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# The effect of Dry Season Stretch on Chlorophyll Content and RWC of Wheat Genotypes (*Triticum durum* L.)

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## ABSTRACT

Drought stress is considered among the essential environmental stresses. Moreover, Wheatfields are under the danger of drought stress. In 2013, an experiment with the design of a randomized complete block (RCB) with 3 replications was performed in Ardabil Province, Iran, to assess the impact of drought stress on RWC (relative water content) as well as the chlorophyll content of the wheat genotypes. Six wheat varieties were evaluated in this study, which include Kavir, Sardari, Varinac (resistant varieties), Tajan, Marvdasht, and Ghods (susceptible varieties). At the germination stage, water was withheld to apply drought stress. The results showed the difference between susceptible and resistant genotypes in terms of RWC, chlorophyll content, K, and Na ions concentration. Thus, these measures may be used to screen wheat drought tolerance.

**KEY WORDS:** WHEAT, DROUGHT STRESS, RELATIVE WATER CONTENT, CHLOROPHYLL CONTENT, MINERAL ELEMENT.

## INTRODUCTION

The chlorophyll content is among the important factors that impact the photosynthetic capacity. Drought stress may reduce or does not affect the plants' chlorophyll content in different plant species whose intensity is related to the intensity and duration of stress (Rensburg and Kruger, 1994; Kyparissis et al., 1995; Jagtap et al., 1998). The leaf chlorophyll content is an indicator of the photosynthetic capability of the tissues of plants (Nageswara et al., 2001; Wright et al., 1994). Flooding irrigation near one centimiter above the soil surface caused senescence and reduction in leaves' chlorophyll content. Schelmmer et al. (2005) reported that drought stress does not significantly affect maze leaf chlorophyll content. They concluded that turger pressure reduction due to water deficit alters the quantity of far-red light which crosses the leaf and thus changes the chlorophyll meter device measurements (Gholamin and Khayatnezhad 2020). Drought stress increment increased the light reflection from the leaf surface. Barry et al. (1995) reported a similar result for wheat. Moreover, Fotovat et al. (2007) demonstrated that severe drought stress would significantly reduce the chlorophyll content of wheat leaves.

In the mid-1980s, RWC was developed as the best criterion to show the water status of plant used afterward in place of water potential. RWC is related to the cell volume and thus may accurately indicate the water absorbance and consumption balance through transpiration. Schonfeld et al. (1988) proved that high RWC wheat cultivars show higher resistance when subjected to drought stress. In general, osmoregulation appears as a major mechanism to preserve the turgor pressure in the majority of plant species when facing water loss, which allows the plant to absorb

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water and continue its metabolic activities (Gunasekera and Berkowiz, 1992). Moreover, Zlatko Stoyanov (2005) showed that 14 days of drought stress until reaching a soil potential of -0.9 Mpa strongly decreased the turger pressure and osmotic potential in the first bean leaf. Ramos et al. (2003) demonstrated the significant RWC reduction in the bean leaves when facing drought stress. Lazacano-Ferrat and Lovat (1999) exerted drought stress to the bean plant and evaluated stem RWC 10, 14, and 18 days after withholding irrigation. They reported a significantly lower RWC in comparison to control plants. Gaballah et al. (2007) exerted anti transpirant matters on 2 Sesame cultivars, namely Shanavil 3 and Gize 32. They witnessed this matter via water, avoiding transpiration through the leaves, which resulted in an RWC increment in the mentioned cultivars.

No information is exists regarding the micronutrient spatial distributions in the grasses' raising leaves in drought conditions in addition to the comparative reactions of diverse species when subjected to salinity and drought stresses (Yuncai e al., 2007). The significant role of metal ions (paramagnetic ions) is well known in water binding in plants ( Joseph et al., 1996). Potassium plays a vital role in water relations and stomatal activity (Marchner, 1995; Mengel and Kirkby, 2001). K+ presence in the plant reduces with diminishing soil water content since K+ mobility decreases in such conditions. The plants' capacity to keep high potassium concentrations in tissues appears to be a valuable characteristic to consider in the refining genotypes for the purpose of high resistance of drought stress. Recently, it has been found that intracellular Ca2+ regulates the plant's response to salinity and drought (Gholamin and Khayatnezhad 2020). Also, it has been demonstrated in the transduction of signals of salt- and drought-stress in plants, which play a crucial role in the osmoregulation in such conditions (Knight et al., 1997; Bartels and Sunker, 2005 Sallam et al 2019).

In many plants, high sodium level in an exterior solution reduces both Ca2+ and K+ tissue concentrations (Hu and Schmidhalter, 1997). This reduction may be attributed to Na+ and K+ antagonism at the roots uptake sites, Na+ effect on K+ transportation into the xylem (Lynch and Läunchli, 1984), or the uptake processes inhibition (Suhayda et al., 1990). Not much evidence is known regarding the drought impact on Mg in the plants. Hu and Schmidhalter (2005) reported that drought decreases the uptake of Mg.This study is intended to define chlorophyll content, RWC, and the mineral elements of the Wheat leaves when subjected to drought stress in Karaj, Iran.

## MATERIAL AND METHODS

In 2008, to assess the impact of drought stress on the chlorophyll content, RWC (relative water content), and the mineral element of six Wheat genotypes, we conducted an experiment with three replications using randomized complete block design in Karaj, Iran. This study included six Wheat genotypes (Sardari, Kavir, Tajan, Varinac, Marvdasht, and Ghods). We exerted drought stress through water withholding at the anthesis stage. A chlorophyll meter device was used to measure the chlorophyll content. For RWC calculation, we weighted the Leaf fresh samples, then flooded the fresh leaves in distilled water and directly heated them for 48 h at 70 °C. We weighted the leaves again. Finally, we calcuated RWC based on Dhopte and Manuel (2002):

$$RWC = (FW\text{-}DW/TW\text{-}DW) \times 100$$

Where, FW is fresh weight, DW is dry weight and TW is turger weight of leaf samples. Na and K were determined by flame photometry (Eppendorf Flex 6361 model). Ca and Mg were determined by potentiometric titration with EDTA solution.

## RESULTS AND DISCUSSION

**Change of Leaf Chlorophyll:** Drought stress significantly ($p<0.01$) affected the chlorophyll content of leaf genotypes (Table 1). The results of this study showed that the highest chlorophyll content belongs to resistant genotypes, and the Kavir genotype as a resistant genotype had significantly higher chlorophyll content (51.89 SPAD) under drought stress. Tajan and Ghods genotypes, as susceptible genotypes, had a significantly low chlorophyll content. Water deficit may damage chlorophyll and inhibit chlorophyll synthesis (Lessani and Mojtahedi, 2002).

Table1. Mean comparisons of effect of genotypes on measured trails in drought stress

| Treatments | Chlorophyll content | RWC | K | Na | Ca | Mg |
|---|---|---|---|---|---|---|
| | Resistant genotypes | | | | | |
| Sardari | 49.34b | 74.43a | 5a | 4.16a | 1.2a | 0.26c |
| Kavir | 51.89a | 79.96a | 5a | 2.5c | 0.7c | 2.88a |
| Varinac | 50.07b | 72.2ab | 5a | 4.16a | 0.66c | 0.32c |
| | Susceptible genotypes | | | | | |
| Tajan | 45.01d | 64.3bc | 3.75c | 3.66ab | 1b | 0.56bc |
| Marvdasht | 46.98c | 73.2ab | 2.5d | 2.91bc | 0.3d | 0.92b |
| Ghods | 44.26d | 59.3c | 3.9b | 2.83c | 1.13ab | 0.29c |

Moreover, a group of investigators have stated that leaf pigment damage caused by water deficit (Montagu and WOO, 1990; Nilsen and Orcutt, 1996). Mensah et al. (2006) exposed Sesames to drought stress and showed that it leads to increased leaf chlorophyll, which remains unchanged. Besides, Beeflink et al. (1985) revealed increased chlorophyll content in onion when subjected to drought stress. Water deficit may reduce chlorophyll content through heat or drought stress through producing ROS (reactive oxygen species), including H2O2 and O2-, which may cause lipid peroxidation and hence, chlorophyll damage (Mirnoff, 1993; Foyer et al., 1994). Similarly, reduced chlorophyll content caused by the change of the leaf's green color into yellow leads to an increment of the incident radiation reflectance (Schelmmer et al., 2005 Sallam et al 2019). Apparently, the mentioned mechanism may guard the photosynthetic system when facing stress. Lawlor and Cornic's (2002) study showed that reducing carbon assimilation, which confronts water deficit led to the destruction of photosystem 2 D1 protein (Xian-He et al., 1995) without any currently known explanation.

RWC was significantly affected by drought on the genotypes ($p<0.01$) (Table 1). The highest values belonged to Sardari and Kavir genotypes with 74.43 and 79.96%, respectively, while the lowest RWC belonged to Ghods genotype with 59.3%. Leaf RWC is among the best biochemical/ growth indexes, which show the severity of stress (Alizade, 2002). The RWC rate in highly resistant plants against drought is above other plants. Alternatively, plants with higher yields when subjected to drought stress require to have a high RWC. Thus, according to the results of this study, the mentioned genotypes, classified as genotypes with high and medium yield when subjected to drought stress, would show higher RWC. Plant RWC reduction when subjected to drought stress depends on its vigor decrement, which is the case in many plants (Liu et al., 2002). In the case of water deficit, the cell membrane is vulnerable to alterations including reduced sustainability and penetrability (Blokina et al., 2003). A microscopic study of dehydrated cells showed injuries such as cell membrane cleavage and cytoplasm content sedimentation (Blackman et al., 1995). Possibly, under such states, osmotic adjustability is decreased (Meyer and Boyer, 1981). In this case, it appears that the concentration of proper solutes is not enough to maintain the membrane.

Change of Mineral Elements: The current paper indicated that the varying of the mineral element among genotypes when subjected to drought stress (Table 1). Accordingly, tolerant genotypes provided the maximum potassium concentration, while susceptible genotypes provided the maximum sodium concentration. Though Ca and Mg differences were not significant between susceptible and resistant genotypes. K and Mg deficiency may lead to a considerable reduction in the metabolism of photosynthetic C as well as fixed carbon utilization (Mengel and Kirkby, 2001). Due to the distinctive impacts of K and Mg on the photo-oxidative damage in the plants which are matured in marginal conditions, including chilling, salinity, and drought may be worsened in the case of low K or Mg soil supply. The sufficient potasium supply beneficial effect was attributed to the K role in photoassimilates retranslocation in roots, which caused superior root growth when subjected to drought stress (Egilla et al., 2001). Considering these results, we can attribute the K protective effects in drought stress to its inhibitory effects, which makes the plants more sensitive to the drought stress.

## CONCLUSION

Crop plants' productivity and survival depend on their exposure to environmental stresses and their adaptive mechanisms in order to prevent or tolerate stress. Mounting evidence shows that the plant's mineral nutritional status considerably impacts its adaptation ability when subjected to hostile environmental conditions. In the current study, we discussed the effect of the mineral nutritional status of the tolerant genotype in adapting to a state of drought stress. The present study was intended to investigate the characteristics of resistant plants against drought stress. Results of the current study demonstrated that RWC, chlorophyll content, the concentration of K, and Na ions were different between susceptible and resistant genotypes. Hence, these measures may be utilized as a screening tool to assess Wheat drought tolerance.

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