Inherit\text{ance of Grain Dry-Down in Corn (\textit{Zea mays} L.).}

Andrei FILIPENCO*, Valentin MANDACHE, Gabriela VALSAN, Florin IVAN, Ion CIOCAZANU

Pioneer Hi-Bred Seeds Agro SRL, DN2, km 19.7, Comuna Ganeasa, 077104 Sat Sindrilita, Judetul Ilfov, Romania. andrei.filipenco@pioneer.com

Abstract. Breeding for faster grain dry-down in corn is an essential objective of modern corn breeding programs all over the world due to important economic reasons. A reliable, large scale, fast, non-destructive wood moisture Voltcraft FM-200 Humidity meter was used to successively measure the grain moisture of field corn individual plants for a large number of corn genotypes, hybrids and inbred lines, in different stages of Pioneer corn breeding program, during 2010-2012. A calibration curve (successive determinations of the grain moisture by using in parallel the wood moisture meter readings and grain moisture obtained by standard gravimetric method) has been used to transform the wood moisture meter readings in estimated % grain moisture (EPGM). DDIND values, a propose selection index, computed as the slope between EPGM and measurement timing, have been used to apply ANOVA analysis; Preliminary results showed that the methods allowed identification of real genotypic differences and advance genotypes with fast DDR. Using the components of variances obtained in ANOVA analysis, an estimate of the heritability of the DDIND was computed. The relative large value of the heritability, of more than 0.50 (50%), suggested the efficiency of the method in detecting genotypic variations and that selecting by using DDIND for rapid dry down would result in an efficient improvement of this important agronomic trait of modern corn inbred lines and hybrids.

Key words: corn, dry down, selection index, heritability, \textit{Zea mays} L.

INTRODUCTION

Breeding for faster grain dry-down rate (DDR) in corn is an essential objective of modern corn breeding programs all over the world due to important economic reasons losses (Boute et al., 2002; Cross 1985; Eckert 1978; Hellevang and Reef 1987; Hellevang 2004; Lackey 2008; Ragai and Loomis 1954; Stere et al., 1995). DDR is a complex trait influenced by weather and genetic factors (Aldrich et al., 1975; Baron and Daynard 1984; Cavalieri and Smith 1985; Crane et al., 1959; Hiks et al., 1976; Kang et al., 1975, 1983, 1986; Nass and Crane 1970; Purdy and Crane 1967; Schmidt and Hallauer 1966; Stere et al., 1995; Sweeney et al., 1994; Tollenaar and Daynard 1978; Troyer and Ambrose 1971). High correlations, phenotypic and/or genotypic, between DDR and agronomic traits connected to husks, kernels and plants structure have been identified (Cavalieri and Smith, 1985; Hick et al., 1976; Kang et al., 1975; Purdy and Crane, 1967; Troyer and Ambrose, 1971). Literature with regard to DDR genetic inheritance in corn is relatively limited. DDR was found to be a heritable trait when measured in the laboratory conditions and large genetic differences among genotypes where reported (Crane et al., 1959; Hillson and Penny, 1965; Purdy and Crane, 1967a; Nass and Crane, 1970; Cross, 1985), but there have been conclusions that in laboratory fast DDR could not be effective in the field. Diallel studies with this trait performed by Purdy and Crane, 1967a; Cross and Kabir, 1989; Stere, 2002 revealed significant effects of both GCA and SCA. Additive effects were the predominant type of gene action; non-additive effects, although lower were also significant, while cytoplasmatic and nuclear x cytoplasmatic
Effects where lower and significant only in particular environments (Stere, 2002). Kondapi et al., 1993 found relative high heritability in narrow sense for this trait, suggesting that recurrent selection could be effective in two populations for increasing the frequency of favourable genes and gene combination for DDR.

MATERIAL AND METHOD

Non-destructive determinations of the grain moisture of individual corn field grown plants with a wooden moisture meter Voltcraft FM-200 Humidity has been used to assess a large number of corn genotypes, hybrids and inbred lines, in different stages of Pioneer corn breeding program, in 2 locations, during 2010-2012 (Tab. 1). A calibration curve (successive determinations of the grain moisture by using in parallel the wood moisture meter readings and grain moisture obtained by standard gravimetric method) has been used to transform the wood moisture meter readings in estimated percent grain moisture (EPGM). DDIND (Dry-down Selection Index) values, computed as the slope between EPGM and timing of the measurement, were used to apply ANOVA analysis. Using variance components obtained in ANOVA analysis, an estimate of the heritability of the DDIND was computed:

\[ H^2 = \frac{((e-1)/(g*e-1))/\left(s^2_Gight)}{s^2_T} \]

where:
- \( H^2 \) – coefficient of heritability; \( e \) – no. of environments; \( g \) – no. of genotypes; \( s^2_G \) - genotypic variance; \( s^2_P \) - phenotypic variance
- \( s^2_P = s^2_G + s^2_E + s^2_G \times E \)

Tab. 1

<table>
<thead>
<tr>
<th>Year</th>
<th>Exp.</th>
<th>Loc.</th>
<th>Type of entries</th>
<th>No. of entries</th>
<th>Type of plot</th>
<th>No. of plants per plot</th>
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<tbody>
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<td>10DPI</td>
<td>2</td>
<td>Inbreds</td>
<td>185</td>
<td>1 row/plot</td>
<td>5</td>
</tr>
<tr>
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<td>11TCNSH</td>
<td>2</td>
<td>Hybrids</td>
<td>197</td>
<td>2 rows/plot</td>
<td>6</td>
</tr>
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<td>11TCSSH</td>
<td>2</td>
<td>Hybrids</td>
<td>250</td>
<td>2 rows/plot</td>
<td>6</td>
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<tr>
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<td>2</td>
<td>Hybrids</td>
<td>121</td>
<td>4 rows/plot</td>
<td>10</td>
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<td>2</td>
<td>Inbreds</td>
<td>467</td>
<td>1 row/plot</td>
<td>5</td>
</tr>
</tbody>
</table>
RESULTS AND DISCUSSIONS

Values of the component of variance and heritability of DDIND, as a synthetic index to estimate the DDR in corn, are presented in Tab. 2. Relative large values of the heritability, of more than 50 %, were obtained for all experiments, but the experiment with inbred lines from 2011 (only 11.58 %). However, the data presented in Tab. 2, indicate that a large proportion of the variations in DDR, detected in the most of the experiments, was due to genetic factors and selecting by using DDIND for rapid dry down in corn would result in an efficient improvement of this important agronomic trait of modern corn inbred lines and hybrids. DDIND could be use in an efficient way for detecting genotypic variations and for selecting new superior products with fast DDR. Additionally, the utilization of the proposed non-destructive method to determine the grain moisture on the plants grown in the field allow application of this index in very early stages of corn breeding with encouraging results. There is an urgent need of additional genetic studies for field DDR, particularly for the breeding programs from corn areas from Europe.

CONCLUSIONS

(i) Large values of the heritability of DDIND have been detected in most part of the experiments.
(ii) DDIND could be used in successfully selecting of genotypes with fast DDR.
(iii) Additional studies are needed for germplasm characterization and breeding from corn areas from Europe.
(iv) The non-destructive method could be used for genetic studies in very early generations of the breeding stages, for different purposes, even on individual plants.

REFERENCES

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