10	21.45	-18.17	-14.50	-29.58**	-21.45	59.40**	47.03**	40.83*	48.73**	288.23**	267.23**	261.67**	271.58**
x 7	22.41	13.72	23.21	19.89	-19.75	-22.79*	-19.11	-20.47	77.11**	95.50**	60.59**	76.72**	245.65**	301.08**	282.88**	276.63**
6 x 7	-18.10	-19.18*	-28.63**	-22.52*	-22.46*	-22.74	-32.50**	-26.45	6.67	6.13	0.71	4.33	24.44	21.29	5.63	16.08

* and ** Significant at 0.05 and 0.01 levels of probability, respectively.

Table (9): Cont.

Crosses	Seed yield/ plant (g)															
	M.P				B.P				Hysum				G. 101			
	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb	N	N2	N3	Comb
1 x 2	32.29**	24.98*	18.35	22.72*	32.22**	21.94	18.22	19.72	40.45**	34.79*	38.06*	37.72**	12.4	12.88+	17.23+	14.28+
x 3	6.38	4.07	-8.55	0.13	-1.85	-5.61	-16.78	-8.58	4.26	-0.74	-0.90	0.77	-16.5	-16.87	-15.86	-16.38
x 4	74.49**	83.53	85.84**	86.50**	39.82**	44.98**	44.43**	47.06**	48.54**	52.47**	68.98**	57.03**	18.9	27.69*	43.48**	30.30**
x 5	9.28	10.57	-2.38	5.25	-29.74*	-28.03*	-33.60**	-30.56*	-25.40**	-24.30	-20.93	-23.45	-40.2	-36.61**	-32.86**	-36.48**
x 6	4.40	24.69	35.40**	51.72**	-7.40	8.18	13.28	5.47	-1.63	13.77	34.89*	16.35	-21.2	-4.72	14.54	-3.45
x 7	-33.18**	39.41**	30.83**	34.43**	20.76	30.80*	18.50	23.24	28.28*	37.56**	41.11**	35.90**	2.6	12.20	19.82*	12.77+
2 x 3	-17.15	-13.03	-11.24	-15.18	-23.53	-22.84	-19.31	-24.27*	-18.86	-14.71	-3.72	-12.16	-35.0	-28.57*	-18.25	-27.11*
x 4	-13.97	-15.99	-11.19	-15.43	-31.03*	-34.82**	-31.12*	-34.51**	-26.82*	-27.97*	-17.82	-24.05	-41.4	-39.67**	-30.22*	-36.98**
x 5	19.00	-29.44	-34.50*	-30.28	-47.91**	-54.59**	-55.48**	-54.55**	-44.73**	-49.81**	-46.88**	-47.19**	-55.7	-57.97**	-54.90**	-56.18**
x 6	-24.48*	-29.73*	-34.52**	-15.35	-33.25**	-0.40**	-45.26**	-41.97**	-29.18*	-34.00*	-37.70*	-33.78*	-43.3	-44.73**	-47.10**	-45.05**
x 7	-11.56	-5.04	-6.37	-9.08	-19.77	-12.93	-15.27	-18.50	-14.87	-3.76	1.09	-5.54	-31.8	-19.39	-14.16	-21.61
3 x 4	21.21	-18.99	24.69	21.72	3.83	1.88	4.07	3.37	-6.78	-12.79	1.61	-5.87	-25.3	-26.96*	-13.72	-21.89
x 5	-5.19	-1.37	-16.0	-8.33	-36.56*	-32.41*	-39.53**	-36.44*	-43.05**	-42.14**	-40.96**	-42.00**	-54.4	-51.54**	-49.87**	-51.88**
x 6	-9.42	-12.64	-14.16	11.84	-13.24	-16.87	-21.80	-17.66	-22.10	-28.79*	-25.20	-25.43	-37.6	-40.37**	-36.48**	38.12**
x 7	-26.18*	-31.78*	-31.89	-30.84*	-27.56	-34.21*	-32.24*	-31.15*	-34.97**	-39.39**	-33.84*	-36.06**	-47.9	-49.24**	-43.82**	-46.94**
4 x 5	38.31	32.57	25.73	31.54	1.95	0.77	3.89	2.19	-34.73**	-38.54**	-31.67*	-34.94*	-47.7	-48.53**	-41.98**	-46.01**
x 6	-13.03	-11.29	-11.19	17.18	-22.65	-23.34	-19.16	1.79	-36.41**	-40.74**	-35.20*	-37.43**	-49.1	-50.37**	-44.97**	-48.08**
x 7	-27.64	-30.99*	-14.81	-24.13	-37.01*	-42.66**	28.42	-35.80*	-45.57**	-47.15**	-30.83*	-40.95**	-56.4	-55.74**	-41.27**	-51.00**
5 x 6	-0.18	-1.54	-4.74	43.64	-31.66*	-30.56	-26.86	30.63	-43.82**	-46.32**	-41.37**	-43.81**	-55.0	-55.05**	-50.22**	-53.37**
x 7	22.92*	11.99	-3.95	8.99	-16.95	-24.74	-30.65*	-24.61	-28.23*	-30.63*	-32.98*	-30.70*	-42.5	-41.90**	-43.09**	-42.49**
6 x 7	-14.31	-18.87	-19.03	24.97	-16.40	-25.42	-25.93	-8.26	-27.73*	31.25*	-28.42	-29.15*	-42.1	-42.42**	-39.22**	-41.21**

+, * and ** Significant at 0.1, 0.05 and 0.01 levels of probability, respectively.

Table (9): Cont.

Crosses	Seed yield/ plant (g)				Oil percentage							
	Vidoc				M.P				B.P			
	N1	N2	N3	Comb	N1	N2	N3	Comb	N1	N2	N3	Comb
1 x 2	27.76*	19.69+	25.23+	24.13+	16.64**	19.49**	18.34**	18.15**	7.38**	9.89**	8.88**	8.72**
x 3	-5.16	-11.85	-10.11	-9.17	-1.77	1.31	2.23	0.56	-14.55**	-14.56**	-9.84**	-12.38**
x 4	35.11**	35.39**	53.28**	41.54**	10.38**	12.57**	11.93**	11.61**	-5.00**	-3.61**	-2.91*	3.86**
x 5	-32.11**	-32.78**	-28.28*	-31.00*	3.81*	4.73**	4.90**	4.47**	-11.18**	-11.34**	-10.85**	-11.13**
x 6	-10.52	1.03	22.36	4.88	12.36	14.49**	13.37**	13.39**	-1.89	-1.46	-2.10	-1.80
x 7	16.69+	22.15+	28.00*	22.49+	17.74**	21.30**	20.41**	19.79**	6.45**	8.92**	8.03**	7.79**
2 x 3	-26.19*	-24.26*	-12.66	-20.83	1.59**	7.74**	9.68**	7.72**	-0.51	16.16**	4.69**	1.47
x 4	-33.43**	-36.03**	-25.45	-31.55*	4.26**	6.96**	7.74**	6.51**	-3.18	-1.11	0.98	-0.94
x 5	-49.72**	-55.43**	-51.82**	-52.40**	4.89**	7.27**	6.85**	6.33**	-3.21*	-2.03	-2.10	-2.47
x 6	-35.57**	-41.40**	-43.48**	-40.31	-3.62	-1.78	-1.70	-2.37	-9.06**	-8.68**	-8.32**	-8.69**
x 7	-22.56	-14.54	-8.29	-14.85	3.26	-0.41	-1.74	-1.80	-4.76**	-2.99**	-4.42**	-4.18**
3 x 4	-15.21	-22.55	-7.83	-15.15	1.34	3.25**	4.72**	3.13**	0.78	2.32	2.73*	1.75
x 5	-48.19**	-48.62**	-46.45**	-47.73**	-3.22**	2.64*	-0.96	-2.56*	-5.08**	-5.58**	-5.13**	-5.27**
x 6	-29.14*	-36.77**	-32.14*	-32.79**	-0.95	-1.77	0.71	-0.73	-1.38	-2.06	-1.84	-1.48
x 7	-40.84**	-46.18**	-39.99**	-42.37**	3.24*	4.80**	0.45	2.87*	-1.13	15.86**	-1.48	-0.79
4 x 5	-40.63**	-45.43**	38.02**	-41.35**	1.19	2.16	2.72*	2.02	0.49	0.75**	0.25	0.49
x 6	-42.16**	-47.37**	-41.22**	-43.61**	-1.60	-2.40*	-0.32	-1.49	-3.25*	-2.98*	-0.97	-2.09
x 7	-50.49**	-53.07**	-37.25**	-46.77**	-2.43	0.27	1.14	-0.36	-7.68**	-4.97**	-2.65*	-5.15**
5 x 6	-48.90**	-52.33**	-46.82**	-49.35**	-1.97	-1.39	-2.70	-2.08	-4.27**	-3.33**	-4.54**	-4.05**
x 7	-34.72**	-38.40**	-39.21**	-37.53**	-7.43**	-6.02**	-6.62**	-6.70**	-12.98**	-12.09**	-12.96**	-12.44**
6 x 7	-34.26**	-38.95**	-35.07**	-36.14**	-1.21	-0.90	-4.54**	-2.21	-5.00	-5.55**	-8.58**	-6.37**

+, * and ** Significant at 0.1, 0.05 and 0.01 levels of probability, respectively.

Table (10): Estimates of general combining ability effects for the seven parents studied at the three nitrogen fertilizer levels as well as the combined data.

Characters	No. of days to flowering				Plant height				No. of leaves/ plant			
Parent	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
P1	1.24**	1.41**	1.55**	1.40**	35.34**	38.86**	40.64**	38.19**	2.37**	2.49**	1.94**	2.27**
P2	-0.22	-0.75**	-0.93**	-0.63**	6.71**	6.23**	6.68**	6.52**	0.15	0.05	0.48	0.22
P3	-0.57**	-0/17	-0.29	0.34	-1.33	-0.10	-0.84	-0.66	-0.69*	-0.23	0.26	-0.22
P4	1.56**	2.30**	2.50**	2.12**	-4.96**	-5.88**	-5.10**	-5.22**	0.16	-0.76*	-1.21**	-0.60
P5	0.73**	1.21**	1.18**	1.04**	-21.81**	-25.14**	-26.32**	-24.42**	-1.53**	-1.94**	-1.26**	-1.58**
P6	-2.09**	-2.11**	-2.27*	-2.16**	-10.07**	-7.62**	-8.43**	-8.81**	0.53	0.40	-0.42	-0.18
P7	-0.65**	-1.56**	-1.75**	-1.32**	-3.88**	-6.36**	-6.62**	-5.56**	0.08	0.23	0.21	0.18
L.S.D (gi- gj) 0.05	0.40	0.53	0.49	0.47	2.68	2.49	2.09	2.39	0.69	0.59	0.79	0.69
L.S.D (gi- gj) 0.01	0.54	0.71	0.66	0.62	3.58	3.33	2.79	3.16	0.92	0.79	1.10	0.91
r	0.73	0.76*	0.81*	0.78*	0.48	0.98**	0.98**	0.98**	0.61	0.81*	0.78*	0.72*

* and ** significant at 0.01 and 0.05 levels of probability, respectively.

N1 = refers to 20 kg N/ fed.
N2 = " " 30 kg N/ fed.
N3 = " " 40 kg N/ fed.

Table (10): Cont.

Characters	Head diameter (cm)				100 seed size (ml)				No. of seed/ head			
Parent	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
P1	2.01**	2.06**	3.08**	2.38**	1.65**	1.76**	1.65**	1.68**	103.54**	103.06**	130.00**	112.20**
P2	0.75**	0.74**	0.31	0.61*	2.19**	2.13**	3.12**	2.48**	-114.21**	-112.38**	-112.30**	-112.96**
P3	0.26	0.23	-0.04	0.15	0.01	0.17	0.21	0.13	43.97**	53.61**	23.88	40.49**
P4	-0.23	-0.30	0.01	-0.17	0.40**	-0.84**	-1.05**	-0.76**	-8.31	-32.06*	-22.49	-20.95
P5	-2.58**	-3.06**	-3.44**	-3.04**	-2.24**	-2.18**	-2.50**	-2.31**	13.33	-4.20	37.13**	15.42
P6	-0.74**	-0.13	-0.38	-0.41	0.34*	-0.19	-0.36*	-0.29*	39.37**	-61.76**	-87.08**	-62.73**
P7	0.51*	0.44	0.46	0.47*	0.86**	-0.86**	-1.05**	-0.92**	1.05	53.73**	30.85*	28.54*
L.S.D (gi- gj) 0.05	0.49	0.55	0.58	0.54	0.28	0.28	0.32	0.28	28.03	26.51	25.65	26.34
L.S.D (gi- gj) 0.01	0.65	0.74	0.78	0.71	0.38	0.75	0.43	0.37	37.42	35.39	34.24	34.77
r	0.93**	0.96**	0.97**	0.96**	0.99**	0.99**	0.99**	0.99**	-0.097	-0.07	0.21	0.41

* and ** significant at 0.01 and 0.05 levels of probability, respectively.

Table (10): Cont.

Characters	1000 seed weight (g)				Husk percentage			
Parent	N1	N2	N3	Comb.	N1	N2	N3	Comb.
P1	12.65**	12.44**	12.44**	12.51**	5.18**	5.44**	4.59**	5.07**
P2	18.02**	19.29**	18.11**	18.47**	3.88**	5.19**	3.97**	4.35**
P3	-2.91**	-3.93**	-2.30*	-3.49**	-0.74*	-1.93**	-1.27**	-1.31**
P4	-2.91**	-2.19**	-1.44	-3.03**	-0.47	0.17	1.50**	0.40
P5	-18.02**	-17.78**	-19.04**	-16.81**	-3.86**	-4.77**	-5.22**	-4.62**
P6	-4.31**	-6.15**	-8.33**	-1.83*	-0.50	-0.64	-1.37**	-0. 83*
P7	-2.53**	-1.67*	0.56	-3.62**	-3.49**	-3.46**	-2.20**	-3.00**
L.S.D (gi- gj) 0.05	1.50	1.61	1.74	1.69	0.65	0.71	0.88	0.74
L.S.D (gi- gj) 0.01	2.01	2.15	2.32	2.11	0.86	0.95	1.18	0.98
r	0.98**	0.95**	0.97**	0.92**	0.88**	0.92**	0.88**	0.90**

* and ** significant at 0.01 and 0.05 levels of probability, respectively.

Table (10): Cont.

Characters	Seed yield (g)				Oil percentage			
Parent	N1	N2	N3	Comb.	N1	N2	N3	Comb.
P1	16.46**	19.26**	21.79**	19.11**	-2.33**	-2.37**	-2.18**	-2.29**
P2	4.00**	5.18**	5.00**	4.72**	0.84**	-0.86**	-0.62**	-0.78**
P3	0.03	-1.42	-0.86	-0.93	0.77**	0.71**	0.24**	0.58**
P4	-2.07*	-3.23**	-1.28	-2.33*	1.60**	1.51**	1.38**	1.49**
P5	-14.31**	-15.69**	-19.41**	-15.94**	1.22**	1.26**	1.40**	1.29**
P6	-3.57**	-5.31**	-5.65**	-4.72**	0.48**	0.55**	0.64**	0.56**
P7	-0.52	1.21	0.41	0.15	-0.89**	-0.79**	-0.86**	-0.85**
L.S.D (gi- gj) 0.05	1.94	2.19	2.42	2.16	0.16	0.13	0.13	0.14
L.S.D (gi- gj) 0.01	2.59	2.93	3.23	2.85	0.22	0.17	0.17	0.18
r	0.87**	0.86**	0.87**	0.86*	0.86*	0.97	0.95**	0.97**

* and ** significant at 0.01 and 0.05 levels of probability, respectively.

Table (11): Estimates of specific combining ability effects for crosses studied in the F1- generation at the three nitrogen levels as well as the combined data.

Crosses	No. of days to flowering				Plant height (cm)				No. of leaves/ plant			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	-0.85	-2.49**	-2.66**	-2.00**	10.00*	1.58	-1.97	3.47	0.68	1.80*	-2.71*	-1.25
x 3	-1.88**	-1.08	0.06	-0.97	-16.63**	-16.42**	-14.79**	-15.81**	2.90**	1.07	0.61	1.53
x 4	0.25	1.66*	0.80	0.90	-2.00	-0.31	1.47	-0.19	0.39	0.60	1.67	0..89
x 5	-0.15	-0.28	-0.78	-0.40	20.52**	14.95**	10.36**	15.72**	8.58**	2.94**	1.21	2.58*
x 6	1.26*	-1.83*	1.81*	-1.64*	-16.89**	10.92**	4.20	-0.58	2.57*	0.26	-0.78	0.68
x 7	0.02	-0.85	-0.51	-0.45	-8.41*	-11.49**	-6.34*	-8.64*	-0.45	1.23	-0.71	-0.81
2 x 3	-2.25**	-1.92*	-2.70**	-2.29**	-13.00**	-6.12	-5.49	-8.16*	-0.54	-0.48	-0.99	-0.67
x 4	-0.03	-1.28	-1.72*	-1.01	-1.70	-7.01	-0.23	-2.94	-1.12	-0.80	-1.13	-1.02
x 5	0.11	1.88*	2.97**	1.65*	-9.85*	-14.08**	-12.01**	-12.96**	0.97	0.64	1.59	1.07
x 6	0.35	1.64*	1.38	0.76	-3.93	-10.27**	-11.57**	-8.35*	-4.54**	-5.83**	-6.25**	-5.54**
x 7	-0.65	-0.15	0.11	-0.23	-2.78	8.81*	11.29**	5.79	-0.05	-0.20	-0.55	-0.27
3 x 4	-1.86**	-3.87**	-2.74**	-2.82**	3.33	9.99**	6.29*	6.47	4.51 **	3.81**	.75	3.03**
x 5	2.27**	4.96**	5.82**	4.35**	-5.82	-9.08*	-6.82*	-7.22*	-3.80**	-4.25**	-4.52**	-4.19**
x 6	-0.65	-0.03	-0.83	-0.50	0.22	-4.27	-3.05	-2.38	-5.51**	-1.49	-0.03	2.34*
x 7	1.64**	0.09	-0.45	0.43	-1.74	-0.53	-2.86	-1.72	-4.31**	-1.25	0.27	-1.77
4 x 5	7.31**	7.25**	6.83**	7.13**	-1.85	12.36**	8.77**	6.50	2.20*	2.28*	4.04**	2.84*
x 6	-3.56**	-2.16**	-1.65*	-2.46**	14.74**	8.51*	9.55**	11.12**	0.51	-0.48	-2.56*	-0.84
x 7	0.52	-1.31	-1.14	-0.99	-5.11	-7.08	-4.94	-5.89	-0.16	-0.62	-0.87	-0.55
5 x 6	-2.18**	-3.76**	-3.93**	-3.29**	6.93	1.44	1.44	3.49	4.07**	2.44**	2.16	2.89*
x 7	-2.36**	-1.56*	-1.88*	-1.93**	13.41**	14.27**	11.47**	13.05**	0.03	2.62**	2.19	1.61
6 x 7	2.56**	3.34**	3.62**	3.17**	2.33	-3.01	-5.27	-1.96	2.44*	2.11*	2.15	2.23*
LSD 0.05 (S_{ii}- s_{ik})	2.70	3.96	3.72	3.44	20.11	18.63	15.61	14.69	5.14	4.46	5.97	5.12
LSD 0.01 (S_{ii}- s_{ik})	3.60	5.27	4.95	4.51	26.75	24.78	20.77	19.20	6.55	5.93	7.94	6.72
LSD 0.05 (S_{ii}- s_{kl})	2.53	3.71	3.48	3.21	18.58	17.43	14.61	13.70	4.81	4.17	5.58	4.79
LSD 0.01 (S_{ii}- s_{kl})	3.36	4.93	4.63	4.21	25.02	23.18	19.42	17.96	6.39	5.55	7.43	6.28

* and ** Significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (11): Cont.

Crosses	Head diameter (cm)				100 seed size (ml)				No. of seeds/ head			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	-1.02	-1.66*	-2.71**	-1.80*	-1.65**	-1.94**	-1.74**	-1.77**	132.59**	112.59**	111.48**	118.89**
x 3	-0.99	-1.65*	-2.28**	-1.61*	-0.74	-1.07*	-1.13*	-0.98*	239.40**	-53.40	155.25**	198.57**
x 4	2.72**	1.45	3.34**	2.51**	1.14**	0.70	1.46**	1.10*	104.15*	151.95**	301.21**	185.77**
x 5	1.03	0.41	-1.71*	-0.09	0.55	0.51	-0.29	-0.11	-95.04*	-102.21*	-124.98**	-107.41**
x 6	1.60*	3.40**	2.28**	2.43**	-0.52	0.26	0.57	0.10	-61.56	58.99	65.94	21.12
x 7	0.55	1.49	2.42**	1.49	0.73	0.52	0.60	0.62	57.89	26.48	13.24	32.53
2 x 3	2.10**	2.56**	2.07*	2.24**	1.59**	3.46**	3.20**	2.75**	-137.06**	-89.89*	35.95	-87.63*
x 4	0.46	0.07	1.19	0.57	-1.57**	-0.94*	-2.14**	-1.55**	-17.96	2.46	-18.24	-11.25
x 5	-1.35	-0.33	-0.46	-0.71	-1.30**	-0.73	-1.75**	-1.26**	-85.73*	-260.21**	-254.72**	-169.89
x 6	0.26	-0.60	-0.66	-0.33	-0.73	-0.98*	-1.69**	-1.23**	-4.60	-10.70	1.55	-4.58
x 7	-1.12	-0.40	0.003	-0.51	-0.41	0.01	-0.74	-0.38	11.10	-40.80	4.69	-8.35
3 x 4	-0.73	-0.88	-0.43	-0.09	-0.56	-0.44	-0.30	-0.43	98.06*	80.93*	109.24**	96.07*
x 5	0.33	-0.07	0.89	0.38	-1.18**	-1.63**	-1.65**	-1.49**	-176.18**	-104.36*	-156.47**	-145.67**
x 6	-1.38	2.12*	-0.83	-1.44	-1.28**	-1.35**	-0.59	-1.07*	-7.42	-41.86	117.55**	22.76
x 7	-1.81*	-1.73*	-1.05	-1.53	-0.03	-0.35	-0.16	-0.18	-135.01**	-110.25**	-109.63**	-118.29**
4 x 5	2.17**	1.94*	3.08**	2.39**	0.10	-0.16	-0.05	-0.04	-37.41	-9.27	-69.54	-38.74
x 6	-1.86*	-2.03*	-3.79	-2.56**	-0.67	-0.61	-0.06	-0.45	-118.48**	-125.64**	-108.78**	-117.64**
x 7	0.22	-0.06	-0.54	-0.13	-0.36	-0.68	-0.71	-0.58	-192.60**	-257.64**	-128.33**	-192.86**
5 x 6	6.58**	6.00**	6.02	6.20**	2.03**	1.33**	1.59**	1.65**	-127.98**	-112.02**	-114.31**	-118.11**
x 7	2.40**	2.70**	2.47**	5.52**	0.09	1.39**	1.21*	0.90*	18.03	92.47*	55.57	55.36
6 x 7	-2.18**	-0.67	-0.08	-0.97	-0.56	-0.86*	-1.67**	-1.36**	7.77	13.12	62.79	27.89
LSD 0.05 (S_{ii}- s_{ik})	3.66	4.16	4.37	3.50	2.11	2.13	2.40	2.17	209.75	198.37	191.98	177.61
LSD 0.01 (S_{ii}- s_{ik})	4.87	5.53	5.81	4.59	2.81	2.83	3.19	2.85	278.96	263.83	255.33	232.89
LSD 0.05 (S_{ii}- s_{kl})	3.05	3.89	4.08	3.27	1.98	1.99	2.14	2.03	196.20	185.56	179.58	166.14
LSD 0.01 (S_{ii}- s_{kl})	4.06	5.17	5.43	4.29	2.83	2.65	2.98	2.67	260.94	246.79	238.84	217.85

* and ** Significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (11): Cont.

Crosses	1000 seed weight (g)				Husk percentage			
	N1	N2	N3	Comb.	N1	N2	N3	Comb.
1 x 2	1.60	-1.44	-1.22	0.87	-4.10**	-0.91	-1.53	-2.18*
x 3	-17.81**	-18.89**	-25.15**	-22.63**	-6.97**	-8.69**	-8.83**	-8.14**
x 4	15.53**	15.37**	17.33**	14.47**	0.83	2.78**	1.84	1.81
x 5	-1.69	-2.70	-4.07	14.36**	4.18**	3.45**	4.52**	4.05**
x 6	10.27**	10.00**	16.56**	5.38*	0.91	0.95	0.47	0.78
x 7	2.82	7.52**	6.33*	5.52*	-0.40	-1.20	0.73	-0.29
2 x 3	8.82**	9.93**	6.52*	11.56**	0.39	-0.94	2.66*	0.70
x 4	-14.18**	-12.48**	-3.00	-0.01	6.06**	0.83	2.06	2.98**
x 5	-5.40*	-4.56	-5.07*	-3.79	9.01**	7.74**	8.48**	8.41**
x 6	-11.44**	-6.85**	-4.44	-9.32**	-2.39*	-4.20**	-3.18*	-3.25**
x 7	-1.21	0.67	-3.67	3.69	-2.86**	-4.34**	-2.81*	-3.34**
3 x 4	5.42*	5.07*	2.07	4.50	-4.15**	-1.18	-3.01*	-2.78*
x 5	6.86**	5.67*	1.33	2.61	-2.20*	-1.61	-3.02*	-2.27*
x 6	2.16	3.04	-0.04	0.63	2.67*	2.83**	1.23	2.24*
x 7	-11.62**	-7.11**	-1.26	-4.80*	0.63	-0.66	-1.01	-0.34
4 x 5	3.19	6.26*	9.82**	4.82*	4.40**	3.19**	6.68**	4.76**
x 6	8.49**	8.63**	7.11**	-2.60	-5.40**	-3.51**	-4.97**	-4.62**
x 7	1.38	-0.19	-9.11**	-0.37	1.91*	-2.49*	-4.07**	-2.82*
5 x 6	11.27**	13.56**	13.04**	5.73*	3.29**	2.17*	1.98	2.48*
x 7	3.16	-0.59	5.48*	2.63	3.61**	7.19**	4.21**	5.01**
6 x 7	8.12**	6.44**	3.11	-10.90**	1.25	1.49	1.36	1.36
LSD 0.05 (S_{ii}- s_{ik})	11.25	12.07	13.01	11.89	4.86	5.30	6.61	5.53
LSD 0.01 (S_{ii}- s_{ik})	14.96	16.06	17.30	15.59	6.46	7.05	8.79	7.25
LSD 0.05 (S_{ii}- s_{kl})	10.52	11.94	12.17	11.12	4.55	4.96	6.18	5.17
LSD 0.01 (S_{ii}- s_{kl})	13.99	15.02	16.19	14.58	6.05	6.60	8.23	6.78

* and ** Significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (11): Cont.

Crosses	Seed yield/ plant (g) N1	N2	N3	Comb.	Oil percentage N1	N2	N3	Comb.
1 x 2	14.15**	9.57**	6.45	10.61**	2.65**	2.63**	2.39**	2.56**
x 3	-3.38	-6.53*	-13.56**	-7.83*	-2.46**	-1.85**	1.67**	-1.99**
x 4	25.02**	29.27**	33.26**	29.81**	1.38**	1.46**	1.09**	1.31**
x 5	-6.64*	-7.24*	-10.51**	-8.13*	-0.21	0.33	-0.23	-0.26
x 6	-3.28	6.04	14.68**	5.82	2.43**	2.78**	2.53**	2.58**
x 7	11.43**	15.30**	13.07	13.31**	0.80**	4.19**	4.39**	4.15**
2 x 3	-4.66	-1.39	1.37	-1.56	0.62*	1.61**	2.04**	1.73**
x 4	-7.29*	-8.05*	-7.58*	-7.68*	0.73**	1.15**	0.99**	0.83**
x 5	-5.68*	-9.55**	-8.75*	-8.70**	1.53**	1.90**	1.68**	1.70**
x 6	-7.19*	-9.83**	-16.41**	-10.77**	-1.83**	-1.49**	-1.39**	-1.56**
x 7	-1.74	2.98	3.30	1.55	-1.75**	-1.45**	-1.50**	-1.56**
3 x 4	8.58**	8.25*	11.18**	9.41**	0.38	0.68**	0.80**	0.63**
x 5		2.03	-0.82	0.17	-0.85**	-1.10**	-0.38*	-0.78**
x 6	0.98	-0.51	-1.22	-0.25	-0.14	-0.53**	0.22	0.15
x 7	-9.71**	-13.19**	-14.04**	-12.31**	1.34**	1.44**	0.04	0.94**
4 x 5	6.32*	6.05	7.63*	6.04	0.59*	0.63**	-0.60**	0.62**
x 6	-5.42	-5.73	-8.46*	-6.76*	-0.73**	-1.23**	-0.60**	-0.83**
x 7	-13.91**	-16.35**	-11.62**	-13.85**	-1.13**	-0.65**	0.14	-0.63**
5 x 6	2.42	3.17	5.56	2.83	-0.22	-0.04	-0.55**	-0.27
x 7	8.64**	6.68*	5.07	6.24	-2.38**	-2.20**	-2.09**	-2.23**
6 x 7	-1.81	-4.10	-5.65	-4.00	-0.21	-0.36	-1.25**	-0.61**
LSD 0.05 (S_{ii}- s_{ik})	14.52	16.40	18.13	16.09	1.24	1.13	0.94	0.60
LSD 0.01 (S_{ii}- s_{ik})	19.32	21.81	24.11	12.18	1.64	1.30	1.25	0.79
LSD 0.05 (S_{ii}- s_{kl})	13.53	15.34	16.96	15.05	1.16	0.91	0.88	0.56
LSD 0.01 (S_{ii}- s_{kl})	18.07	20.40	22.56	19.73	1.54	1.21	1.17	1.17

* and ** Significant differences from zero at 0.05 and 0.01 levels of probability, respectively.

Table (12): Estimates of genetic components and ratios derived from 7 x 7 diallel cross analysis at the three nitrogen fertilization levels as well as the combined data.

Component	Number of days to flowering			Plant height			Number of leaves/ plant		
	N1	N2	N3	N1	N2	N3	N1	N2	N3
$\hat{D}$	4.294 +	8.976+	10.967*	1683.76*	1837.36*	1947.16*	7.706	13.980*	10.268*
$\hat{F}$	1.070+	2.994+	2.761+	635.07*	480.95*	421.31*	11.378+	19.270*	14.906
$\hat{H}1$	24.395*	33.070*	34.716*	401.22*	378.44*	300.58*	38.891*	27.893*	20.913*
$\hat{H}2$	19.911*	26.225*	27.679*	293.69*	278.58*	209.36*	27.043*	18.193*	13.296
$\hat{h}2$	1.011	-0.186	-1.028	6.64	-23.70	-15.96	1.389	-1.542	-1.457
$\hat{D}$- $\hat{H}1$	-20.101	-24.094	-23.749	1282.54	1458.92	1646.58	-31.185	-13.913	-10.645
$\hat{E}$	0.997	2.232	2.149	62.29*	59.31*	38.98*	3.357	3.639*	5.440*
$(\hat{H}1/\hat{D})^{1/2}$	2.38	1.910	1.78	0.49	0.450	0.39	2.250	1.41	1.430
$\hat{H}2/4\hat{H}1$	0.204	0.198	0.199	0.183	0.184	0.174	0.174	0.163	0.159
Kd/ Kr!	1.11	1.19	1.15	1.39	1.81	1.76	1.980	2.91	3.070
Heritability narrow sense	0.392	0.422	0.457	0.810	0.849	0.899	0.288	0.212	0.151
broad sense	0.899	0.853	0.871	0.913	0.931	0.957	0.764	0.650	0.488
t^2	3.592*	2.666*	2.627+	0.199	0.376	0.911	1.542	0.745	0.509
r	0.196	0.374	0.249	0.013	-0.29	-0.398	-0.181	-0.580	-3.838

+, * and ** significant at 0.10, 0.05 and 0.01 levels of probability, respectively

r : Correlation coefficient between the parental performance (Yr) and order of dominance (Wr + Vr).

! $KD/KR = [(4\hat{D}\hat{H}1)^{1/2} + \hat{F}] / [(4\hat{D}\hat{H}1)^{1/2} - \hat{F}]$

N1, N2, and N3 refer to 20, 30 and 40 kg N/ fed., respectively.

Table (12): Cont.

Components	Head diameter (cm)			100- seed size (ml)			No. of seeds/ head		
	N1	N2	N3	N1	N2	N3	N1	N2	N3
$\hat{D}$	20.266*	21.452*	25.131*	11.310*	9.897*	17.363*	33421.3*	28002.9*	45536.1*
$\hat{F}$	22.434*	19.533*	17.797*	3.255	1.189	4.951	65679.7**	422404.0**	68933.3**
$\hat{H}1$	23.721*	19.905*	22.139*	3.357*	5.583*	7.199*	2112270.7**	145698.1**	163052.6**
$\hat{H}2$	16.048	14.695	18.296*	3.306*	5.439*	6.731*	1857641.5**	100504.9**	101913.3**
$\hat{h}2$	5.939+	7.392+	7.317+	4.060*	1.898+	3.809*	71223.0**	40434.6*	7080.7
$\hat{D}$- $\hat{H}1$	-3.455	1.547	2.992	7.953	4.314	10.164	-2078849.4*	-11765.12*	-117516.5*
$\hat{E}$	1.924	2.344	2.695*	0.697*	0.631+	0.794*	6482.5	6105.6	5245.1
$(\hat{H}1/\hat{D})^{1/2}$	1.08	0.96	0.940	0.545	0.751	0.644	7.95	2.28	1.89
$\hat{H}2/4\hat{H}1$	0.169	0.185	0.207	0.246	0.244	0.234	0.22	0.17	0.16
Kd/ Kr[!]	3.090	2.790	2.210	1.12	1.11	1.070	1.28	1.99	2.33
Heritability narrow sense	0.317	0.372	0.435	0.227	0.690	0.722	0.06	0.26	0.33
broad sense	0.779	0.755	0.790	0.875	0.902	0.911	0.37	0.61	0.73
t^2	0.156	0.334	2.090	0.406	2.78	1.413	2.021	2.891	2.910
r	-0.810+	-0.870**	-0.648	0.645	0.103	0.674	0.641	0.982**	0.831*

+, * and ** significant at 0.10, 0.05 and 0.01 levels of probability, respectively

r : Correlation coefficient between the parental performance (Yr) and order of dominance (Wr + Vr).

! $KD/KR = [(4\hat{D}\hat{H}1)^{1/2} + \hat{F}]/[(4\hat{D}\hat{H}1)^{1/2} - \hat{F}]$

Table (12): Cont.

Component	1000- seed weight (g)			Husk percentage			Seed yield (g)			Oil percentage		
	N1	N2	N3	N1	N2	N3	N1	N2	N3	N1	N2	N3
$\hat{D}$	888.04*	886.49*	910.45*	97.28*	121.90*	101.85*	276.92*	223.22*	227.01*	16.97*	18.78*	16.14*
$\hat{F}$	516.22*	433.57*	478.37*	98.19*	106.64*	104.10*	48.50+	-105.69+	-227.92*	14.86*	18.27*	16.23*
$\hat{H}1$	492.19*	452.46*	541.76*	104.80*	94.23*	105.66*	724.43*	755.56*	963.40*	15.70*	17.96*	17.11*
$\hat{H}2$	364.95*	364.87*	406.90*	64.36*	56.23*	61.78*	528.48*	549.29*	771.78*	11.76*	12.83*	11.91*
$\hat{h}2$	81.88+	122.82*	91.96+	3.10	-1.68	-2.03	25.17	-45.01	-65.98	1..92+	5.24*	4.87*
$\hat{D}$- $\hat{H}1$	395.85	434.03	368.69	-7.52	27.67	-3.81	-447.51	-532.34	-736.39	1.27	0.82	-0.97
$\hat{E}$	53.42*	61.64*	71.38*	4.25	5.26*	7.28*	19.07	112.10*	140.98*	0.21	0.14	0.55
$(\hat{H}1/ \hat{D})^{1/2}$	0.74	0.71	0.77	1.04	0.88	1.02	1.62	1.80	2.06	0.96	0.98	1.03
$\hat{H}2/4\hat{H}1$	0.185	0.20	0.19	0.15	0.15	0.15	0.18	0.18	0.20	0.19	0.18	0.17
KD/ KR!	2.28	2.04	1.52	2.89	2.98	3.01	1.11	-0.795	-0.608	2.67	2.98	2.91
Heritability narrow sense	0.63	0.64	0.62	0.49	0.58	0.48	0.58	0.52	0.49	0.49	0.46	0.42
broad sense	0.86	0.85	0.84	0.89	0.89	0.83	0.95	0.79	0.79	0.97	0.98	0.91
t2	3.468*	1.466	0.323	0.069	0.296	0.383	3.469*	4.273*	4.421*	0.084	0.423	-0.002
r	0.841*	.879**	0.352	-0.740	-0.599	-0.835*	0.437	0.488	0.446	-0.603	-0.716	-0.725

+, * and ** significant at 0.10, 0.05 and 0.01 levels of probability, respectively

r : Correlation coefficient between the parental performance (Yr) and order of dominance (Wr + Vr).

! KD/KR = $[(4\hat{D}\hat{H}1)^{1/2} + \hat{F}]/ [(4\hat{D}\hat{H}1)^{1/2} - \hat{F}]$

Table (13): Simple correlation coefficients between seed yield/ plant and other studied traits in the three nitrogen levels.

Traits	Flowering date	Plant height (cm)	No. of leaves/ plant	Head diameter (cm)	100- seed size (ml)	No. of seeds/ plant	1000- seed weight (g)	Husk percentage	Oil percentage	Seed yield/ plant (g)
20 kg N/ fed.										
Flowering date	1.000									
Plant height	0.202	1.000								
No. of leaves/ plant	0.106	0.520**	1.000							
Head diameter	0.073	0.625**	0.576**	1.000						
100 seed size	0.047	0.697**	0.394*	0.608**	1.000					
No. of seed/ plant	0.073	0.196	0.182	-0.085	-0.066	1.000				
1000 seed weight	0.024	0.709**	0.500**	0.675**	0.839**	-0.213	1.000			
Husk percentage	0.294	0.657**	0.358	0.614**	0.638**	-0.228	0.621**	1.000		
Oil percentage	-0.013	-0.655**	-0.278	-0.382*	-0.471*	-0.032	-0.428*	-0.329	1.000	
Seed yield/ plant	0.129	0.782**	0.547**	0.664**	0.677**	0.405*	0.736**	0.500**	-0.356	1.000
30 kg N/ fed.										
Flowering date	1.000									
Plant height	0.145	1.000								
No. of leaves/ plant	0.129	0.607**	1.000							
Head diameter	-0.056	0.697**	0.587**	1.000						
100 seed size	-0.060	0.730**	0.417*	0.679**	1.000					
No. of seed/ plant	0.019	0.258	0.203	0.042	-0.012	1.000				
1000 seed weight	0.071	0.720**	0.360	0.711**	0.777**	-0.132	1.000			
Husk percentage	0.301	0.710**	0.542**	0.644**	0.723**	-0.178	0.748**	1.000		
Oil percentage	-0.098	-0.613**	-0.299	-0.324	-0.465*	-0.121	-0.439*	-0.382*	1.000	
Seed yield/ plant	0.078	0.815**	0.508**	0.696**	0.655**	0.465*	0.739**	0.588**	-0.358	1.000
40 kg N/ fed.										
Flowering date	1.000									
Plant height	-0.020	1.000								
No. of leaves/ plant	0.078	0.587**	1.000							
Head diameter	0.048	0.701**	0.536**	1.000						
100 seed size	-0.245	0.654**	0.509**	0.532**	1.000					
No. of seed/ plant	-0.033	0.247	0.158	0.108	-0.068	1.000				
1000 seed weight	-0.043	0.725**	0.551**	0.758**	0.760**	0.028	1.000			
Husk percentage	0.222	0.664**	0.558**	0.683**	0.609**	-0.235	0.715**	1.000		
Oil percentage	0.096	-0.610**	-0.446*	-0.378	-0.415*	-0.058	-0.337	-0.272	1.000	
Seed yield/ plant	-0.058	0.827**	0.583**	0.777**	0.659**	0.402*	0.812**	0.608**	-0.318	1.000

* and ** significant at 0.01 and 0.05 levels of probability, respectively.

Table (14): Partitioning of simple correlation coefficient between seed yield and some of its components at the three nitrogen levels.

Sources	N levels (kg/ fed.		
	20	30	40
I- Head diameter			
Direct effect (Py_1)	0.2453	0.1947	0.3077
Indirect via no. of seeds/ head	-0.0487	0.0229	0.0380
Indirect via 1000 seed weight	0.4673	0.4780	0.4311
Total (ry_1)	0.6640	0.6960	0.7770
II- No. of seeds/ head			
Direct effect (Py_2)	0.5733	0.5455	0.3527
Indirect via head diameter	-0.0208	0.0081	0.0332
Indirect via 1000 seed weight	-0.1475	-0.0888	0.0159
Total (ry_2)	0.4050	0.4650	0.4020
III- 1000 seed weight			
Direct effect (Py_3)	0.6924	0.6724	0.5688
Indirect via head diameter	0.1655	0.1384	0.2332
Indirect via no. of seeds/ head	-0.1220	-0.0720	0.0098
Total (ry_3)	0.7360	0.7390	0.8120

Table (15): Direct and joint effects of seed yield components as percentage of yield variation at the three nitrogen levels.

Seed yield components	N levels (kg/ fed.)					
	20		30		40	
	C.D+	% ++	C.D	%	C.D	%
1- Head diameter	0.0601	6.01	0.0379	3.79	0.0946	9.46
2- No. of seeds/ head	0.3286	32.86	0.2975	29.75	0.1243	12.43
3- 1000- seed weight	0.4794	47.94	0.4521	45.21	0.3235	32.35
4- Head diameter x no. of seeds/ head	-0.0239	2.39	0.0089	0.89	0.0234	2.34
5- Head diameter x 1000 seed weight	0.2293	22.93	0.1862	18.62	0.2653	26.53
6- No. of seeds per head x 1000 seed weight	-0.1691	16.91	-0.0961	9.61	0.0112	1.12
7- Residual	0.0884	8.84	0.1135	11.35	0.1577	15.77
Total	1.0000	100.00	1.0000	100.00	1.0000	100.00

\+ Coefficient of determination
++ Contributed %

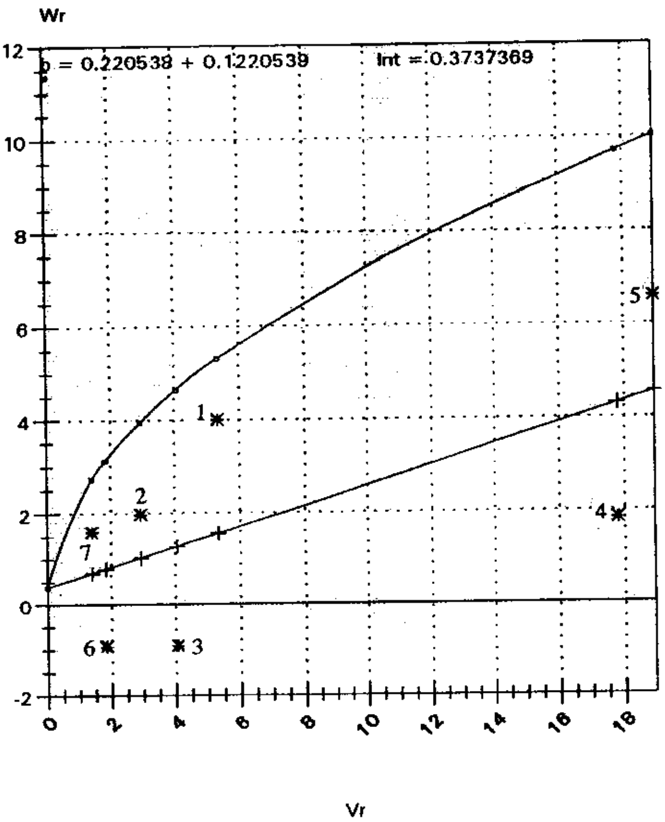

Fig. 1: WR/VR graph for No. of days to flowering
N1 = 20 kg N/fed

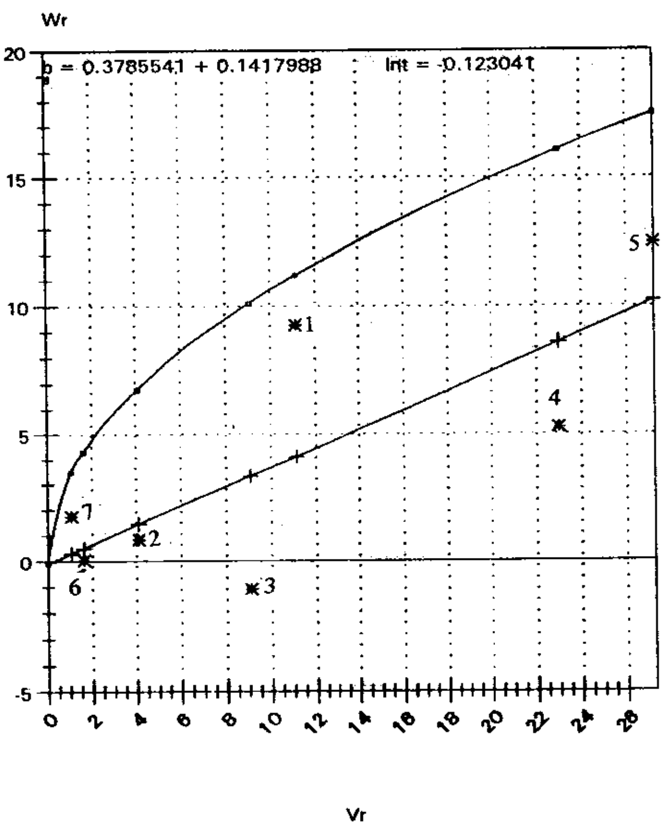

Fig. 2: WR/VR graph for No. of days to flowering
N2 = 30 kg N/fed

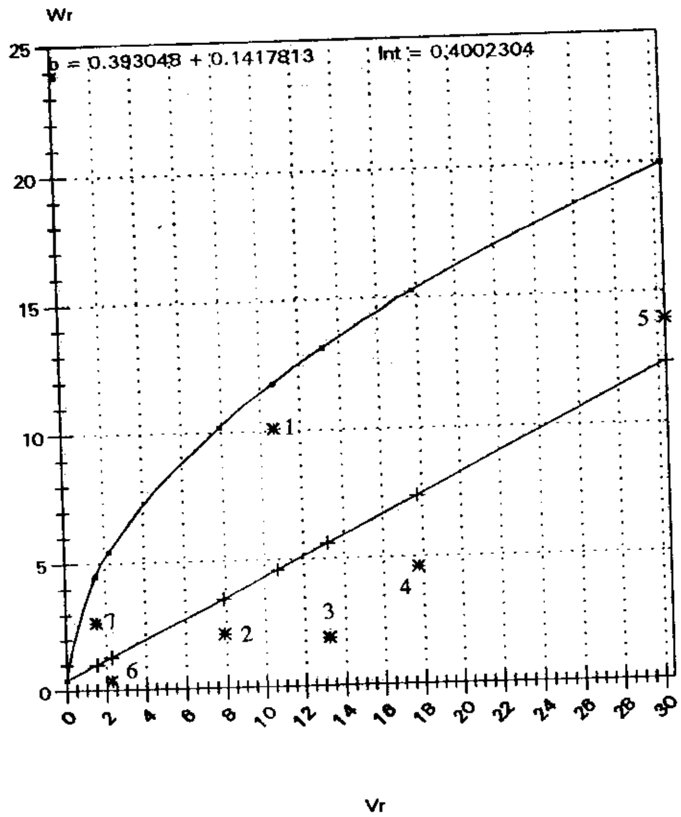

Fig. 3: WR/VR graph for No. of days to flowering
N3 = 40 kg N/fed

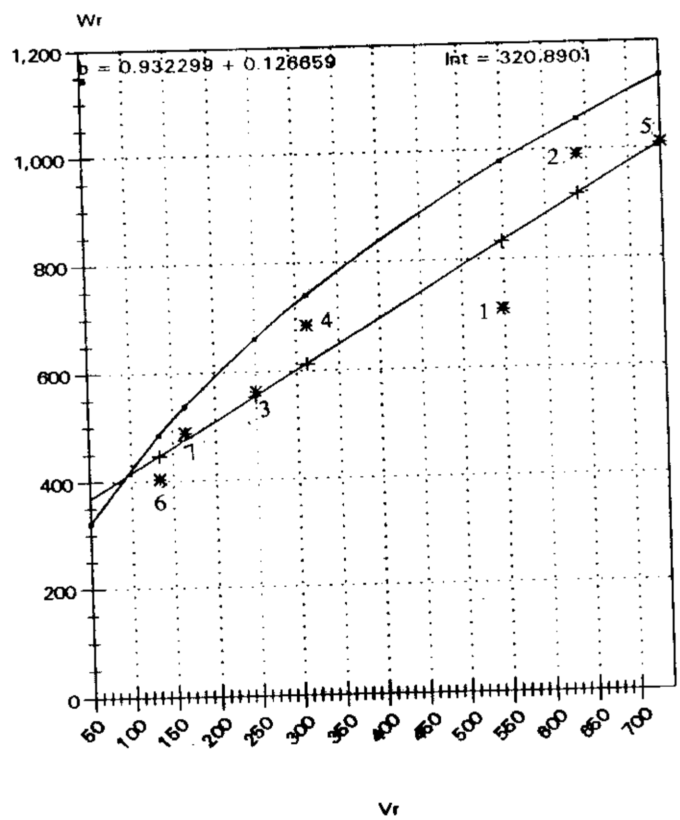

Fig. 4: WR/VR graph for plant height
N1 = 20 kg N/fed

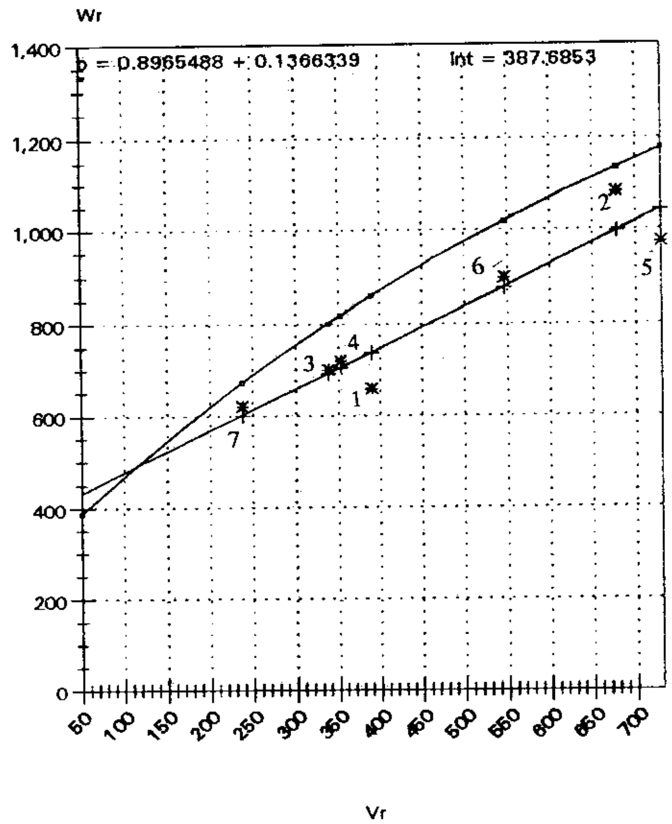

Fig. 5: WR/VR graph for plant height
N2 = 30 kg N/fed

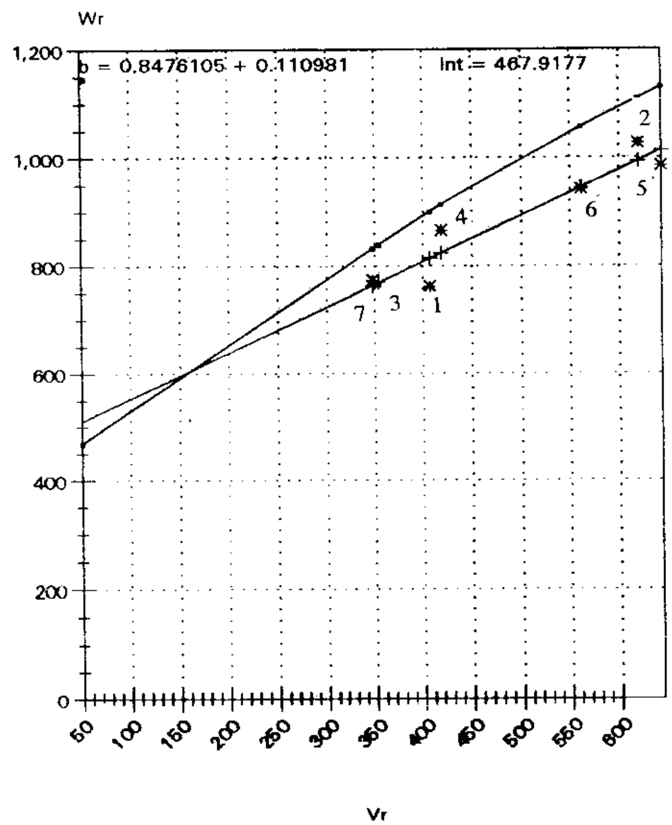

Fig. 6: WR/VR graph for plant height
N3 = 40 kg N/fed

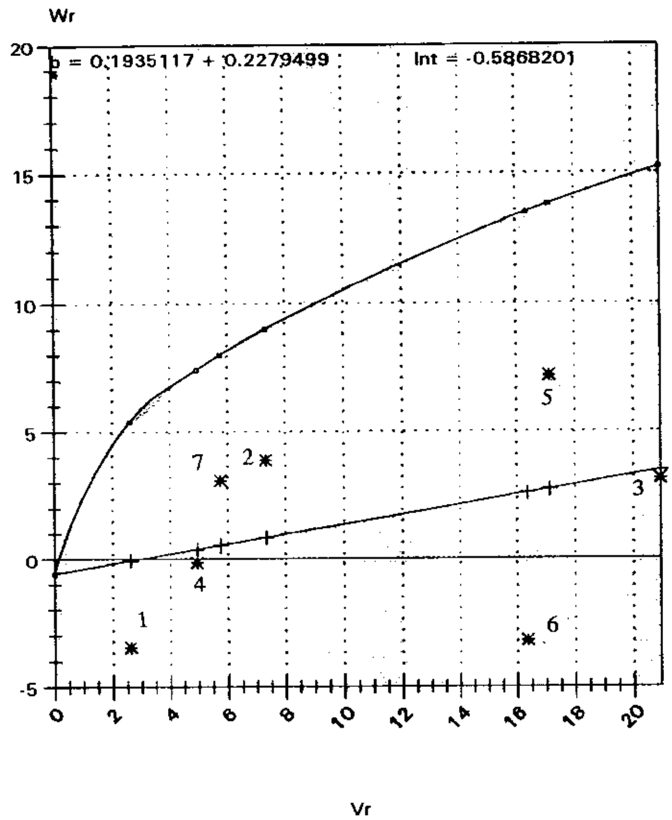

Fig. 7: WR/VR graph for No. of leaves/plant
N1 = 20 kg N/fed

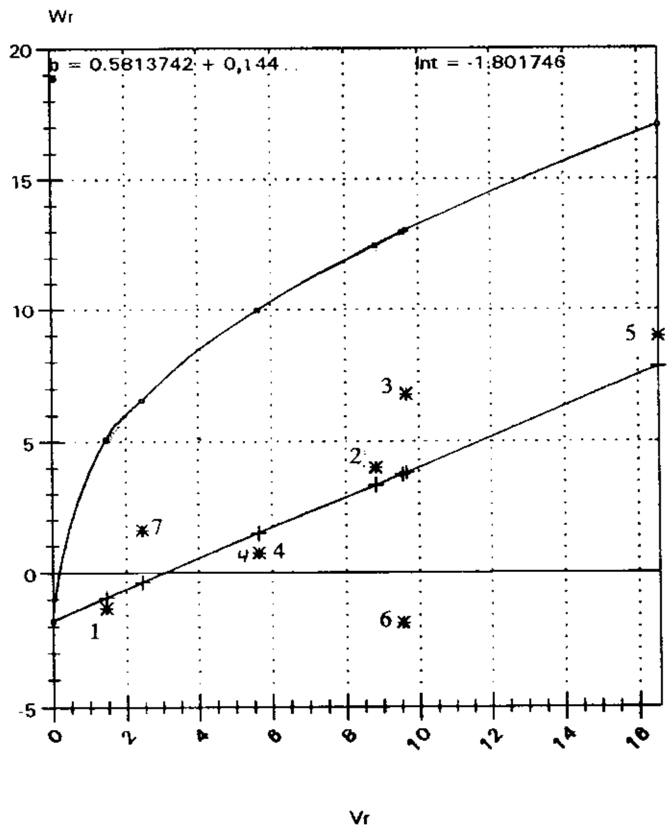

Fig. 8: WR/VR graph for No. of leaves/plant
N2 = 30 kg N/fed

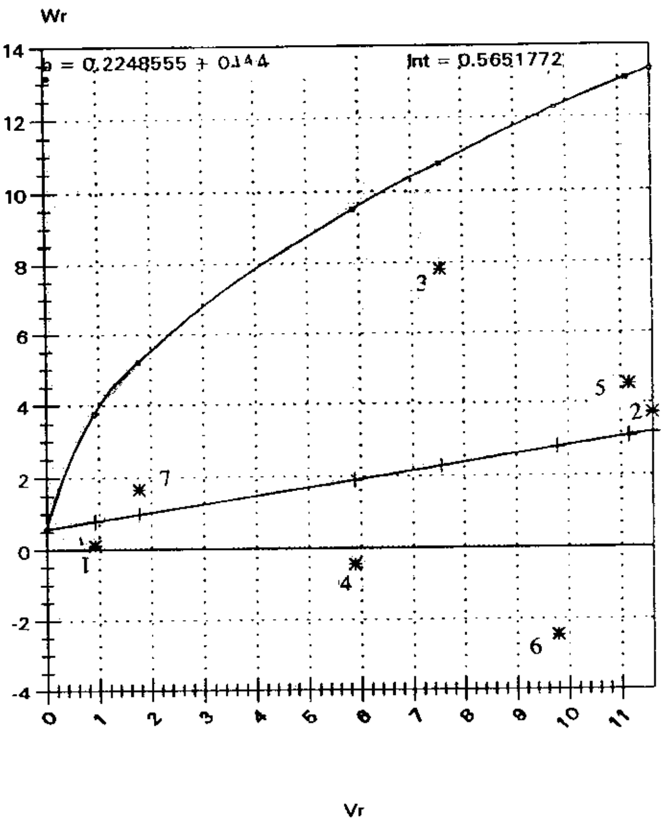

Fig. 9: WR/VR graph for No. of leaves/plant
N3 = 40 kg N/fed

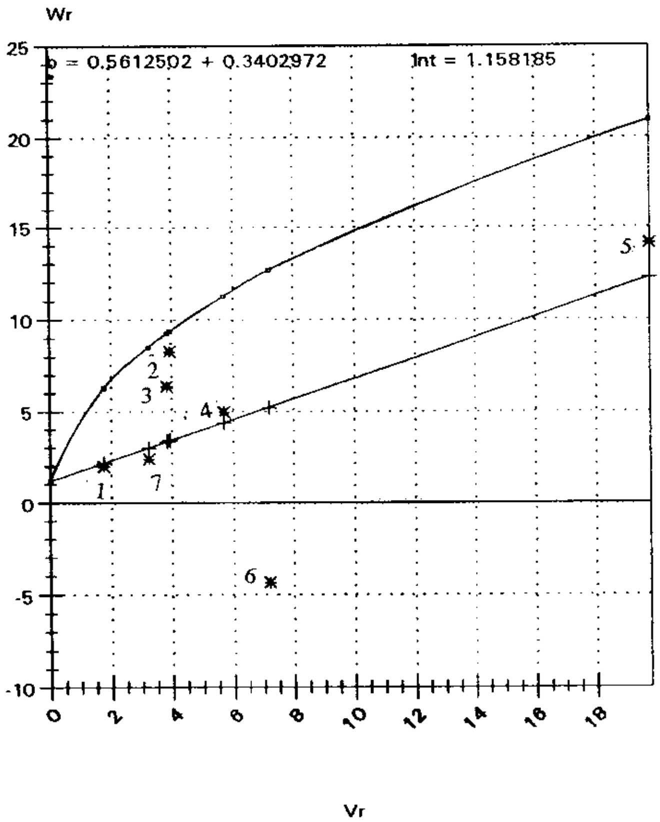

Fig. 10: WR/VR graph for head diameter
N1 = 20 kg N/fed

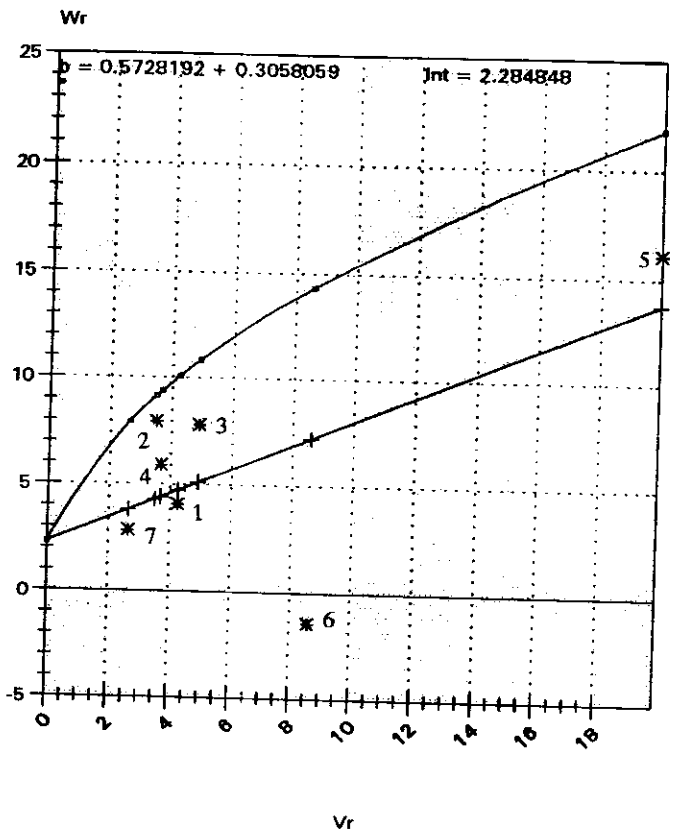

Fig. 11: WR/VR graph for head diameter
N2 = 30 kg N/fed

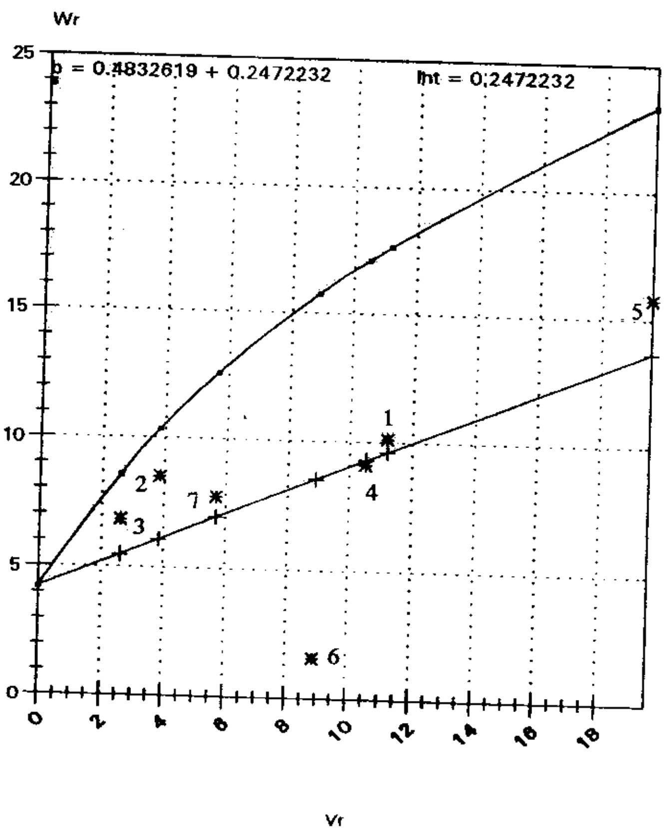

Fig. 12: WR/VR graph for head diameter
N3 = 40 kg N/fed

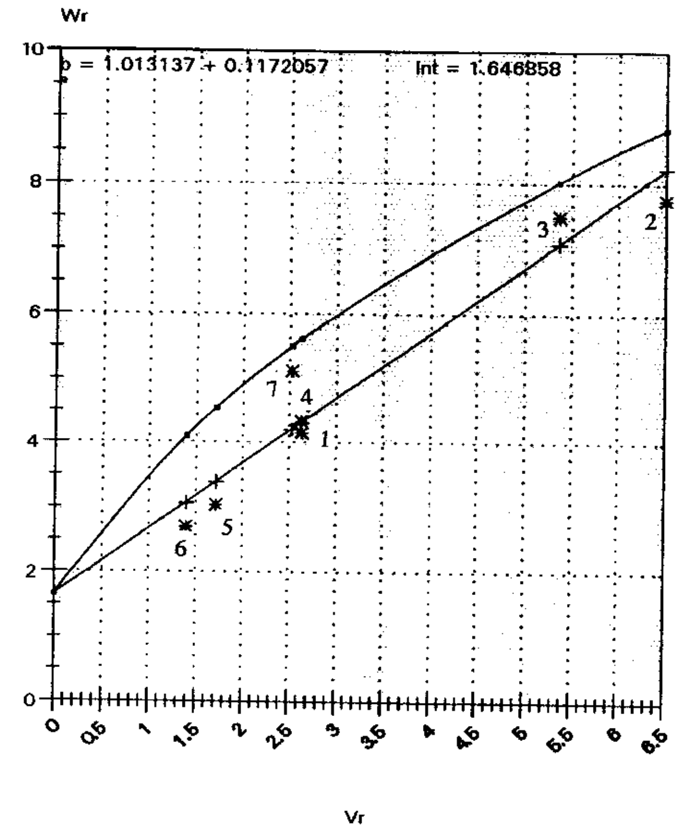

Fig. 13: WR/VR graph for 100 seed size
N1 = 20 kg N/fed

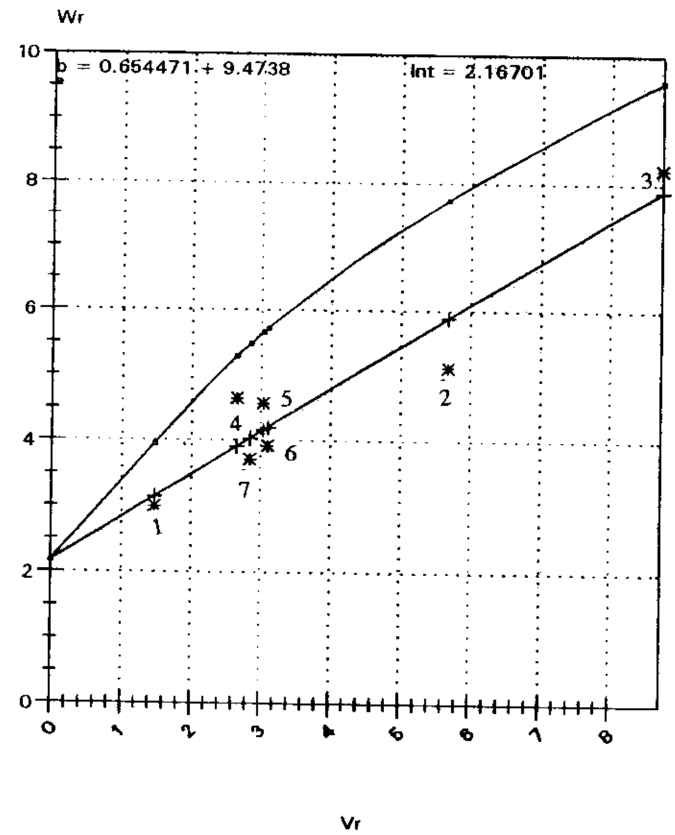

Fig. 14: WR/VR graph for 100 seed size
N2 = 30 kg N/fed

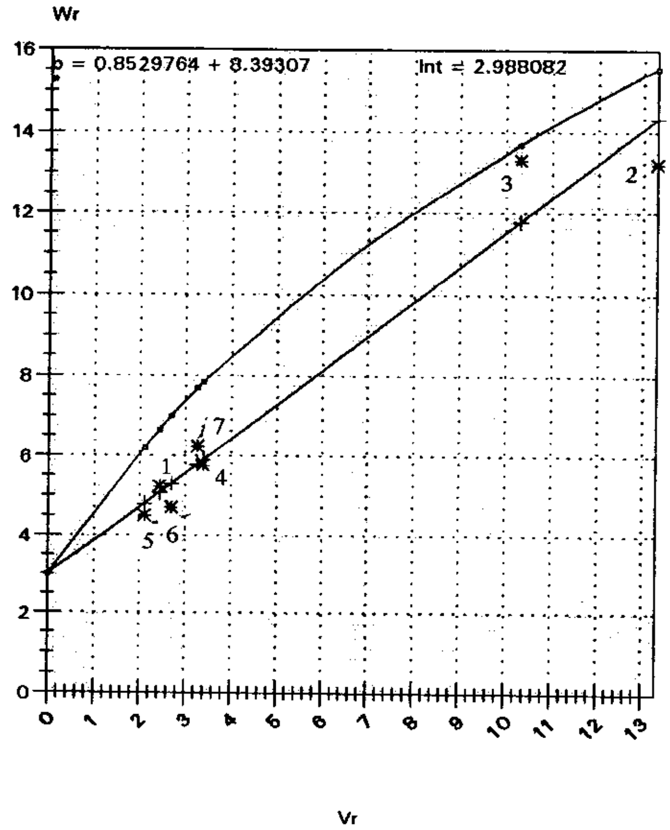

Fig. 15: WR/VR graph for 100 seed size
N3 = 40 kg N/fed

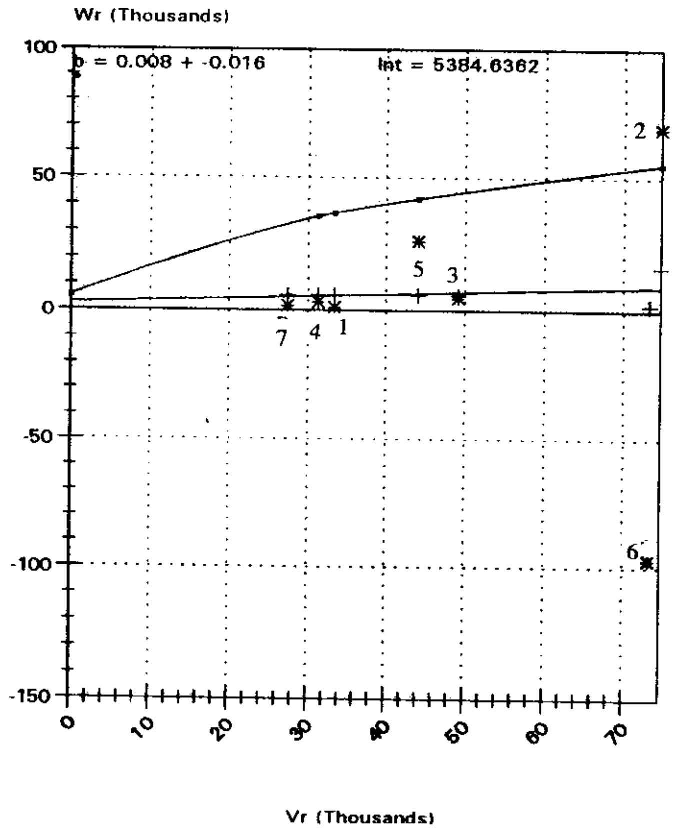

Fig. 16: WR/VR graph for number of seeds/head
N1 = 20 kg N/fed

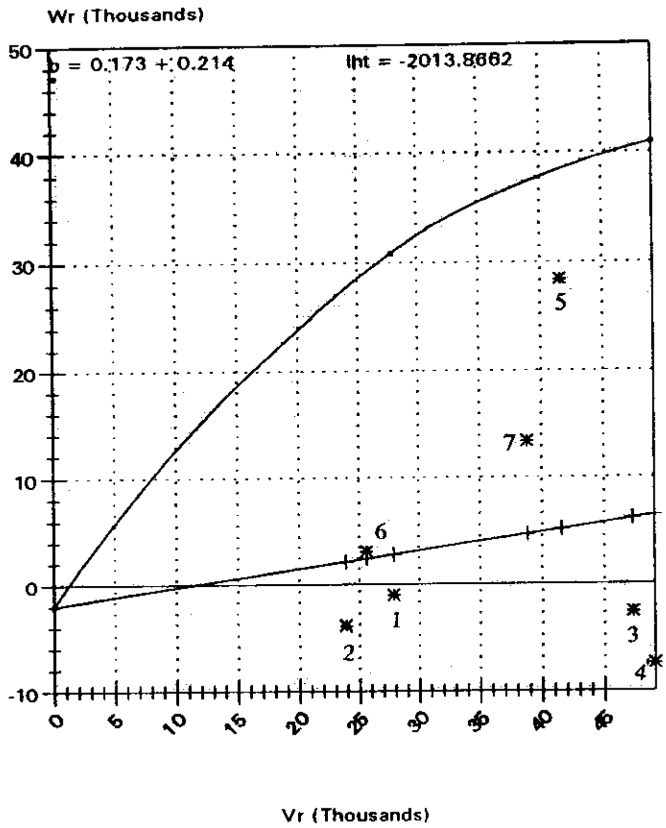

Fig. 17: WR/VR graph for number of seeds/head
N2 = 30 kg N/fed

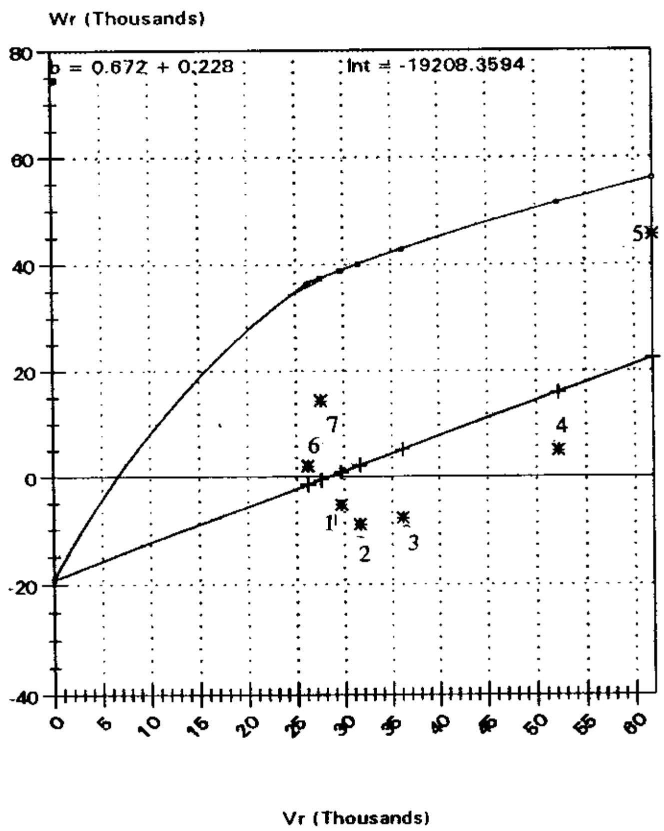

Fig. 18: WR/VR graph for number of seeds/head
N3 = 40 kg N/fed

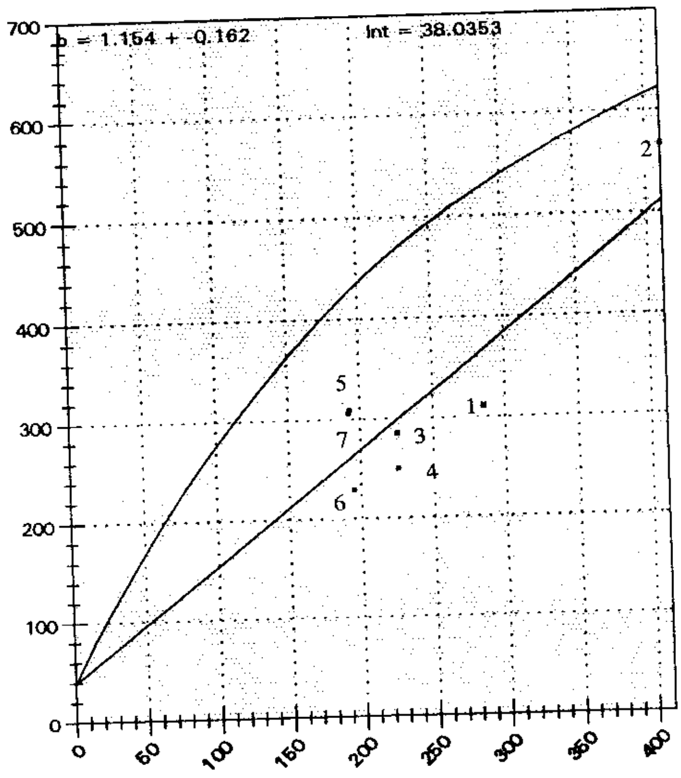

Fig. 19: WR/VR graph for 1000 seed weight
N1 = 20 kg N/fed

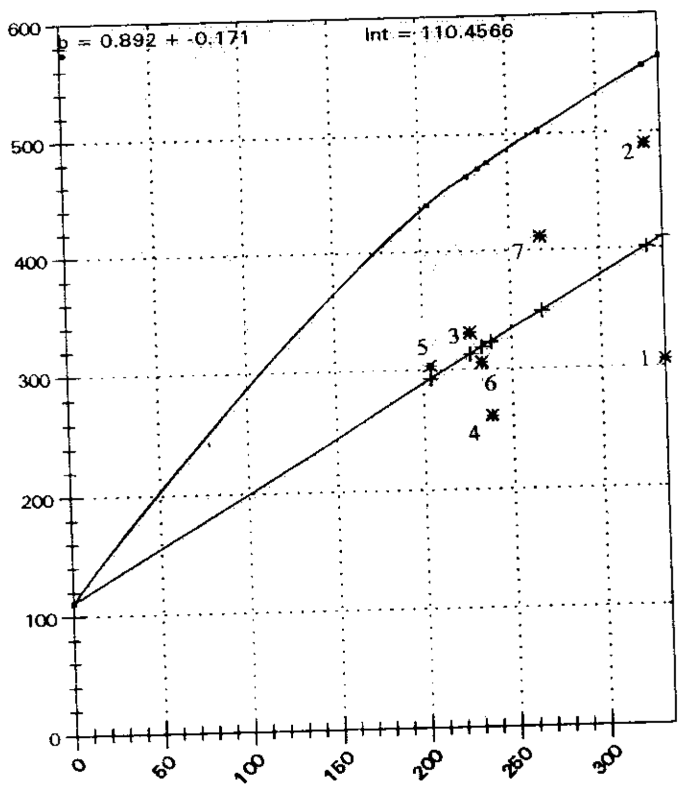

Fig. 20: WR/VR graph for 1000 seed weight
N2 = 30 kg N/fed

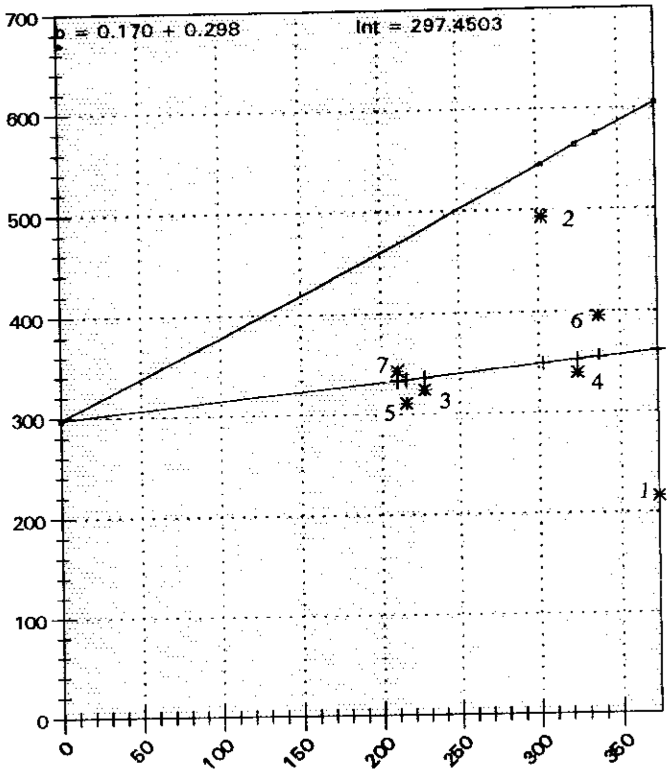

Fig. 21: WR/VR graph for 1000 seed weight
N3 = 40 kg N/fed

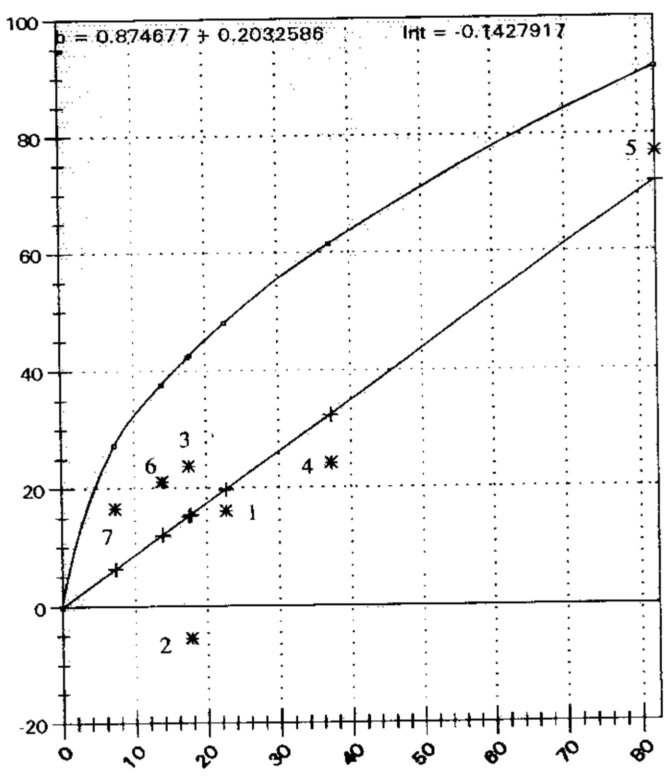

Fig. 22: WR/VR graph for husk percentage
N1 = 20 kg N/fed

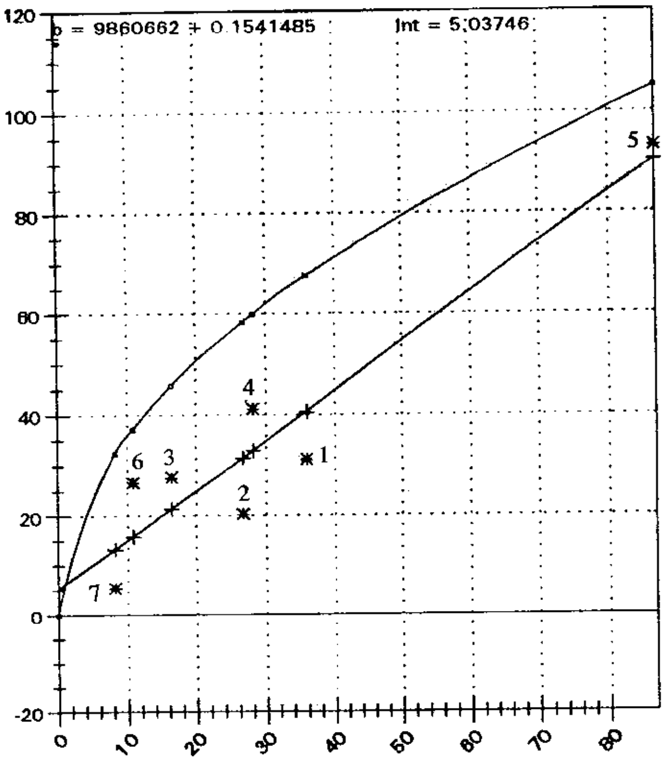

Fig. 23: WR/VR graph for husk percentage
N2 = 30 kg N/fed

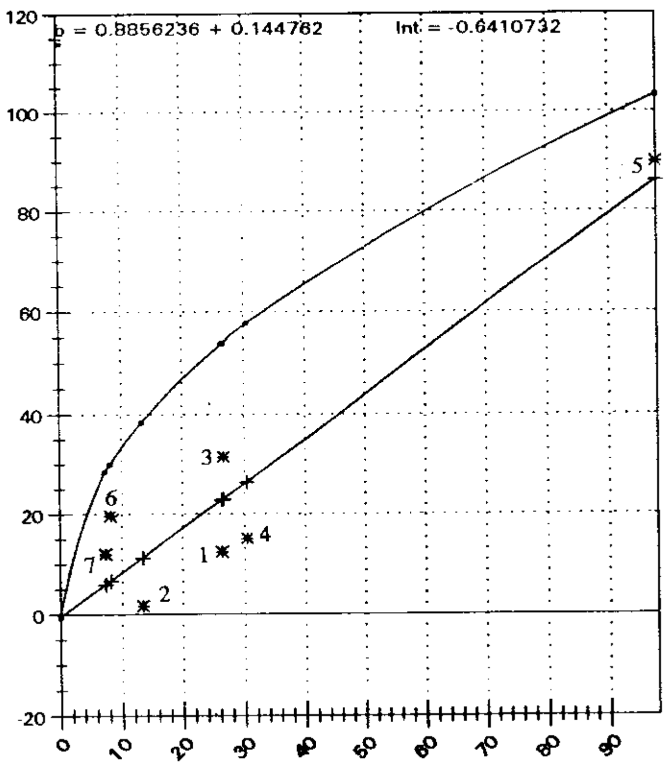

Fig. 24: WR/VR graph for husk percentage
N3 = 40 kg N/fed

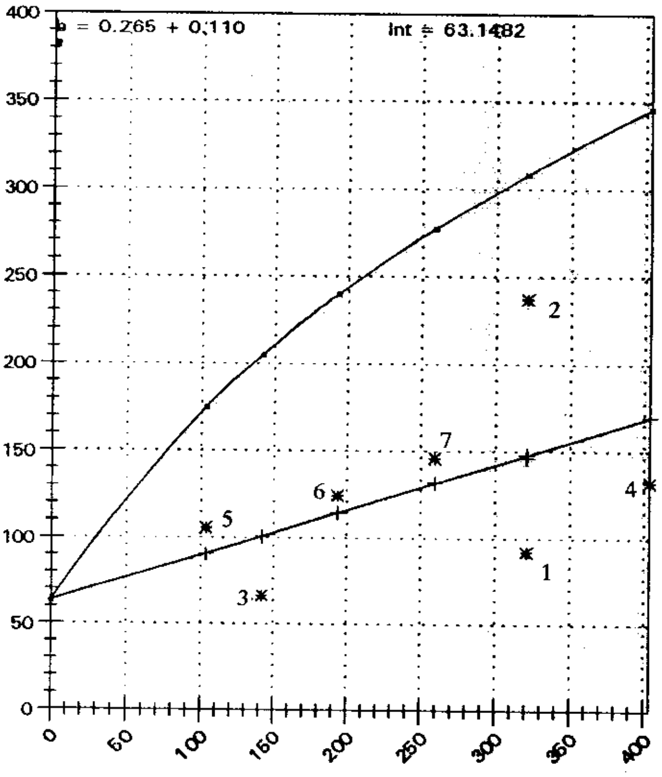

Fig. 25: WR/VR graph for yield/plant
N1 = 20 kg N/fed

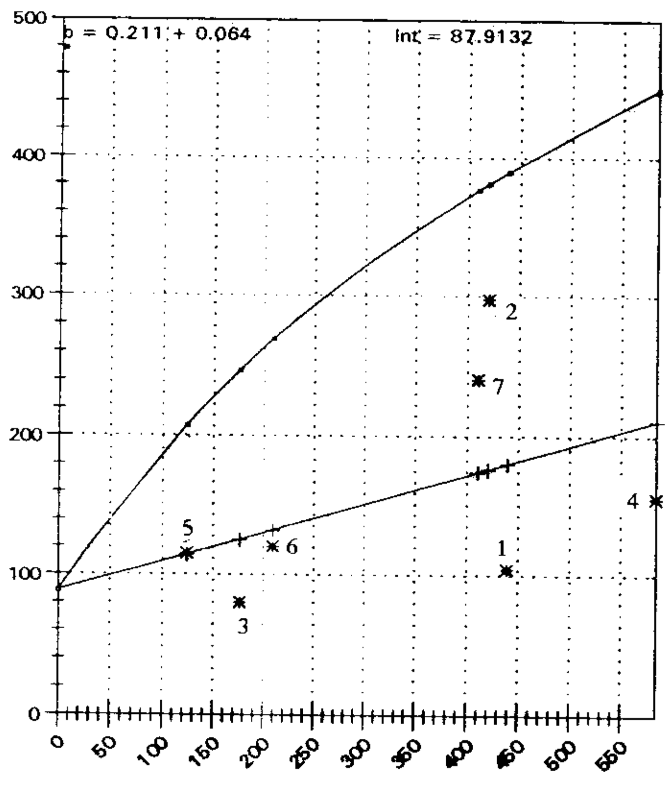

Fig. 26: WR/VR graph for yield/plant
N2 = 30 kg N/fed

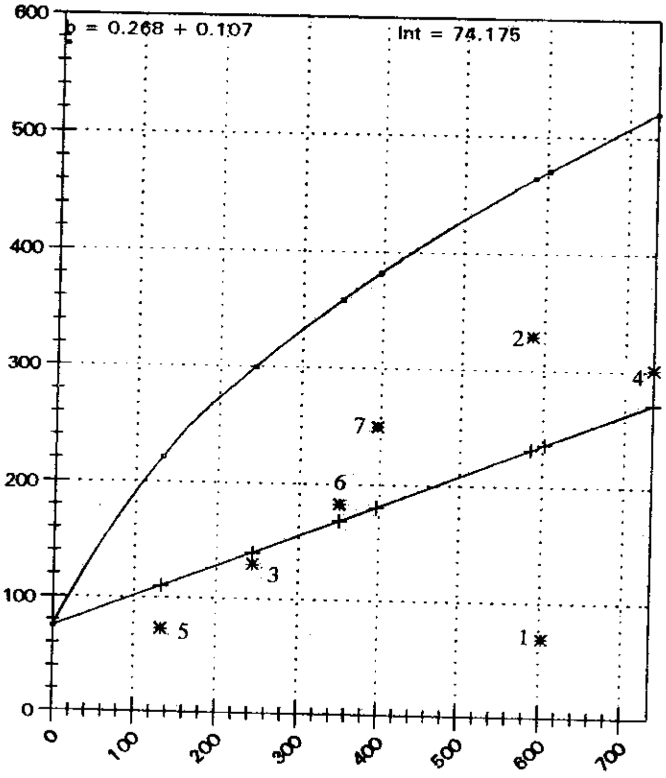

Fig. 27: WR/VR graph for yield/plant
N3 = 40 kg N/fed

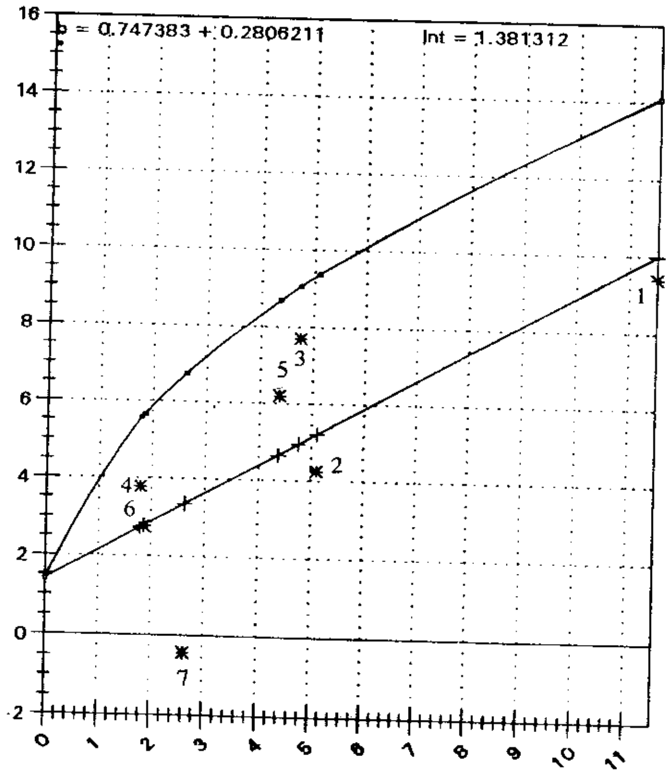

Fig. 28: WR/VR graph for oil percentage
N1 = 20 kg N/fed

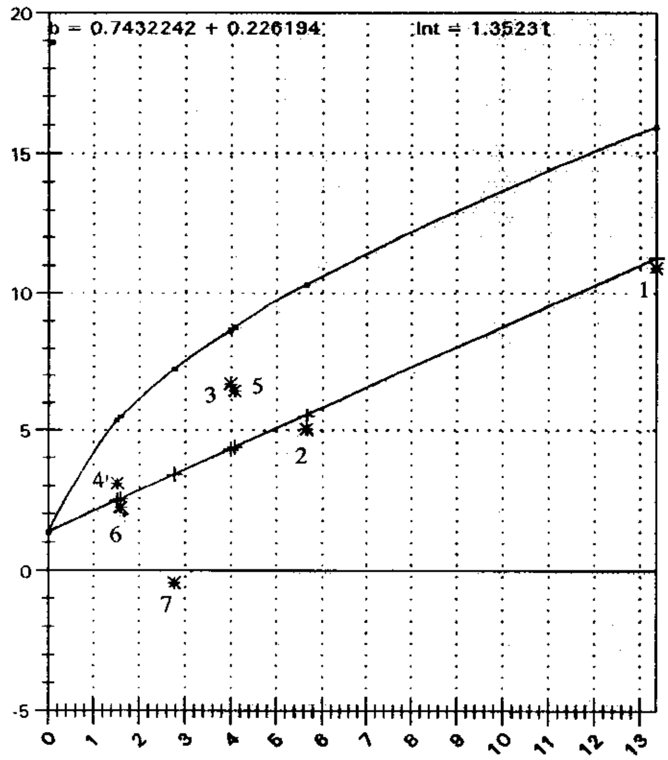

Fig. 29: WR/VR graph for oil percentage
N2 = 30 kg N/fed

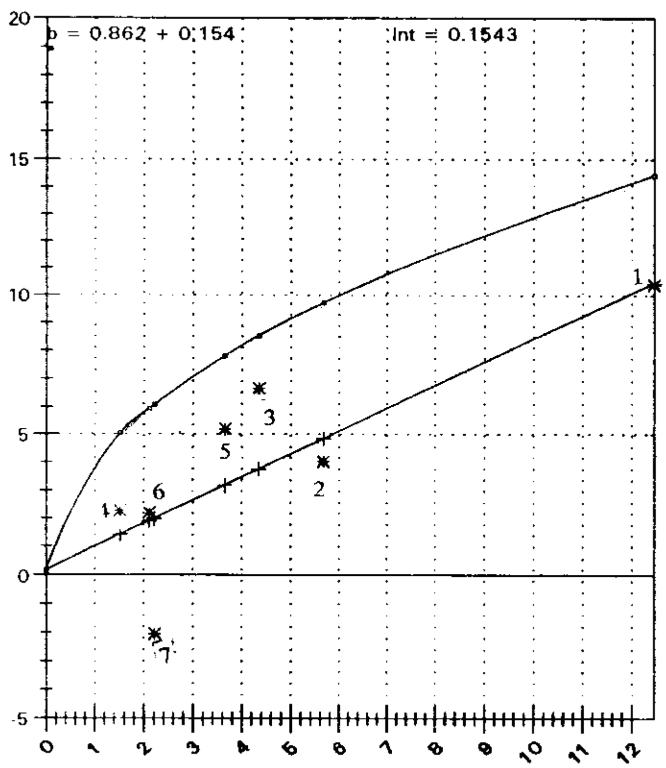

Fig. 30: WR/VR graph for oil percentage
N3 = 40 kg N/fed