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SUMMARY

The present investigation was carried out at the farm of Rice Research and Training Center (RRTC), Sakha, Kafr El-Sheikh, Egypt during the three successive rice growing seasons of 2000, 2001 and 2002. This work aimed to study the genetic behavior of some rice characters related to drought tolerance and its relation with yield and its components. Four rice genotypes with different levels of drought tolerance namely, IET 1444, Cica 4, Sakha 102 and GZ 5688-10-3-4-1 were used in this study as parental materials. These genotypes were crossed to produce the three main crosses; i.e. IET 1444 x GZ 5688-10-3-4-1 (cross I), IET 1444 x Cica 4 (cross II) and Cica 4 x Sakha 102 (cross III). Eighteen characters were studied in the present work. These characters were :

1- Root characters, i.e. root length, root number, root volume, root fresh weight, root dry weight and root/shoot ratio.
2- Growth characters; i.e. number of tillers, shoot fresh weight, shoot dry weight, plant height, days to 50% heading and panicle length.
3- Yield and its components characters, i.e. number of panicles/plant, number of grains/panicle, number of filled grains/panicle, 100-grain weight, sterility percentage and grain yield/plant.

Six populations P_1, P_2, F_1, BC_1, BC_2 and F_2 for each cross were benefit in the genetical study. A brief summary was stated on the following six points :

1. Mean performance of the six populations.
2. Estimates of heterosis and nature of dominance.
3. Estimates of gene action and genetic effects of genes.
4. Estimates of genetic variance, heritability and genetic advance.
5. Estimates of phenotypic correlation coefficients among all possible pairs of the studied characters.

a) **Root Characters :**

1. Mean performance :

The F_1 mean values were higher than the two parents in crosses I and II for root length and root dry weight and all studied crosses for number of roots/plant, root volume, root fresh weight. While mean values of root/shoot ratio was higher than the highest parent in only cross II. However, the F_1 mean values for the other root characters were intermediate between the two parents in the other remaining crosses. Moreover, the F_2 mean values were intermediate between the two parents for all studied root characters except root number was found to be higher than their parental mean value in cross I and III. Regarding the BC_1 and BC_2 mean values were intermediate between the mean of the two parents except cross III for root length, root dry weight and number of roots/plant, cross II for root volume in BC_1 and number of roots in crosses I and III, root volume in cross II in BC_2.

2. Heterosis and degree of dominance :

The most proclain useful heterosis for mid-parent was recorded for root volume, root/shoot ratio, root number, root dry weight and root fresh weight in cross I. While cross III showed none useful heterosis for root length.

The most pronounced useful heterotic effects measured as a deviation from better-parent were recorded for root number and root volume, root fresh weight and root dry weight in cross II. On the contrary, cross I showed none useful heterosis as a deviation from better-parent for root length.

Regarding to degree of dominance, the over-dominance was recorded in crosses I and II for root length, all studied crosses for root number, root volume, root fresh weight, crosses I and II for root dry weight and crosses II and III for root/shoot ratio. On the other hand, the incomplete dominance was recorded in cross III for root length, root dry weight, and cross I for root/shoot ratio.

3. Genetic components :

The nature of gene action was differed in the four studied crosses in all root characters, it could be reported that the additive gene active was played an important role in the root length (crosses I and II), root number (crosses I, II and III), root volume (cross I), root fresh weight (crosses I and II) and root/shoot ratio (cross I). Dominance effect was played important role in all studied crosses, except cross I for root number, cross II for root dry weight and cross I for root/shoot ratio. Additive x additive was played an important role in all studied crosses except of cross III for root dry weight and cross I for root/shoot ratio. Additive x dominance was affected in cross II for root length, crosses I, II and III for root number, crosses I and III for root volume and crosses II and III for root fresh weight. Dominance x dominance was affected in cross II for root length, crosses II and III for root number, crosses I and III for root volume, root fresh weight, root dry weight and crosses I for root/shoot ratio.

4. Genetic variances, heritability and genetic advance :

The additive genetic variance was greater than the dominance genetic variance in crosses I and II for root length, cross I for root volume, cross II for root dry weight, crosses II and III for root/shoot ratio, the relative magnitude of the additive genetic variance were approximately twice or more than that of the dominance genetic variance.

The heritability in broad sense for the present root characters were recorded from moderate to high in all studied crosses. While narrow sense heritability was estimated from low for root fresh weight (cross II) to high for root/shoot ratio (cross I).

Expected genetic advance were ranged from low in all studied crosses for number of roots/plant to high in the three studied crosses for root dry weight.

5. Phenotypic correlation coefficient of variation between root and al possible studied characters :

Estimates of phenotypic correlation coefficients were significant or highly significant positive or negative between root length and root number (cross I), root volume (cross II), root fresh weight (crosses I, II and III), root dry weight (crosses I and III), number of tillers (crosses I, II and III), plant height (crosses I, II and III), number of panicles (cross I), and grain yield/plant (crosses I, II and III). The root number was significant or highly significant positive correlated with each of root volume (cross I), root fresh weight (crosses I and III), root dry weight (crosses I and III), root/shoot ratio, plant height (cross I), and grain yield/plant (crosses I and III).

Significant or highly significant positive were found between root volume and root fresh weight (cross I), root dry weight (cross I) and grain yield/plant (crosses I and II). The significant or highly significant positive correlation were found between root fresh weight and root dry weight (crosses I, II and III) and root/shoot ratio (crosses I and II). The root dry weight was significant or highly significant positive with root/shoot ratio (crosses I and II), number of tillers and grain yield/plant (cross II).

b) **Growth Characters** :

1. Mean performance :

The highest mean values for F_1 comparing with two parents was recorded for number of tillers, shoot fresh weight and panicle length in crosses I and II, and shoot dry weight in cross II. While, the highest values compared with the highest parent were found in crosses I and II for number of days to 50% heading and all studied crosses for plant height. While, the intermediated mean values were found in the other remaining crosses.

Regarding F_2 mean values was estimated intermediate between two parents in all studied crosses for number of tillers/plant, shoot fresh weight, shoot dry weight and number of days to 50% heading. While the highest mean values for plant height and panicle length were found in all studied crosses and crosses II and III, respectively, while the other remaining characters for F_2 mean values were found intermediated between the two parents.

BC_1 coming higher than two parents in the last two crosses for number of tillers, crosses I and III for days to 50% heading, all studied crosses for plant height and panicle length except cross II for the panicle length and number of days to 50% heading. The highest mean values for BC_2 comparing with two parents was found in cross I for number of tillers, cross II for number of days to 50% heading, all studied crosses for plant height, cross II for panicle length. The other remaining crosses were found intermediated between the two parents in the BC_1 and BC_2.

2. *Heterosis and degree of dominance* :

Heterosis as a deviation from mid (MP) and better-parent (BP) estimates were found highly significant and significant in all studied crosses for agronomic characters except cross III for number of tillers (MP) and shoot fresh weight and cross I for panicle length as a deviation from better parent.

Concerning to potence ratio, the over-dominance was found in number of tillers, shoot fresh weight and panicle length in the first two crosses, while all studied crosses showed over-dominance for number of days to 50% heading and plant height only. On the other hand, the remaining crosses in the agronomic characters showed incomplete dominance except cross II for shoot dry weight.

3. *Genetic components :*

Additive gene action was played an important role in all studied crosses for number of tillers, days to 50% heading, plant height and crosses I and III for panicle length. Dominance gene action was played an important role in the all studied crosses for number of tillers and days to 50% heading, cross I for shoot fresh weight and shoot dry weight, crosses I and II for plant height and cross I for the panicle length.

Additive x additive was played an important role in the crosses I and III for number of tillers and all studied crosses for shoot fresh weight, shoot dry weight and plant height. On the other hand, the crosses I and II for number of days to 50% heading and cross III for panicle length, number. of tillers/plant (all studied crosses), shoot fresh weight (cross I), number of days to 50% heading (crosses I and II), plant height and panicle length (all studied crosses) were affected by additive x dominance. While dominance x dominance was played an important role in the three studied crosses for number of tillers, days to 50% heading and plant height and cross I for panicle length.

4. Genetic variances, heritability and genetic advance :

The additive genetic variance was higher than the dominance genetic variance in cross II for number of tillers/plant, crosses I and II for shoot fresh weight, cross II for shoot dry weight, all studied crosses for days to 50% heading and plant height and crosses I and II for panicle length. On the contrary the dominance genetic variance was higher than three additive genetic variance in the remaining studied crosses for agronomic characters.

Heritability in broad sense estimated for the attendant agronomic character were found moderate to high. High narrow sense heritability was found in cross II for plant height, while the narrow sense heritability was ranged from moderate to low in the remaining agronomic characters in the three studied crosses.

High estimated of expected genetic advance were found in all studied crosses for shoot dry weight. While the low estimates of expected genetic advance was found in cross III for shoot fresh weight.

5. *Phenotypic correlation coefficients between growth and all possible studied characters :*

Significant or highly significant positive phenotypic correlation between number of tillers and shoot fresh weight, shoot dry weight and number of tillers (crosses I and III), plant height (cross I, II and III). while significant negative phenotypic correlation was found between number of tillers and sterility (cross I), number of days to 50% heading and positive in grain yield (cross II). The phenotypic correlation between shoot fresh weight and shoot dry weight (crosses I, II and III), days to 50% heading (cross II) and grain yield/plant (cross I) were found positive significant or highly significant.

Concerning to phenotypic correlation between shoot dry weight and plant height (cross II) and grain yield/plant (cross I) were found significant and positive direction. The phenotypic correlation between number of days to 50% heading and each plant height (cross I), sterility % (cross I) and grain yield (cross II) were found significant or highly significant and positive. While significant positive phenotypic correlation were found between plant height and panicle length (crosses I and III), number of panicles, number of filled grains/panicle and grain yield/plant in cross II. Significant or highly significant, positive or negative phenotypic correlation were found between panicle length and number of panicles (crosses II and III), number of grains/panicle, number of filled grains/panicle (crosses I and II), 100-grain weight (cross II), sterility % and grain yield/plant (cross II).

c) **Yield and its components** :

1. Mean performance :

Higher mean values for F_1 compared with two parents was found in all studied crosses for number of panicles/plant, number of grains/panicle, number of filled grains/panicle, 100-grain weight and grain yield/plant. While the other crosses remaining showed the mean values was intermediated between the two parents. On the other hand, the F_2 mean values was come intermediate between the two parents in all crosses studied for yield and its components except cross II gave the highest mean values compared with the parent.

High mean values comparing with two parents in BC_1 was recorded in crosses II and III for number of panicles/plant, crosses I and III for number of grains/panicle, cross III for number of filled grains/ panicle, and all studied crosses for grain yield/plant. High mean values in BC_2 was found in cross II for grain yield/plant, while the other remaining mean values was come intermediate between the two parents in the BC_1 and BC_2.

2. Heterosis and degree of dominance :

High significant and positive heterosis for mid-parent was estimated in all studied crosses for yield and its components characters. Heterosis of better-parent estimates gave the significant or highly significant positive or negative in all studied crosses for yield and its component characters except cross I for number of filled grains/panicles. On the contrary, the sterility % character showed highly significant and negative heterosis of mid- and better-parent.

Over dominance was played an important role in all studied crosses for yield and its component characters.

3. *Genetic components :*

Additive gene action was played an important role in the number of panicles/plant (crosses II and III), number of grains/panicle (all studied crosses), number of filled grains/panicle, 100-grain weight and sterility in crosses II and III and crosses I and III for grain yield/plant.

Dominance gene action was played an important role in all studied crosses for number of panicles/plant, number of grains/panicle, number of filled grains/panicle, sterility % and grain yield/plant, while the last two studied crosses for 100-grain weight were also affected by dominance gene effects.

Additive x additive was played an important role in the all studied crosses except cross II for number of panicles/plant, cross III for number of grains/panicle and 100-grain weight in cross I. Additive x dominance was played an important role in crosses II and III for number of panicles/plant, all studied crosses for number of filled grains/panicle and 100-grain weight and cross I in the sterility % and grain yield/plant. Dominance x dominance was played an important role in the crosses I and II for number of panicles/plant, crosses I and III for number of grains/panicle, crosses I and II for number of filled grains/panicle, crosses II and III for 100-grain weight and all studied crosses for grain yield/plant.

4. *Genetic variances, heritability and genetic advance :*

Additive genetic variance was greater than the dominance genetic variance in cross II for number of panicles/plant, crosses I and II for number of filled grains/panicle, and 100-grain weight, and crosses II and III for grain yield/plant. On the contrary, the dominance gene action was higher than the additive gene action in the remaining studied crosses.

Heritability in broad sense for the yield and its component in three studied crosses was ranged from high to moderate. On the other hand the narrow sense heritability was ranged from low to moderate in all studied crosses. High estimates of expected genetic advance was recorded in the cross II for sterility

5. Phenotypic correlation coefficients between yield and its components and all possible studied characters :

The phenotypic correlation between number of panicles/plant and number of grains/panicle, number of filled grains/panicle and grain yield/plant were significant or highly significant and positive or negative in the four studied crosses while significant and positive phenotypic correlation were found between these trait and 100-grain weight in crosses I and II, whereas the phenotypic correlation between these trait and sterility % were found significant and negative in crosses I and II. Phenotypic correlation between number of grains/panicle and number of filled grains/panicle (crosses I and III), 100-grain weight, sterility % and grain yield/plant in all studied crosses were found significant or highly significant and positive or negative. Significant or highly significant, positive or negative were found in the phenotypic correlation between number of filled grains/panicle and 100-grain weight, sterility % and grain yield/plant in all studied crosses. Phenotypic correlation between 100-grain weight and sterility % (crosses II and III) and grain yield/plant in all studied crosses were significant or highly significant, negative or positive. While the phenotypic correlation between sterility % and grain yield/plant were found significant or highly significant and negative direction in all studied crosses.

CONCLUSION

From the foregoing discussion it could be concluded that :

* The most desirable mean values were detected from the parents "IET 1444 and Cica 4" and cross "IET 1444 x Cica 4" for all studied characters. On the other hand, the most pronounced useful heterotic effects relative to the mid-parent and better-parent were detected in the cross "IET 1444 x Cica 4" also for most of the studied characters.

* The results obtained from the mean of parents, F_1 and F_2 generations showed the presence of partial and over-dominance for root characters and over-dominance for most of growth and yield component characters.

* Most of the computed parameters of scaling test were significant for root, growth and yield and its related characters, indicating the presence of non-allelic interaction and therefore these characters affected by non-allelic and the genotypes X environment interaction.

* The additive types of gene action were of greater important in the inheritance of most of root and growth characters studied (especially in crosses I (IET 1444 x GZ 5688-10-3-4-1) and II (IET 1444 x Cica 4). On the other hand, dominance genetic variance was more important than additive genetic variance in the inheritance of most yield and its related characters studied. The root length, root number, root/shoot ratio, panicle length, number of tillers/plant and plant height characters could be used as a selection criteria for selecting drought tolerance varieties under drought conditions.

* Heritability estimates in broad sense were moderate to high for some of root, growth and yield and its related characters studied. While, in narrow sense were moderate to low for most of the studied characters, indicating that all these characters could be improved by the traditional breeding method and the selection would be effective in late generations.

* From the foregoing results, it can e concluded that there are good chance to breed for improving drought tolerance in high yielding genotypes.