https://doi.org/10.29042/2020-10-5-93-97

Helix (2020) 10 (5): 93-97

Assessment of the Correlation between Chlorophyll Content and Drought Resistance in Corn Cultivars (Zea Mays).

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Received: 09th September 2020, Accepted: 14th October 2020, Published: 31st October 2020

Abstract

The most critical issue regarding plants production is drought stress. Due to the near dating amongst leaves chlorophyll content within the plant achievement prices for photosynthesis and their resistance against the environmental strain, it may be beneficial to decide on varieties (cultivars) associated with superfluous chlorophyll content in the breeding (Revisory) programs. Thus, to assess the relationship between chlorophyll strain resistances in the experimental maize cultivars, we used 4 replications of five Maize genotypes with both irrigation and dry farming using the randomized entire block layout in 2016-17 agricultural year in Ardabil. We used Fernandez strain tolerance indices to calculate the strain tolerance of different genotypes. Besides, we used CCI-2 hundred tool to measure the leaves chlorophyll content. The results showed that strain-resistant genotypes which provided superior capability yield as well as 1.2 fold chlorophyll content compared with the resistant cultivars. Accordingly, genotypes 1 and 5 had the maximum chlorophyll content and the highest quantity of yield and thus, these genotypes are the maximum resistant genotypes against the drought. Moreover, further studies are required to choose genotypes compatible with dry situations.

Keywords

Chlorophyll Content, Stress Resistance, Drought, Correlation

Introduction

Maize is among the most vital food grains and bioenergy crops (Ammani, Ja'Afaru et al. 2012, Khayatnezhad and Gholamin 2012, Song, Jin et al. 2019), with a mean 157 million ha harvested area and 781 Mt production during 2000 to 2014 (Bassu, Brisson et al. 2014). Maize may grow in the areas with an annual precipitation levels of 200 mm (Ramirez-Cabral, Kumar et al. 2017). Moreover, maize cultivation has gradually spread to semi-arid and arid areas in the recent years, which is a considerable proportion of the land resources. Drought stress significantly impact the crop growth and yield (Farooq, Wahid et al. 2009). In semi-arid and arid climates, soil water supply reduction or a high rate of transpiration may lead to plants drought (Somerville and Briscoe 2001). Drought significantly affects metabolic process, most importantly photosynthesis (Kalaji, Jajoo et al. 2016, Liu, Guo et al. 2018). High levels of chlorophyll are associated with stress resistance in plants. (Khayatnezhad and Gholamin 2012). Fluorescent Chlorophyll measurement is a fairly new technology used in the recent years in order to assess the impacts of different stresses on efficiency of photosynthesis (or yield) of farm (or field) leaves as well as the greenhouse conditions convention (Baker and Rosenqvist 2004, Zobayed, Afreen et al. 2005). Thus, it seems vital to adopt appropriate strategies to reduce the difference between the yield potential and actual yield of crops considering the patterns of drought changing occurrence (ORT 2002).

The following factors affect the chlorophyll content:

a) Light intensity affects in the leaf chlorophyll content the chloroplasts within a cell. The chlorophyll content is higher in shadow-friendly plants compared with the light-friendly plants.
b) The temperature affects chlorophyll efficiency or yield. In other words, the highest chlorophyll yield is achieved in 30-45°C in C4 plants and 10-25°C in C3 plants.
c) The leaf age is directly related with chlorophyll content. The photosynthesis rate increases since the leaf emergence until full growth and then gradually declines.

Photosynthetic power is lost in old and yellow leaves due to chlorophyll loss (Rahneshan, Nasibi et al. 2018). Water is vital in the chlorophyll synthesis.

The chlorophyll content increases following a heavy rain, though its value declines during the arid time. Additionally, in the case of water-saturated soil, the chlorophyll content of leaves reduces. Maintain the maximum chlorophyll content requires high water content (Khayatnezhad and Gholamin 2012). Under environmental stress, chlorophyll content decreases in the susceptible cultivar leaves in the green plants, though it increases in the leaves of resistant cultivar leaves and the color of susceptible cultivar is darker green. Rapid chlorophyll loss in the cold-sensitive cultivars leads to photosynthetic activity reduction. Several environmental factors lead to plant chlorosis or yellowing. The present study was conducted to assess correlation between the chlorophyll content of leaf and the resistance against drought stress in Corn cultivars in Ardabil province.

Methods and Materials

We carried out an Experiment to assess the relationship between the leaf chlorophyll substance and the dry spell resistance within the maize lines by evaluating five cultivars of maize (specified in Table 1) in four replications with a randomized total piece plan (counting two full water system and dry spell push on the crops in Ardabil, Iran in 2016-17.

Table 1: Genotype Names used in Test

NO.	Genotype
1	Single cross 704
2	Single cross 647
3	Golden west
4	BC666
5	OS499

Seeds were manually sown in five rows with 50 cm of each other in 2 m length. Each plot had an area of 4 square meters. The farm was irrigated immediately after planting to saturate the soil with water in the root developing zone.according to the treatment, the germination was easily done. Flag leaves' chlorophyll content was measured using a chlorophyll meter tool CCI-200 (Opti-science company). This tool is able to measure the leaves' chlorophyll content index.

To determine the resistance and sensitivity of the evaluated lines in drought conditions, the stress tolerance index (STI) was used (Fernandez 1993).

$$STI=(Y_{Pi})(Y_{Si})/(Y_{P})^2$$

where YPi is the genotype yield under no surface stress (i.e. , adequate irrigation), YSi is the genotype yield under sufrcae stress surface (i.e., lack of surface irrigation), and YP is the average yield in without surface stress.

We used the average data of eafch plot to measure variance analysis. Analysis of variances was calculated using MSTATC and SPSS-26 statistical softwares. Since no significant difference was observed between the blocks, we carried oyt an analysis of variance for a complete randomized block design experiment. Multidomain Duncan's comparison test was used to compare the obtaind data. Lastly we used Microdsoft Excel to draw the charts.

Results

According to analysis of variance (Table 2), replication significantly affects yield at 0.05 level, while genotype, condition, and the interaction between genotype and condition significantly affect the yield at 0.01 level. Regarding chlorophyll, except replication which is non-significant, the other factors significantly affected the chlorophyll at 0.05 level. The average chlorophyll content index in full irrigation and drought conditions were 56.42 and 44.05 respectively. We tested the corn genotypes in terms of their leaves' chlorophyll content index which were significantly different at 1% level. The mentioned results indicate the studied cultivars genetic richness.

Table 2: Results of Analysis of Variance

		MS	
S.O.V	df	Yield	chlorophyll
Replication	2	0.24*	12.28^{ns}
condition	1	38.27**	2865.27*
Genotype	4	8.95**	700.92*
G×C	4	0.56**	68.52*
Error	13	0.072	14.49
CV	-	6.01	7.58

The average chlorophyll content of different genotypes (Figure 1) showed that in both full irrigation and drought stress, the highest chlorophyll content belonged to genotype No. 2 with 68.2 and 60.27 chlorophyll content, respectively. On the other hand, genotype 5 had a low cholorhyl content with full irrigation at 58.1 which showed the least decline in case of drought stress which proves it as one of the most drought stress resistant. Conversly, genotype 4 is

  Helix E-ISSN: 2319-5592; P-ISSN: 2277-3495

the most drougt sensitive due to the highest chlorophyll loss, while ranked fourth in terms of chlorophyll content in the irrigation.

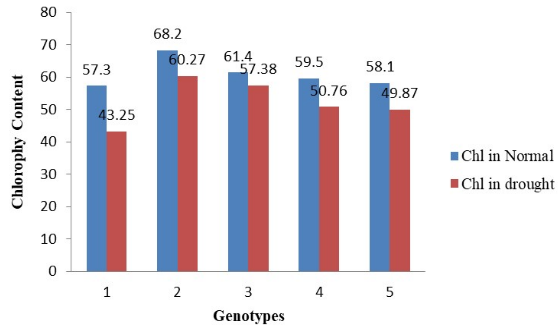

Figure 1: The Comparison of Leaf Chlorophyll Content of Cultivars in terms of Normal and Stress Conditions.

Results of the stress tolerance index (STI) are presented in Table 3. Higher STI values indicat higher drought resistnace of the genotype leading to higher potential yield of the genotype. Genotypes 1 and 5 had the highest STI and thus considered as the most resistant genotypes. On the other hand, genotypes 2 and 3 are the most sensitive genotypes.

Table 3: Drought Tolerance Index Rates

NO	Yp	Ys	STI
1	4.33	3.85	0.88
2	4.84	3.60	0.74
3	4.81	3.52	0.73
4	5.27	4.19	0.79
5	5.35	4.28	0.80

According to Fernandez (Fernandez 1993) plants genotypes are divided into four groups based on their yield in different environments than plants in two environments:

1- High yield genotypes in both stress and non-stress environment (group A).
2- High yield genotypes only in non-stress environment (group B).
3- High yield genotypes only in stress environment (group C).
4- Low yield genotypes in both stress and non-stress environment (group D).

Fernandez believes in the appropriate selection criterion of group A which is distinguished from other groups. Higher STI values show higher drought resistance of a given genotypes leading to higher yield potential.

For Comparison the mean of chlorophyll content and yield are shown shown in Figure 2. Accordingly, Genotype 1 and 5 present the highest yield and are thus most resistant against drought stress considering STI index.

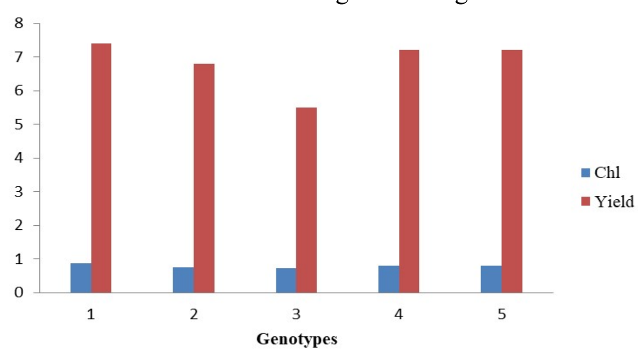

Figure 2: The Chart of Interaction between Chlorophyll and Yield.

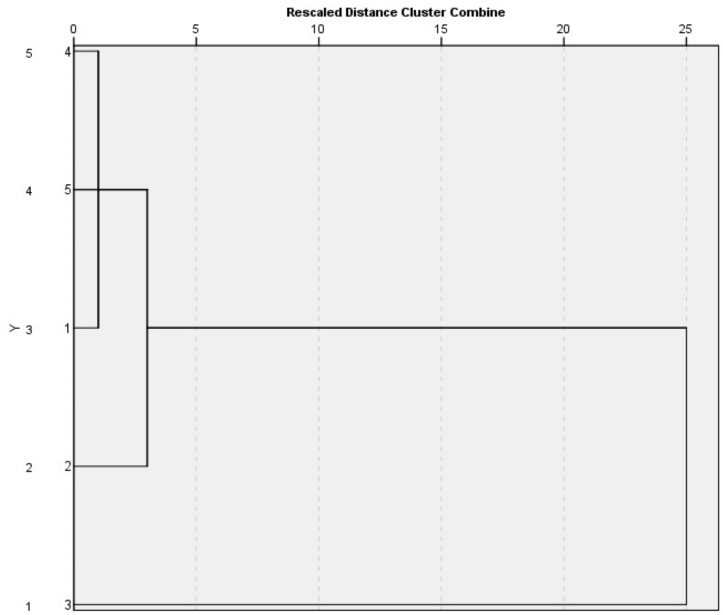

Figure 3: Dendogram of Cluster Analysis based on STI and Yield

Cluster analysis according to Yield and STI classified genotypes to two major clusters (Figure 3). Genotype 3 is mentioned in one group. Results demonstrated that this genotype is more drought-sensitive and provides low yield.

Discussion

Shahriari (Shahriari 1999) reported that under drought stress, the chlorophyll content increases in resistant cultivars leaves. Based on our comes about, it may be concluded that cultivars 8 and 10, i.e., stress-tolerant cultivars, the chlorophyll substance was expanded and driven to higher push resistance in these cultivars and at last to get the most elevated surrender utilizing these two cultivars. Also, Sydaq and et al. (Khayatnezhad and Gholamin 2012) showed that conisdeing the alteration of drought occurrence pattern during the plant growth period, its tall surrender and solidness beneath soil water shortfall, the most excellent choice is utilizing dry season tolerant cultivars. Appropriately, both genotypes 8 and 10 may be chosen due to their tall abdicate. Khazaei (Khayatnezhad and Gholamin 2012) expressed that the water shortage stretch brigngs a arrangement of physiological impacts depending to the sort and seriousness of harm as well as the plant resitance and stretch concentrated. Thus, in case of chloroplast damage in the leaves, the photosynthesis process maynot be continued, accordingly this selection may be useful for researchers. It appears that in Genotypes 1 and 5, the genes of drought resistance exist and thus they may be used in breeding programs agianist drought resistance. Yet, further studies are required to chose drought resistant genotypes.

Conclusion

The conventional breeding methods of identifying and developing crops with drought-resistant properties are impractical as they are both costly and time-taking, and above all, the process is complicated. Thus, investigating existing varieties to identify cultivars with optimal drought-tolerance by screening under arid conditions seems to be a viable solution. The results showed that strain-resistant genotypes which provided superior capability yield as well as 1.2 fold chlorophyll content compared with the resistant cultivars. Accordingly, genotypes 1 and 5 had the maximum chlorophyll content and the highest quantity of yield and thus, these genotypes are the maximum resistant genotypes against the drought. Moreover, further studies are required to choose genotypes compatible with dry situations.

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