The study of earliness components and morphological characteristics in two, early and late inbred line groups

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ABSTRACT: In this study components of earliness and its related physiological characteristics of different groups handled in a completely randomized design with four replications were evaluated. According to analysis of variance, the effect of inbred lines for all the traits except for yield was significant at the one percent level. For better analysis this issue, the effect of treatment was separated into its components. The results showed that in a comparison group between inbred lines for all the traits and performance, there was no significant difference in the level of one percent. Treatments are not significantly inbred lines for yield and its significance in the comparison group, indicating that What is the significance of the performance between the lines early or late relative to the average performance of each group. Therefore, the maturity index, the performance cannot be accurately predicted. Stepwise regression also showed that the early components of degree-days required from planting to grow milky stage, 72 percent of the variation of quantitative trait premature justified.

Keywords: Earliness index, phenological, yield, growth day degrees, corn

INTRODUCTION

Maturity is an important aspect of physiological maturity that is important in plant breeding (Chase and Nanda, 1967). So that the efficiency modified and selectivity of maize in different regions according to climatic characteristics, depending on the reaction the development of plant growth to conditions governing. Therefore, in areas where the growing season is short, Production and crop is important for varieties that Do their development process faster and take the maximum use of the conditions (Heidari, 2005). Corn maturity is generally calculated based on the number of days from planting to maturity (khavari khorasani, 2008). As for the comparison different stages of crop development in different spaces (Due to differences in environmental conditions), the use of a number of days unit is not sufficiently accurate (Aiken, 2005). Since the corn is C₄ and thermophiles plant and its phenological traits, are strongly dependent on temperature (Shoa Hosseini, 2010).

Measurement of thermal parameters, such as degree-day growth (GDD), Compared to systems based on the number of days, will have Higher capability to accurately predict the growth rate and growth stages of corn hybrids (Shaykewich, 1995). Accordingly, when plants absorb a certain amount of heat from the environment, arrived at a certain stage of development that can calculate the amount of heat absorbed and reported in the form of heat unit or growing degree-days. Must be considered that the plant reaches each phenological stage, is influenced by genotype (Gilmour and Rogers, 1985). Studies show that degree-days from planting to maturity in late hybrids is more than medium and early hybrids (Dwyer, 2003). Also between maturity groups in phenology traits (growing degree-days
from sowing to tassel emergence stage, ear emergence, the appearance of silky filaments, time of pollination, etc.), reported a significant difference at one percent (Heidari, 2005).

In breeding for Maturity groups in corn, should be particular attention to yield. Among maturity groups, Late cultivars due to long duration of the grain filling period, will have the highest yield (Esfandiari, 2001), but it is true as long as conditions are favorable for growth and development (Anonymous, 2006). Therefore, in areas where the risk of drought during the growing season and early autumn chill in the end of the growing season, maize yield threatening, late varieties can not be used (Hicks, 1990; Alizadeh, 1999), because of, late hybrids can not profit from the entire growing season (Lauer, 1999). Breeding and use of early maize varieties in areas with short growing seasons, is inevitable (Heidari, 2005). Zeinali (2004) with principal component analysis for yield showed that the first factor is 24.8 of the total variance was accounted for was phenology traits (Days to 50% of pollination, days to tassel emergence, days to silking and tassel). The purpose of this study is to evaluate early components and morphological characteristics associated with it, in different groups.

**MATERIALS AND METHODS**

This research was conducted In the spring of 2012 in the greenhouse of College of Agriculture, Shahrekord University. Desired location has 2061 meters above sea level. Genetic material used in this experiment consisted of two groups: early and late inbred line who late group includes five inbred lines (I1 to I5) and early group included three inbred lines (I6 to I8). In this study, components of early and the physiological characteristics associated with it, in different maturity groups in a completely randomized design with four replications were evaluated.

After preparation of the substrate using by manually furrower, were created slots, the distance of its was 35 cm. Experiment with four replications, a total of 32 experimental units were formed. Each plot consisted of four planting lines of length 150 cm and plant spacing in a row was considered of 12 cm. In order to supply the food needs of corn, urea Fertilizer calculated on the basis of 300 kilograms per hectare and Was used in two stages, 7-9 leaf and stem elongation. In this experiment of each inbred line, randomly selected three plants from the middle rows because of avoided from marginal effects. The growing degree-days for the Study of phenological stages (such as growing degree-days from sowing to germination, growing degree-days from sowing to stage 7 to 9 leaves, growing degree-days from sowing to tassel flower development, growing degree-days from sowing to the appearance of silky filaments, growing degree-days from sowing to milky stage, growing degree-days from sowing until maturity) was calculated by following formula.

1) \[ \text{GDD} = \sum \left( \frac{(T_{\text{max}} + T_{\text{min}})}{2} - T_b \right) \] (Cross and Zuber, 1972)

In this formula GDD, the sum of effective temperatures during the growing season, T_{\text{min}} and T_{\text{max}} are respectively minimum and maximum daily temperature and T_b is the base temperature of 10 °C is considered to corn. In order to determine a specific scientific definition for each phenological stage, was used from the Zadoks scoring system and Zadoks code for each phenological stage can be seen in the Table 1.

<table>
<thead>
<tr>
<th>Phenological stage</th>
<th>7 – 9 leaf stage</th>
<th>Emergence of tassel</th>
<th>Emergence of silk filaments</th>
<th>Milky stage</th>
<th>Physiological maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zadoks code</td>
<td>18</td>
<td>55</td>
<td>63</td>
<td>73</td>
<td>87</td>
</tr>
</tbody>
</table>

Grain yield in plant, corn hundred seed weight and leaf area index of corn were morphological traits, due to their great importance in the study were evaluated. Measurements of leaf area index were performed on the evolved flag leaf. For this purpose, after separating the leaves From the stems, using the leaf area meter set, AM200 model, was measured leaf area on the mm². In this study, after data collection, was performed analysis of variance and comparison of mean by Duncan's multiple range test. Then for determining the difference between early and late groups, was used From comparison group methodology to analyze the effect of treatment. Then use simple correlation and stepwise regression to examine the relationship between phenological and morphological traits with indices maturity. Also, for the grouping of lines, were used of different maturity indices and different physiological indices by using multivariate clustering. All statistical analysis was performed by using the SAS and Minitab softwares.
RESULTS AND DISCUSSION

Analysis of variance related to phenological and morphological traits are presented in Table two. According to the results, the effect of inbred lines for the all traits except yield was significant at one percent. This is while was expected late inbred lines in optimal conditions and equal, have better performance compared to earlier inbred lines (Anonymous, 2006).

For better analysis this issue, the effect of treatment was separated into its component pieces (early groups, late groups and a comparison group between early and late groups). This result showed in the comparison group between early and late groups lines for all the traits and even yield, there was a significant difference in the probability of one percent. Lack of significantly effect of inbred lines for the yield and then significantly of it showed that something that makes the Significance of between early and late lines for yield, is the mean yield of each group toward another. As a result, can not predict yield from characteristics of early or late inbred lines and is possible that there are early inbred lines such as inbred lines evaluated in this experiment that have yield about some late inbred lines. The remarkable thing is that there are numerous reports about the existence of a negative correlation between earliness and yield (Hallauer and Miranda, 1988;Ehdaei, 1993). While with creating a variety in early varieties and selection based on yield and yield components could have early genotypes with high yield (Samanci, 1996).

Within group of early inbred lines, just for two characters, growing degree-days From sowing to stage 7 to 9 leaf and hundred seed weight, was observed significant difference in level of five percent and in late lines for the three traits, i.e: growing degree-days from sowing to germination, growing degree-days from sowing to emergence of tassel and leaf area, significant difference in the one percent level. Mean compared to the inbred lines (Table 3) showed that for characteristics included growing degree days from sowing to the emergence of silk filaments, growing degree-days from sowing to milky, growing degree days from sowing to physiological maturity, inbred lines were classified into two groups. This is represents a clear difference between early and late inbred lines. In growing degree days from sowing to physiological maturity trait, highest average was related to late inbred line (I2) with an average of 2288 and lowest average was related to early inbred line (I6) with an average of 1771 that was consistent with findings of Dwyer and colleagues in (2003).

Also in growing degree days from sowing to tassel emergence trait, highest average was related to late inbred line (I4) with an average of 1386 and lowest average was related to early inbred line (I6) with an average of 1215. Several reports show that about the amount of growing degree days from sowing to tassel emergence of, there are differences between maize genotypes but in general earlier genotypes compared to late genotypes need to less number of days and less growing degree-days from sowing to tassel emergence (Heidari, 2005). About the hundred seed weight, late inbred line I5 with an average of 30.02 gr was highest and early inbred line I7 with an average of 19.71 gr was lowest. In other words, a longer growing season creates higher grain yield potential (Emam and Nicknegad, 1994). For the leaf area trait, highest average was related to late inbred lines I1 with an average of 643 mm² and lowest average was related to early inbred lines I7 with an average of 468 mm². Hunter also reported that In cultures of normal density, leaf area index early hybrids compared to other maturity groups was lower (Hunter, 1980).
The correlation coefficients between measured traits showed positive relationship and highly significant at the one percent between growing degree-days from sowing to maturity with other traits. So that highest correlation of phenological traits with growing degree-days from sowing to maturity respectively related to traits included: growing degree-days from sowing to milky (0.85**), growing degree-days from sowing to emergence of silk filaments (0.84**), growing degree-days from sowing to germination (0.54**), growing degree-days from sowing to tassel emergence
(0.51**) and growing degree-days from sowing to 7-9 leaf stage (0.50**) (Table 4). Also correlation coefficients between measured traits and yield showed that hundred seed weight trait had highest significant direct effect on grain yield.

Other studies on maize hybrids also shown that 300 seed weight has the most significant effect on grain yield (Vaezi ., 2000). Growing degree-days from sowing to germination, growing degree-days from sowing to physiological maturity and leaf area index were also positively correlated and significantly with yield. IN other studies also between yield and grown degree-days from sowing to physiological maturity, was reported a significant positive correlation (Berzsenyi and Lap, 2005; Heidari, 2005). Also Sharma and Kumar (1987) in their study on maize showed that there is a correlation between leaf area index and yield.

### Table 4. The correlation coefficients between phonological and morphological traits

<table>
<thead>
<tr>
<th>Number of trait</th>
<th>Traits</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Growing degree days from sowing to physiological maturity</td>
<td>1.0</td>
<td>0.60**</td>
<td>0.64**</td>
<td>0.64**</td>
<td>0.85**</td>
<td>0.84**</td>
<td>0.51**</td>
<td>0.50**</td>
<td>0.54**</td>
</tr>
<tr>
<td>2</td>
<td>Yield per plant</td>
<td>1.00</td>
<td>0.90**</td>
<td>0.48**</td>
<td>0.38*</td>
<td>0.37*</td>
<td>0.14*</td>
<td>0.23ns</td>
<td>0.23ns</td>
<td>0.59**</td>
</tr>
<tr>
<td>3</td>
<td>Hundred seed weight</td>
<td>1.00</td>
<td>0.50**</td>
<td>0.35*</td>
<td>0.34ns</td>
<td>-</td>
<td>0.24ns</td>
<td>0.77**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Leaf area index</td>
<td>1.00</td>
<td>0.51**</td>
<td>0.50**</td>
<td>0.27*</td>
<td>0.30*</td>
<td>0.64**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Growing degree days from sowing to milky stage</td>
<td>1.00</td>
<td>0.99**</td>
<td>0.75**</td>
<td>0.52**</td>
<td>0.27ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Growing degree days from sowing to emergence of silk filaments</td>
<td>1.00</td>
<td>0.75**</td>
<td>0.52**</td>
<td>0.26ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Growing degree days from sowing to tassel emergence</td>
<td>1.00</td>
<td>0.41*</td>
<td>0.15ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Growing degree days from sowing to 7-9 leaf stage</td>
<td>1.00</td>
<td></td>
<td>0.31ns</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Growing degree days from sowing to germination</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ns, * and **: respectively, no significant difference, significant difference in the level of five percent and significant difference in the level of one percent

### Multiple regression stepwise

To evaluate the relationship between phenological traits with maturity index (growing degree-days from sowing to physiological maturity) were used of the stepwise regression. The results of the stepwise regression are given in Table 5. The regression equation obtained from the stepwise regression was obtained as follows.

\[
2) \text{GDD from sowing to physiological maturity} = -11013 + 29.45 x_1 + 54.46 x_2 - 28.02 x_3
\]

In this equation, \(x_1\), \(x_2\) and \(x_3\) respectively are growing degree days from sowing to milky stage, growing degree-days from sowing to germination and growing degree-days from sowing to emergence of silk filaments. As can be seen in the model, growing degree-days from sowing to milky stage, with a positive coefficient (29.45) was the first trait that entered to model and 72.3 percent of variation maturity index to be justified. This indicates that growing degree-days from sowing to milky stage each level is more, physiological maturity also occurs later. The second trait that was entered into the model, was growth degree-days from sowing to germination. This trait justifies the 10.4 percent from variation maturity index. The third trait that was due on maturity index, growing degree-days from sowing to the appearance of Silky filaments that would justify 3.2 percent of total variation. This trait has a negative coefficient (-28.02) that show whatever inbred lines intended have less growing degree-days from sowing to emergence of silk filaments, occurs later physiological maturity.
Table 5) Results of stepwise regression for maturity index as a function trait and other phenological traits as independent traits

<table>
<thead>
<tr>
<th>Step</th>
<th>Entered trait in the model</th>
<th>Model parameters</th>
<th>component of the $R^2$</th>
<th>model of the $R^2$</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Growing degree-days from sowing to milky stage</td>
<td>29.456</td>
<td>0.723</td>
<td>0.723</td>
<td>78.65**</td>
</tr>
<tr>
<td>2</td>
<td>Growing degree-days from sowing to germination</td>
<td>54.464</td>
<td>0.104</td>
<td>0.827</td>
<td>17.69**</td>
</tr>
<tr>
<td>3</td>
<td>Growing degree-days from sowing to emergence of silk filaments</td>
<td>-28.027</td>
<td>0.033</td>
<td>0.860</td>
<td>6.64*</td>
</tr>
</tbody>
</table>

Cluster analysis

In order to determine the affinity between inbred lines studied and grouped them, cluster analysis was used by linkage between groups using the Euclidian distance as a similarity measure method. The purpose of this analysis was to identify inbred lines that were most similar to each other. Determine the extent of similarity and proximity inbred lines in addition to being effective in deciding Select the parental lines, largely reduces from the volume of corrective actions, time and cost (Heidari, 2005). Classification tree diagram derived from inbred lines grouping shown in Figure One. The results of cluster analysis showed that inbred lines were different and this analysis was able to separate the good inbred lines based on the traits. The first grouping of lines I₁, I₂, I₃, I₄ and I₅ were in a group. This five inbred lines were all late. Also lines I₆, I₇ and I₈ were in a group, all of whom were early. The results of cluster analysis showed that the late and early groups were similar with a 21.24% similarity. Lines that are grouped together have more similar to each other and probably the closest genotype. So that the inbred lines within each maturity group have similarity more than 73 percent.

![Classification dendrogram of inbred lines](image)

Figure 1. Classification dendrogram of inbred lines

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