EFFICIENCY OF UTILIZATION OF A DROUGHT INDEX IN EVALUATION OF ADAPTABILITY TO DROUGHT OF CORN HYBRIDS (*Zea mays* L.*)* IN EARLY TESTING STAGES

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Abstract

Evaluation of drought tolerance is a complex and relatively difficult process. Two main approaches were considered by scientist for drought tolerance estimation: (i) testing in water managed locations and (ii) testing in large corn testing network, in targeted environments and managed irrigation – full and limited. A large volume of field data and other related traits could be generated in this type of approach , but usually for drought evaluation purpose two data breakouts were examined: full irrigated (non-stressed) and limited irrigated (water stressed). Selection of the hybrids is done for dual performance, for reaching a balance between a reasonable performance in drought conditions and a good response to favourable water regime. Usually a regression chart between performance in limited irrigation and full irrigation (non-stressed) is used to select hybrids. A new selection drought index (DRIND) is proposed. Application of DRIND on experimental data obtained in 2011 in East European Pioneer corn yield test network showed good efficiency in selecting the most adapted (drought tolerant) corn hybrids.

Key words: *corn, drought tolerance, drought index, hybrids, Zea mays* L.

INTRODUCTION

Large areas cultivated with corn in Eastern Europe are frequently affected by drought. Long period of drought generally enhanced by heat during flowering and grain setting and filling are extremely harmful to corn, causing significant yield losses that can sometimes end with total failure of the crop. Consequently, improving drought tolerance of the modern corn hybrids has become in the last decade one of the essential breeding objective of any breeding program from Eastern Europe and even world-wide. Drought tolerance quantification in corn is a difficult and complex process that requires precise phenotyping in locations where water stress is precisely managed and has been based on the comparison between yields obtained in water stress environment and low or non-water stressed locations. This approach generated in a relative large number of indices for drought selection based on a mathematical relation between stress- and optimum conditions [4, 9]. Fischer and Maurer proposed in 1978 an index S of drought stress susceptibility [3]. Lin and Binns, in 1988, using grain yield in different environments proposed a formula for quantifying the drought tolerance taking as reference terms the best performing genotype in each location [5]. In his study, Moghaddam and Hadi-Zadeh [6] found Stress Tolerant Index (STI) was more useful in order to select favorable corn cultivars under stressful and stress-free conditions [2, 4, 8].

Khalili et al., (2004) showed that based on Geometric Mean Productivity (GMP) and STI indices, corn hybrids with high yield in both stress and non-stress environments can be selected. Water shortage during flowering also postpones tasseling and silking, increases Anthesis Silking Interval (ASI) and causes partial or no pollination and pollen reception. Additionally, the emerged silks may dry soon as the result of water shortage and high temperatures, which consequently will affect the reception of pollens, their subsequent germination, elongation and penetration into

the stigma and inside the ovules. Fertilization may not occur well and this can reduce the seed number on the cobs [4]. Bolanos *et al.* (1993) found that the ASI increased to 4.6 days in stress treatment in flowering stage and to 8.3 days in severe stress treatment before and after florescence compared to 2.2 days in control. The occurrence of stress during seed filling period reduced final seed weight [1]. Richards (1996**)** believed that the yield-based selection of genotypes in both stress and non-stress environments can lead to the selection of high yield genotypes under stress conditions since, the response of selection under non-stress conditions is maximal and hereditability of the yield under these conditions is high [7]. The purpose of the present study is to propose a new drought tolerance (adaptability) index (DRIND) for a better, more rapid and precise estimation and selection of the drought tolerance.

MATERIAL AND METHOD

Pioneer corn hybrids representing two early testing stages (first year of testing – R1 and second year of testing – R2) and two maturities group, FAO480 and FAO550, were tested in 2011 in different locations from Eastern Europe, including Romania. For ensuring achievement of the two water stress levels, different irrigation regimes were applied, using small sprinklers equipments. Thus, full irrigation locations were accounted for low water stress level while limited irrigated and non-irrigated locations for high water stress level (table 1).

Table 1. Number of Pioneer R1 and R2 corn hybrids, representing 2011 testing, grouped into two maturities, number and irrigation regime of the testing locations

Stage	R1		R2	
Maturity group	FAO 480	FAO 550	FAO 480	FAO 550
No. of hybrids tested	103	90	99	101
Total no.of locations	12	11	18	16
- Full irrigated - LS	5	5	8	8
- Limited irrigated - HS	3	3	5	4
- Non-irrigated - HS	4	3	5	4

Same sources of seeds were used for planting all locations by centralizing the process of filling seed bags. High input technology was applied to trials in all locations. Trials were mechanically over planted and manually

thinned to the desired plant populations at 6 leaves stage. Experimental plot consisted of 2 rows long of 6 m, distance between rows was 75 cm; entries were randomized or nested into experiment. Yield and other important agronomic traits were collected. Results were processed and were used during a normal advancement process; a large volume of field data and other related traits were generated, but usually for drought evaluation purpose two data breakouts were examined in : yield in full irrigated (non-stressed) and in limited irrigated (water stressed). Selection of the hybrids was done for dual performance, for reaching a balance between a reasonable performance in drought conditions and a good response to favourable water regime. Usually a regression chart between performance in limited irrigation and full irrigation (non-stressed) is issued to select hybrids. In this study, in addition to this regression chart, a new drought tolerance (adaptability) index (DRIND) is proposed for a better, more rapid and precise estimation of the drought tolerance.

The adaptation index (DRIND) is calculated by using a **graphical screening interface,** that in addition to an usual Excel regression chart, displays the prediction and confidence upper and lower limits (for a preselect level of significance); each data point is identified with a tag picked up from the column situated at the left of the "X" column in input sheet. The mean yields for irrigated and rainfed conditions are presented as dashed magenta lines.

Tagging of data points allows a quick visual identification of the hybrids with good performance both under irrigated and rainfed conditions.

DRIND is calculated as a sum of the distance along the regression line between its intersection with Y axis and its intersection with the perpendicular from the data point (representing the average behavior of a hybrid over the two water stress levels) and the distance from the data point to regression line (a correction accounting for the behaviour of a hybrid under water stress conditions). The sign of the distance from data point to regression line (correction factor) is positive if the point is above regression line or negative if it is bellow it.

Some exemplifications of DRIND were computed by using the results of testing of several populations of hybrids presented in table 1; efficiency of DRIND in discriminating more tolerant and adaptable hybrids was estimated by comparing the results of normal advancement (selection on the basis of examination in parallel of the grain yield obtained in the two breakouts of the environments, low and high water stress locations) with selection on the basis of values of DRIND, ordered descending, obtained by using the computing graphical interface proposed.

RESULTS AND DISCUSSIONS

Regression line between average yield over HS locations and over LS locations, as produced by the **graphical screening interface** showing the positions of the tested hybrid on the graph and special tags for outlining the promoted hybrids by the normal advancement process (A in green) and the checks (C in red) are presented for maturity group FAO480 in figures 1 and 2 for R1 hybrids and R2 hybrids, respectively. A rapid visual selection of the most adaptable hybrid with better drought tolerance is possible; most of the advanced hybrids are placed in upper right quarter of the graph for both testing stages, R1 and R2.

Similar situation could be noticed also for maturity group FAO550, shown in figures 3 and 4; a great part of the normally advanced hybrids (parallel selection of most performing hybrids in the two water stress levels) are placed in the graph area (upper right quarter) which is the most favourable for drought tolerance selection.

In tables 2-5, DRIND values, ordered descending are presented for both maturity groups and both testing stages.

High values of a simple statistics such as % of normally advanced hybrids which are placed in the first top third of the DRIND ordered descending in tables 2-5, presented in table 6, suggest that selecting for improved drought tolerance and consequently for better adaptability of the hybrids by using DRIND could have a good efficiency.

Fig. 1. Regression line between average yield in high water stress locations (HS) and average yield in low water stress locations (LS), R1 hybrids, maturity group FAO 480

Fig. 2. Regression line between average yield in high water stress locations (HS) and average yield in low water stress locations (LS), R2 hybrids, maturity group FAO 480

Since the selection criteria took into consideration other agronomics and disease traits part of hybrids placed in top third of DRIND ordered descending, and potentially selectable for adaptability (better drought tolerance) were dropped; the most frequent reason for this are: innapropiate tall plant stature and high ear insertion, low ear profile, root and stalk lodging as weel as low parent test potentiality of the hybrids components.

Fig. 3. Regression line between average yield in high water stress locations (HS) and average yield in low water stress locations (LS), R1 hybrids, maturity group FAO 550
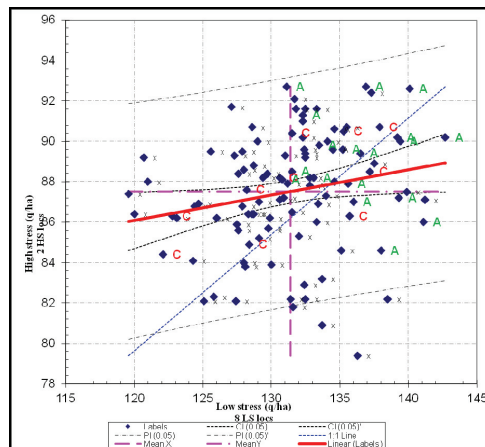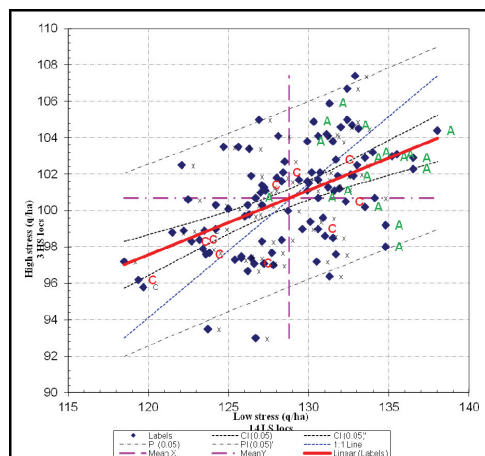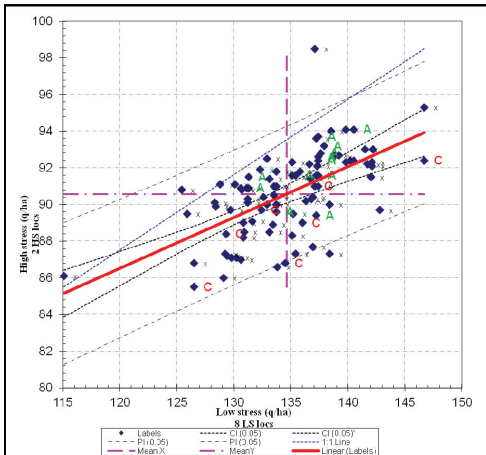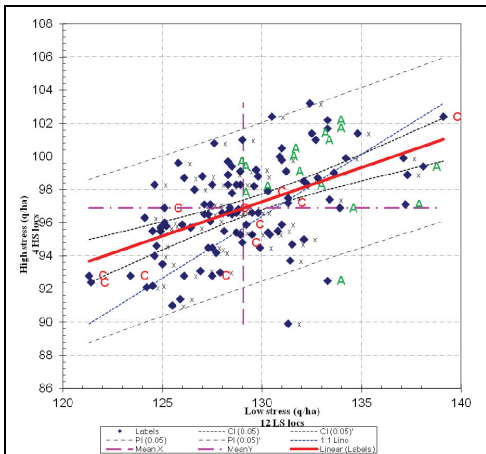

Fig. 4. Regression line between average yield in high water stress locations (HS) and average yield in low water stress locations (LS), R2 hybrids, maturity group FAO 550

The essential advantages of using DRIND are that selection using two breakouts in parallel, which could be some burden and confusing, is avoided; is more precise than visual selection on the graph being an exactly computed index which can be ordered descending and make the selection process easier and more objective.

Table 2. Computation of drought tolerance index (DRIND) for R1 hybrids tested in 2011, maturity group FAO 480

Advancement decision *	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
A	140.1	92.6	145.7
A	142.7	90.2	145.2
x	137.3	92.4	143.0
A	136.9	92.7	143.0
A	139.2	90.2	142.2
A	139.4	90	142.1
C	137.9	90.7	141.6
x	141.2	87.1	140.5
x	139.9	87.5	139.8
x	135.5	90.7	139.5
x	137.5	88.9	139.3
A	141.1	86	139.2
C	135.3	90.5	139.1
A	136.5	89.4	139.0
A	139.3	87.2	138.9
A	134.6	90.6	138.7
x	133.3	91.6	138.6
C	137.2	88.5	138.6
A	135.2	89.6	138.1
A	131.1	92.7	138.0
x	132.5	91.6	137.9
x	131.7	92.1	137.8
x	134.1	90	137.5
A	134.5	89.6	137.4
A	132.3	91.3	137.4
x	131.8	91.6	137.3
x	132.3	91	137.1
A	133.5	89.8	136.8
A	135.6	87.9	136.5
x	132.3	90.2	136.2
A	136	87	135.8
x	134.6	88	135.7
C	131.5	90.4	135.7
x	132.4	89.6	135.6
x	132.5	89.4	135.5
x	132.5	89.2	135.3
A	138	84.6	134.9
C	135.7	86.3	134.8
A	133.1	88.2	134.7
x	134	87.3	134.4
x	132.8	88.2	134.4
x	131	89.3	134.1
A	132.8	87.8	134.0
A	131.5	88.5	133.6
x	128.6	90.7	133.6

*) A – Advanced hybrid using the normal advancement process
C – Check hybrid
X – dropped hybrid

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Table 2. Computation of drought tolerance index (DRIND) for R1 hybrids tested in 2011, maturity group FAO 480 - **continued**

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
x	133.4	86.9	133.5
x	127.1	91.7	133.4
x	129	90	133.1
x	131.2	87.9	132.7
x	138.5	82.2	132.7
A	130.8	88.1	132.6
C	130.6	88.2	132.5
x	133.3	86	132.4
x	135.1	84.6	132.4
x	129.7	88.4	131.9
x	130.9	87.2	131.6
x	127.9	89.5	131.6
x	128.7	88.8	131.5
x	129.4	88.2	131.5
x	131.5	86.5	131.4
x	130.6	87.1	131.3
x	127.3	89.3	130.9
x	128	88.6	130.7
x	132	85.3	130.5
x	127.6	88.4	130.1
x	129.1	87	129.9
C	128.2	87.6	129.7
x	129.9	86.2	129.7
x	125.6	89.5	129.6
x	133.7	83.2	129.6
x	129.8	85.7	129.0
x	129.8	85.7	129.0
x	128.7	86.4	128.8
x	128.6	86.4	128.8
x	127.9	86.8	128.6
x	128.3	86.4	128.5
x	132.4	82.9	128.1
x	129.1	85.2	127.8
x	136.3	79.4	127.6
x	132.5	82.2	127.5
x	127.5	85.9	127.2
x	130	83.9	127.2
x	133.7	80.9	127.0
x	127.6	85.6	127.0
C	128.4	84.9	126.9
x	131.4	82.2	126.5
x	126	86.2	126.3
x	131.6	81.8	126.2
x	124.7	86.9	125.9
x	124.4	86.8	125.6
x	128	84	125.6
x	128.1	83.8	125.4
x	120.7	89.2	125.0

Table 2. Computation of drought tolerance index (DRIND) for R1 hybrids tested in 2011, maturity group FAO 480 - **continued**

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
x	121	88	123.9
x	123.1	86.2	123.8
C	122.8	86.3	123.6
x	127.4	82.1	122.9
x	124.3	84.1	122.5
x	119.6	87.4	122.1
x	125.8	82.3	121.7
x	120	86.4	121.3
x	125.1	82.1	120.9
C	122.1	84.4	120.9

Table 3. Computation of drought tolerance index (DRIND) for R2 hybrids tested in 2011, maturity group FAO 480

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
x	132.9	107.4	147.8
A	138	104.4	147.0
x	132.4	106.7	146.6
A	131.3	105.9	144.9
x	132.4	105	144.4
A	136.5	102.9	144.2
A	132.7	104.7	144.2
x	133.1	104.5	144.2
A	135.5	103.1	143.9
x	132	104.6	143.6
A	135.2	103	143.5
A	136.5	102.3	143.4
A	134	103.2	143.1
A	130.3	104.9	143.0
x	131.1	104.2	142.6
x	131.2	104.1	142.5
A	133.5	102.9	142.4
x	131.5	103.8	142.3
x	130.6	104.1	142.2
x	133	102.5	141.6
A	129.9	103.8	141.4
C	131.7	102.8	141.2
x	126.9	105	141.1
x	132.6	102	140.7
A	132.8	101.9	140.7
x	128.1	104.1	140.6
x	131.8	101.9	140.1
x	134.1	100.7	139.9
x	130.7	102.1	139.7
A	130.2	102.1	139.4
x	131.9	101.2	139.2
x	128.5	102.7	139.1
x	130.6	101.7	139.1

Table 3. Computation of drought tolerance index (DRIND) for R2 hybrids tested in 2011, maturity group FAO 480 – **continued**

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
A	131.2	101.3	138.9
A	133.5	100.2	138.9
A	131.6	101.1	138.9
x	126.3	103.4	138.7
C	132.3	100.5	138.6
x	129.9	101.6	138.5
x	130	101.5	138.5
A	134.8	99.2	138.4
x	129.4	101.7	138.4
x	125.6	103.5	138.4
C	128.4	102.1	138.3
x	129.9	101.1	137.9
A	130.6	100.7	137.8
x	124.7	103.5	137.8
x	128	101.8	137.6
x	128.3	101.6	137.6
A	134.8	98	136.9
x	126.4	101.9	136.8
x	130.9	99.6	136.6
C	127.1	101.4	136.6
x	127.2	101.3	136.5
x	127.3	101.1	136.3
x	127	101	136.0
x	130.1	99.4	135.9
x	128.7	100	135.8
C	130.6	99	135.6
x	131.5	98.5	135.6
A	126.7	100.7	135.4
x	131	98.6	135.4
x	127.1	100.3	135.2
x	129.6	99	135.0
x	122.1	102.5	135.0
x	126.2	100.3	134.6
x	131.7	97.6	134.5
x	126.3	99.8	134.1
x	126	99.7	133.7
x	125	100.1	133.7
x	128.3	98.4	133.5
x	124.2	100.3	133.4
x	130.5	97.2	133.3
x	122.5	100.6	132.8
x	131.3	96.4	132.7
x	127.1	98.3	132.6
x	127.7	97.7	132.2
x	124.2	99	131.8
x	127.8	97	131.4
C	123.5	98.9	131.2
x	127.2	97.1	131.2
x	126.4	97.4	131.1
x	125.8	97.5	130.8
C	126.6	97.1	130.8
x	125.8	97.4	130.7
x	122.2	98.9	130.4
C	123.2	98.4	130.4
x	125.4	97.3	130.3
x	126.2	96.7	130.0
C	122.7	98.3	130.0
x	123.4	97.9	129.9
x	121.5	98.8	129.9
x	123.8	97.7	129.9
C	123.6	97.6	129.6
x	118.5	97.2	126.0
x	126.7	93	125.6
C	119.4	96.2	125.3
C	119.7	95.8	124.9
x	123.7	93.5	124.4

Table 4. Computation of drought tolerance index (DRIND) for R1 hybrids tested in 2011, maturity group FAO 550

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
x	146.7	95.3	153.9
x	137.1	98.5	151.2
C	146.7	92.4	150.4
A	140.5	94.1	148.2
x	142.2	93	148.0
x	139.8	94.1	147.7
x	141.5	93	147.5
x	142.1	92.3	147.0
x	142.1	92.1	146.8
x	141.7	92.2	146.6
x	138.5	94	146.6
x	140.5	92.4	146.1
x	142	91.5	146.0
x	140.2	92.4	145.8
x	139.2	92.7	145.5
A	137.4	93.7	145.5
x	139.8	92.3	145.4
x	138.8	92.7	145.2
x	137.2	93.6	145.2
A	137.9	93.2	145.2
A	137.6	92.8	144.5
x	142.8	89.7	144.3
A	137.4	92.6	144.1
A	137.4	92.4	143.9

Table 4. Computation of drought tolerance index (DRIND) for R1 hybrids tested in 2011, maturity group FAO 550 – **continued**

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
x	137.3	92.1	143.5
x	136.6	92.2	143.1
A	137.4	91.6	142.9
A	137.2	91.6	142.8
x	136.7	91.4	142.2
x	135.1	92.3	142.2
A	137.4	91	142.2
x	135.8	91.8	142.0
C	137.1	91	142.0
x	138.4	90	141.6
A	135.4	91.6	141.5
x	135.1	91.6	141.3
x	136.9	90.4	141.1
x	136.8	90.3	140.9
x	132.9	92.5	140.9
x	133.7	91.8	140.6
A	136.3	90.2	140.4
A	137.2	89.4	140.1
x	132.3	91.9	139.7
x	133.1	91.4	139.7
x	133.7	91	139.6
x	133.5	91	139.5
C	133.5	90.5	138.8
x	135.2	89.5	138.8
C	136	89	138.7
A	131.3	91.5	138.5
x	133.7	90	138.4
x	138.4	87.3	138.3
x	132.6	90.4	138.1
A	133.7	89.6	137.9
A	132.9	90	137.8
x	131.3	90.9	137.8
x	136.9	87.7	137.8
A	131.1	90.9	137.7
x	130.6	90.9	137.3
x	130.7	90.8	137.3
x	135.1	88.3	137.3
x	130.1	91.1	137.2
C	132.4	89.7	137.1
x	131.2	90.3	137.0
x	133.4	88.9	136.8
x	131.2	90.1	136.8
x	128.8	91.1	136.3
x	135.4	87.3	136.2
x	133.1	88.5	136.1
x	131.6	89.1	135.8
x	129.7	89.7	135.2
x	130.8	89	135.1

Table 4. Computation of drought tolerance index (DRIND) for R1 hybrids tested in 2011, maturity group FAO 550 – **continued**

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
C	134.5	86.8	135.0
x	128.3	90.1	134.7
x	130.9	88.5	134.6
x	128.4	89.9	134.6
x	133.8	86.6	134.3
x	130.8	88.2	134.1
x	125.4	90.8	133.6
C	129.3	88.4	133.3
x	130.6	87	132.5
x	130.2	87.1	132.4
x	125.9	89.5	132.3
x	129.8	87.1	132.1
x	129.4	87.2	131.9
x	129.2	87.3	131.9
x	129.1	86	130.2
x	126.5	86.8	129.4
C	126.5	85.5	127.8
x	115.1	86.1	120.6

Table 5. Computation of drought tolerance index (DRIND) for R2 hybrids tested in 2011, maturity group FAO 550

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
C	139.1	102.4	152.3
x	132.4	103.2	149.7
A	133.3	102.2	148.9
x	134.8	101.4	148.6
A	133.3	101.7	148.2
x	137.1	99.9	147.9
A	138.1	99.4	147.8
x	130.5	102.4	147.6
A	132.5	101.4	147.4
A	132.7	101	147.0
x	137.3	98.9	146.7
x	134.2	99.9	146.3
A	131	100.5	145.4
x	129	101	145.0
x	133.6	99	144.8
A	130.9	100	144.7
x	131	99.8	144.5
A	137.2	97.1	144.3
x	132.8	98.7	144.0
x	127.6	100.8	143.9
A	131.2	99.1	143.7
A	132.1	98.5	143.4
A	132.3	98.3	143.2
x	129.7	99.2	143.0

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
A	128.3	99.7	142.9
x	133.4	97.4	142.6
A	128.5	99.4	142.6
x	129.8	98.8	142.5
x	128.9	99.1	142.4
A	133.9	96.9	142.3
x	128.3	98.9	141.8
x	131.3	97.5	141.6
A	129.6	98.2	141.6
C	130.3	97.9	141.6
x	125.8	99.6	141.4
x	128.9	98.3	141.4
x	128.7	98.3	141.3
C	131.3	97.2	141.2
x	128.3	98.3	141.1
x	127	98.8	141.0
x	127.5	98.3	140.6
A	128.5	97.8	140.5
x	126.1	98.7	140.4
x	126.6	98	139.7
x	126.6	98	139.7
x	129.8	96.6	139.6
x	129.5	96.6	139.5
x	131	95.9	139.4
x	128.8	96.8	139.4
C	128.4	96.9	139.3
x	128.7	96.6	139.1
x	124.6	98.3	139.0
x	127.4	97.1	139.0
x	127.1	97.1	138.8
C	128.3	96.6	138.8
x	128.5	96.5	138.8
x	132.1	95	138.8
x	130.8	95.5	138.8
x	128	96.6	138.7
C	129.2	95.9	138.4
x	130.3	95.4	138.4
x	130.4	95.3	138.3
A	127.3	96.5	138.2
x	131.5	94.7	138.1
x	127.1	96.5	138.1
x	129.5	95.3	137.8
x	127.4	96.1	137.7
C	125.1	96.9	137.5
x	128.7	95.4	137.5
A	128.9	95.3	137.5
x	128.1	95.5	137.3
x	129.9	94.5	137.0

Advancement decision	Yield - q/ha - in LS	Yield - q/ha - in HS	DRIND Sorted descending
C	129	94.8	136.9
x	131.4	93.7	136.7
x	126	95.9	136.7
x	126.4	95.7	136.6
x	125.1	96	136.3
A	133.3	92.5	136.2
x	124.1	96.3	136.2
x	125.2	95.8	136.1
x	124.9	95.7	135.8
x	127.5	94.5	135.7
x	124.9	95.5	135.6
x	127.3	94.5	135.5
x	127.7	94.2	135.4
C	124.5	95.5	135.3
x	124.7	94.6	134.3
x	127.9	93	133.9
x	126.9	93.1	133.5
C	127.5	92.8	133.4
x	124.6	94	133.4
x	125	93.5	133.0
x	126.1	92.8	132.7
x	131.3	89.9	131.7
C	123.4	92.8	131.2
x	124.5	92.2	131.0
x	125.9	91.4	130.7
x	124.2	92.1	130.7
C	121.3	92.8	130.1
x	125.5	91	130.0
C	121.4	92.4	129.6

Table 6. Efficiency of DRIND in selecting more drought tolerant hybrids as compared with normally advancement process

FAO maturity group	Testing stage	% of normally advanced hybrids which are placed in the first top third of the values of DRIND ordered descending in tables 2-5
480	R1	76.2
480	R2	65.0
550	R1	50.0
550	R2	78.9

CONCLUSIONS

Percents of normally advanced hybrids which are placed in the first top third of the DRIND ordered descending were relatively high suggesting that selection for improved drought tolerance (for better adaptability) of the hybrids by using DRIND could be at least as efficient as the normal advancement

process based of parallel selection in two outbreaks or/and visual selection on the graph representing the linear regression between the two outbreaks.

Additionally DRIND has several essential advantages; selection using two breakouts in parallel, being some burden and confusing, is avoided; it is more precise than visual selection on the graph being an exactly computed index which can be ordered descending and making the selection process easier and more objective.

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