Evaluation of correlation among traits in corn hybrids under drought stress conditions

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ABSTRACT: In order to analyze genetic variation and the relationship between some agricultural characteristics with the yield of 14 corn hybrids, an experiment was carried out in split plot based on randomized complete block design. In this experiment a number of characteristics including morphological traits, yield and yield components in three different irrigation conditions (normal condition, mild drought stress and severe drought stress) were evaluated. For all the characteristics under investigation except ear diameter, a significant difference was observed between the levels of water stress and the hybrids under investigation. According to the Pearson correlation table, there exists a high and significant correlation between most growth and yield characteristics, the most positive and significant Pearson correlation was observed between the number of leaves per plant and the number of rows in maize and then between the leaf of flag and length of corn. On the other hand the most significant negative correlation was observed between leaf area of flag leaf and the extent of leaf rolling (%). The stepwise regression analysis in the average stress condition showed that the number of rows per ear, 300-seed weight, number of kernels per row, number of leaves per ear explained totally 83% of kernel yield variation. Based on the path analysis, the highest direct effect on kernel yield has been related to the number of rows in the corn.

Keywords: path analysis, drought stress, seed yield, stepwise regression.

INTRODUCTION

Drought is one of the most important factors limiting plant growth all around the world and is the most common environmental stress. It is well recognized that the effects of water stress on growth and yield is dependent on the plant genotype (Bannayan ., 2008). Water is one of the scarcest resources in Iran, which is dependent on rainfall. The effects of water stress are dependent on time duration, permanence, and size of the deficit (Pandey ., 2000). Drought stress affects photosynthetic process through stomata closure and a lack of supply of carbon dioxide to the chloroplasts. Moreover drought stress decreases plant yield by reducing the photosynthetic active radiation received by the canopy, reducing the light utilization efficiency and harvest index (Hugh and Richard, 2003). Maize due to a number of features such as the adaptation to different climatic conditions, high performance, power of frequent exposures, capability of using mechanization and multiple uses, is widely cultivated in many countries. In addition, it is highly desirable forage for springe and is also unique in terms of providing energy for the springe and poultry (Nurmohammady ., 2005). One of the main objectives in maize breeding is improving kernel yield which is itself influenced by many genes (Karimi, 1996) and higher yield in maize is due to the emergence of hybrid maize (Yazdi Samadi ., 1996).
due to low heritability of function direct selection for it is not very effective, therefore for improving yield, applying indirect selection is preferred (Modaresi ., 2004). corn is the best choice for crop production, improvement and stability of yield in water stress conditions for the development of crop varieties which are under water stress conditions. The main objective of the breeding program is the selection of the best genotypes under water deficit conditions (Richard ., 2002). Various morphological, physiological, and molecular reports have been proposed for improving vegetarian characteristics in water stress conditions that are potentially applicable for maize (Hasanuzzaman and Fujita, 2011 and Hasanuzzaman ., 2009). There is no accurate information available about the performance and economic losses of water deficit in maize. However, it is estimated that 20 to 25 percent of the global maize crop each year is affected by drought. In maize yield, reduction of the kernel due to water shortage fluctuates in the range of 10 to 76 percent depending on the intensity and phase of the stress (Bolaoos ., 1993).

To run a breeding program for resistance to water stress and to promote, you need to find the relationships between the features, their stability in different environmental conditions and having knowledge of the direct and indirect effects of these traits. Currently the best way to cope with water shortage stress, is accompanying it. Applying appropriate methods of farming and the use of resistant cultivars to water deficit in drought-prone areas, increases the ability to optimize and improve the management of rather droughty regions, and adds to the area of under cultivation and productivity of these areas. Analyzing the values of yield evaluation in stress conditions and desirable conditions is as a starting point in identifying resistant varieties in the shortage of water (Clark ., 1992). The aim of this study was to identify and introduce maize hybrids resistant to water shortage conditions with optimal performance and stability in a variety of stressful and normal environments.

MATERIALS AND METHODS

In this study, the morpho-physiological traits yield and yield components of 14 new maize hybrids were investigated to determine the effect of water deficiency stress in a field trial at the Agricultural Research Station, University of Tabriz (Khalat Pooshan), in split plot based on a randomized complete block design in four replications. Evaluated hybrids were: SC700, SC704, KSC705, SC706, SC702, SC670, SC647, SC604, K166 x K18, DC370, K48xK19, SC500, K3647 x K18, SC400.

Water deficiency stress evaluated in three levels including, control level (supplying of 100% water requirement of maize), mild drought stress with irrigation period of about 10 days (70 mm evaporation) and severe drought stress with irrigation period of 15 days (120 mm evaporation) was conducted that after the completion of pollination (start of grain filling stage) irrigation treatments began and continued until the end of growth. Irrigation in the stress free treatment was performed with the water requirement of the plant. Water requirement was calculated using information from class A pan evaporation and the daily evaporation from pan was measured daily and based on pan coefficient and crop coefficient, the amount of water needed for each stage of irrigation was determined. Land preparation operation included Semi-deep plugging, disc, leveling, harrowing and furrowing and was performed on the farm of experiment. Kernels cultivation was uniformly done on June 16 hand planting. In this planting the stress levels were considered as main plots and hybrids were considered as subplots. Each of hybrids was planted in 4 planting rows with the length of 5 meters and the width of 0.75 meters. Within the row plant space was 25cm. thinning plant operation was performed in the 3-4 stage. Traits under investigation included number of leaves per plant, 300-seed weight, number of rows per ear, number of seeds per row, ear length, and leaf area of flag leaf, ear diameter, cob diameter, plant height, plant dry weight and grain yield that were measured on 10 competitive plants in each plot. Statistical analysis was performed using the SAS, SPSS and Excel.

RESULTS AND DISCUSSION

Correlation analysis of the traits under study (Table 1) showed that the highest seed yield per plant had the most significance and the most positive correlation with plant height, ear length, number of seeds per row, number of leaves per plant and the number of rows per ear. Based on this study, the correlation between most growing and yield traits was high and significant. For example, 300-seed weight had a significant correlation with plant height, ear length, flag leaf area, ear diameter, cob diameter, and number of leaves per plant. In analyzing correlation of the traits, the most positive and significant correlation was observed between flag leaf area and ear length. With the increase in ear length, number of seeds per row increases which has a direct effect on grain yield (Namakkaka ., 2008). The research showed that grain yield had a positive and significant correlation with plant height, ear height, number
of seed rows (Ashofteh Beiragi, 2011) that confirms the results of this study. It seems that under the water stress conditions, reduction of ear diameter is due to the reduction in current photosynthesis and shortage of assimilation from stalks to the cob occurs. Additionally in drought stress the reduction in ear diameter to some extent is due to reduction in seed growth in the middle and bottom parts of the ear (Majdam, 2006). Dry part production of the plant is strongly related to leaf area and leaf photosynthetic rate and it is necessary to reach the higher rate in production of dry part to keep photosynthesis rate high throughout growing season with maintenance of the leaf surface. On the other hand, maintaining more leaf area during stress periods is very important, since it will result in more carbon uptake for photosynthesis (Porwanto, 2003). Analyzing the mechanisms of drought tolerance in pearl millet proved that water shortage by reducing leaf area and the number of active leaves, reduces the absorption level of carbon dioxide (Hasanuzzaman and Fujita, 2011). To determine the best regression equation and also define the most influential variables on the dependent variable (seed yield), the stepwise regression analysis was used. The first character entered in the model (X1), was the number of rows per ear, which explained 62% changes in kernel yield. Next traits that were entered to the model, were the 300- kernel weight (X2), number of seeds per row (X3) and number of leaves per plant (X4), respectively. These four traits could totally explain 83% of the variation in seed yield per plant (y). The high coefficient of the selected model shows that these characteristics have a major effect on seed yield (Table 2). In order to analyze the direct and indirect traits effects on seed yield, path analysis was performed (Table 3). Path analysis revealed that number of rows per ear has the highest positive direct effect on seed yield. Its indirect effect through the number of leaves per plant is higher and more positive and through 300-seed weight was less that generally had a high and positive correlation with kernel yield (0.79). According to the path analysis it can be said that to maintain maize yield, the traits of number of rows per ear, 300-seed weight, number of seeds per row, number of leaves per plant are very important and selection for yield under water stress can be done based on these traits. In an experiment it was concluded that seeds weight has a statistically-significant and positive correlation with weight of each seed, and number of seeds per ear and each seed weight and the number of seeds per ear directly influences the weight of kernel in ear (Shiva and Jagannath, 1991). In a report 300-seed weight had the highest direct effect on seed yield, although ear weight and number of seeds per row, had an indirect effect through 300-seed weight on yield. In this report 300-seed weight and number of seeds per row is one of the important and effective traits on seed yield on evaluated hybrids. (Vaezi, 1998).

<table>
<thead>
<tr>
<th>Trait</th>
<th>300-seed weight (gr)</th>
<th>plant height (cm)</th>
<th>Length of ear (cm)</th>
<th>ear diameter (cm)</th>
<th>Corn cob diameter (cm)</th>
<th>plant dry weight (gr)</th>
<th>flag leaf area (cm²)</th>
<th>number of seeds per row</th>
<th>number of leaves per plant</th>
<th>number of rows per ear</th>
<th>seed yield</th>
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<tbody>
<tr>
<td>plant height</td>
<td>0.75**</td>
<td>0.77**</td>
<td>0.88**</td>
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<tr>
<td>Length of ear diameter</td>
<td>0.75**</td>
<td>0.77**</td>
<td>0.76**</td>
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<td></td>
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<tr>
<td>Corn cob diameter plant dry weight</td>
<td>-0.59*</td>
<td>-0.36</td>
<td>-0.55</td>
<td>-0.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>flag leaf area number of seeds per row</td>
<td>-0.33</td>
<td>-0.42</td>
<td>-0.24</td>
<td>-0.31</td>
<td>-0.22</td>
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<tr>
<td>number of leaves per plant</td>
<td>0.77**</td>
<td>0.71**</td>
<td>0.90**</td>
<td>0.69</td>
<td>-0.54**</td>
<td>-0.26</td>
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<tr>
<td>number of rows per ear</td>
<td>0.18</td>
<td>0.26</td>
<td>0.35</td>
<td>0.11</td>
<td>-0.27</td>
<td>0.33</td>
<td>0.36</td>
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<tr>
<td>number of seeds per row</td>
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<td>-0.87**</td>
<td>-0.58</td>
<td>-0.48</td>
<td>0.29</td>
<td>0.40</td>
<td>-0.58</td>
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<tr>
<td>number of rows per ear</td>
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<td>-0.35</td>
<td>-0.19</td>
<td>0.07</td>
<td>0.29</td>
<td>-0.32</td>
<td>0.34</td>
<td>0.86**</td>
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<td>seed yield</td>
<td>0.43</td>
<td>0.58</td>
<td>0.64</td>
<td>0.11</td>
<td>-0.21</td>
<td>0.24</td>
<td>0.10</td>
<td>0.69**</td>
<td>0.68**</td>
<td>0.85**</td>
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</table>

*and**: Significant at 0.05 and 0.01 probability level, respectively.
### Table 2. Regression of grain yield and agronomic traits in moderate stress levels

<table>
<thead>
<tr>
<th>Durbin Watson</th>
<th>Corrected coefficient</th>
<th>Regression equation</th>
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<tr>
<td>2.42</td>
<td>0.83</td>
<td>y=286+8.43X_1+2.32 X_2+ 2.34 X_3 + 3.64 X_4</td>
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</table>

### Table 3. Path analysis of grain yield and other traits in maize hybrids on the average stress levels

<table>
<thead>
<tr>
<th>Effective traits on seed yield</th>
<th>Direct effect</th>
<th>Indirect effect through</th>
<th>Simple correlation with seed yield</th>
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<tr>
<td>number of rows per ear</td>
<td>0.45</td>
<td>0.05 0.12 0.15 0.79</td>
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<tr>
<td>300- seed weight</td>
<td>0.34</td>
<td>0.07 0.05 0.00 0.47</td>
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<tr>
<td>number of seeds per row</td>
<td>0.28</td>
<td>0.19 0.06 0.07 0.62</td>
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</tr>
<tr>
<td>number of leaves per plant</td>
<td>0.18</td>
<td>0.39 0.00 0.12 -0.69</td>
<td></td>
</tr>
</tbody>
</table>

### REFERENCES


