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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.03
TPI 2019; 8(5): 647-650

www.thepharmajournal.com
Received: 13-03-2019
Accepted: 15-04-2019

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Effect of drought and high temperature stress on greengram (*Vigna radiata* (L.) Wilczek) at vegetative stage

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Abstract
Drought and high temperature stress are the most acute environmental stresses presently affecting the agriculture. In this study the combined effects of drought and high temperature stress on photosynthetic pigments such as chlorophyll a, chlorophyll b and total chlorophyll content, relative water content and chlorophyll stability index (CSI) were determined to identify the genotypic differences under combined stress condition. The greengram genotypes were exposed to drought and high temperature stress during vegetative stage by withhold the irrigation to maintain a field capacity of 50% and sowing the seeds to coincide with high temperature stress (> 36±2°C). The cholorophyll content, relative water content and chlorophyll stability index were get increased in the tolerant greengram genotypes COGG 1332, VGG 15029, VGG 16069, VGG 17003 and VGG 17004 which could be potential donors in breeding programmes to develop the drought and high temperature tolerant greengram, suitable for the changing environment.

Keywords: Greengram, drought, high temperature, vegetative stage, chlorophyll

1. Introduction

Greengram is one of the important pulse crop after chickpea and pigeonpea (Ranawake *et al*., 2011) [14]. It fixes nitrogen, inhibits soil erosion and requires low inputs. Abiotic stress conditions like drought and high temperature are one of the major factors due to climate change, which affect the plant growth and productivity. Photosynthesis is one of the important physiological phenomena impaired by drought and high temperature stress in plants (Farooq *et al*., 2009) [5]. The reduction in photosynthesis is mainly due to decrease in leaf expansion, improper functioning of photosynthetic machinery and leaf senescence (Wahid *et al*., 2007) [16]. The carbon dioxide (CO_2) availability decreased under drought condition due to stomatal closure makes the plant more susceptible to photo damage (Lawlor and Cornic, 2002) [8]. Under water limited condition plants shows negative changes in photosynthetic pigments which causes damages in photosynthetic machinery (Fu and Huang, 2001) [7] and alter the activity of the photosynthetic enzymes (Monakhova and Chernyadev, 2002) [10]. Similarly high temperature stress also affects the process of photosynthesis by reducing the photosynthetic pigments and activity of photsystem II (Camejo *et al*., 2006) [3] and impairs the regeneration capacity of RuBP (Wise *et al*., 2004) [17] and thus it leads to considerable loses in plant growth and yield.

In this study the impact of drought and high temperature on photosynthetic pigments like chlorophyll a, chlorophyll b and total chlorophyll content, relative water content and CSI were quantified under drought and high temperature stress.

2. Materials and Methods

2.1 Plant material and growing condition

The greengram genotypes (Table 1) were sown in pot to study the influence of drought and high temperature stress on the vegetative phase of greengram. Plants were imposed with drought stress (50% field capacity for 5 days) combined with high temperature stress (36 ± 2°C) during vegetative Stage (20 days after sowing).

Table 1: Details of greengram genotypes used in this study

S. No.	Source	S. No.	Source
1.	CO 8	16.	VGG 16069
2.	COGG 1319	17.	VGG 17001
3.	COGG 1332	18.	VGG 17002
4.	COGG 1339	19.	VGG 17003
5.	LGG 607	20.	VGG 17004
6.	PUSA 9072	21.	VGG 17006
7.	TARM 1	22.	VGG 17009
8.	VBN(Gg) 2	23.	VGG 17010
9.	VBN(Gg)3	24.	VGG 17019
10.	VGG 10008	25.	VGG 17036
11.	VGG 15029	26.	VGG 17037
12.	VGG 15036	27.	VGG 17045
13.	VGG 16005	28.	VGG 17049
14.	VGG 16008	29.	VMGG 12005
15.	VGG 16027		

2.2 Measurement of relative water content
Relative water content (RWC) of leaf was measured by using the formula RWC (%)=((FW-DW)/(TW-DW)) x 100; (FW, fresh weight; TW, turgid weight; dw, dry weight) (Barrs and Weatherley, 1962) [2].

2.3 Measurement of chlorophyll content
Greengram leaf samples were homogenized with 80% acetone and centrifuged to quantify the chlorophyll content, the absorbance was measured at 663 and 645 nm for chlorophyll a (chl a) *a*, chlorophyll b (chl *b)*and total chlorophyll content using UV-VIS spectrophotometer (Eppendorf BioSpectrometer kinetic) (Yoshida *et al*., 1971) [18].

chl $a = 12.9(Abs_{663}) - 2.69(Abs_{645})$ x (V/1000xW)

chl $b = 22.9(Abs_{645}) - 4.68Abs_{663})$ x (V/1000xW)

(V, volume; W, tissue weight; *Abs*663, absorbance at 663 nm; *Abs*645, absorbance at 645 nm)

2.4 Measurement of chlorophyll stability index (CSI)
The chlorophyll stability index (CSI) was measured according to Murthy and Majumdar, 1962 [11]. The greengram leaf bits were taken in test tubes and distilled water was added in control tubes and hot water in treatment test tubes. Then the test tubes with hot water were kept in water bath for 30 min. Then the leaf bits were homogenized with 80% acetone and centrifuged to analyse the CSI. Absorbance was measured at 652 nm in UV-VIS spectrophotometer (Eppendorf BioSpectrometer kinetic).

CSI(%) = (Total chlorophyll content (treated)/Total chlorophyll content (control))x100.

3. Results and discussion
3.1 Relative water content
Relative water content (RWC) is one of the methods to measure the plant water status in plants (Deivanai *et al*., 2010) [4]. The reduction in leaf water status in plants is one of the important effects under drought stress condition (Farooq *et al*., 2010) [6]. During drought and high temperature stress the reduction in plant vigour is mainly due to decrease in RWC, this was observed in various plant species (Liu *et al*., 2002) [9]. The loss of turgidity due to reduction in RWC leads to closure of stomata this in turn reduced the plant photosynthetic rate. Drought and high temperature (HT) stress significantly reduced the relative water content in the greengram genotypes. Decrease in RWC under drought and high temperature stress is a characteristics symptoms of stress condition in plants. Under stress, the greengram genotypes VGG 15029 (77.12%), VGG 17003 (72.89%) and VGG 17009 (72.70%) possessed a higher RWC when compared to the genotypes VGG 17037 (13.27%), VGG 17036 (13.77%), identifying the former to be tolerant genotypes (Fig. 1). The decrease in RWC might be induced by water deficit condition in the soil as a consequence of water lost in plants through the stomata (Abdalla and El-Khoshiban, 2007) [1].

3.2 Chlorophyll content
The decrease in chl *a*, chl *b* and total chl content under drought and high temperature stress may be due to reactive oxygen species (ROS) induced oxidative stress or its biosynthesis inhibited due to increase in temperature and drought condition (Prasad *et al*. 2011) [13]. Under stress the greengram genotypes VGG 15029 (1.82 mg g^{-1} FW), VGG17004 (1.73 mg g^{-1} FW) possessed higher chl *a*; VGG 17004 (1.42 mg g^{-1} FW), VGG 15029 and VGG 16069 (1.16 mg g^{-1} FW) possessed higher chl b; and total chlorophyll content was higher in VGG 17004 (3.15 mg g^{-1} FW) (Fig. 2, 3, 4). Nahar *et al*. (2015) [12] reported that the chl *a*, chl *b*, and total chl content in drought-affected greengram plants decreased when compared to control.

3.3 Chlorophyll stability index (CSI)
Chlorophyll Stability Index (CSI) is also one of the important parameter that reflects the ability of plants to sustain photosynthesis under stress condition (Sayed, 1999) [15]. CSI is higher in the genotypes VGG 17004 (75.33%), COGG 1332 (74.84%), VGG 15029 (74.53%) and lower in the genotypes VGG 17037 (38.06%) and VGG 17036 (38.10%) (Fig. 5).

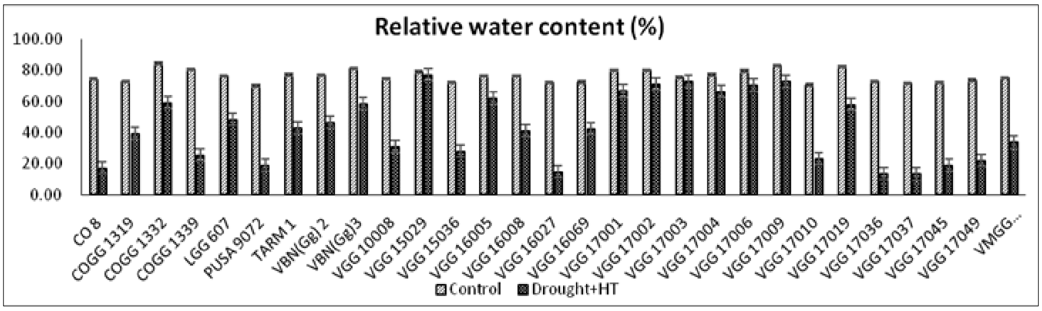

Fig 1: Relative water content in greengram genotypes under drought and high temperature stress

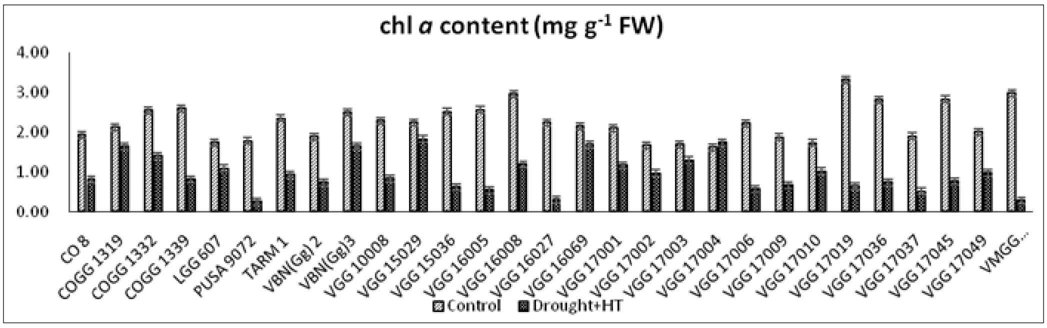

Fig 2: Chl *a* content in greengram genotypes under drought and high temperature stress

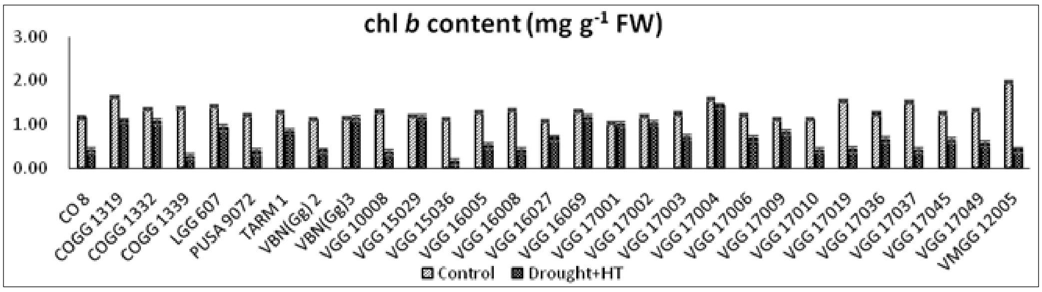

Fig 3: Chl *b* content in greengram genotypes under drought and high temperature stress

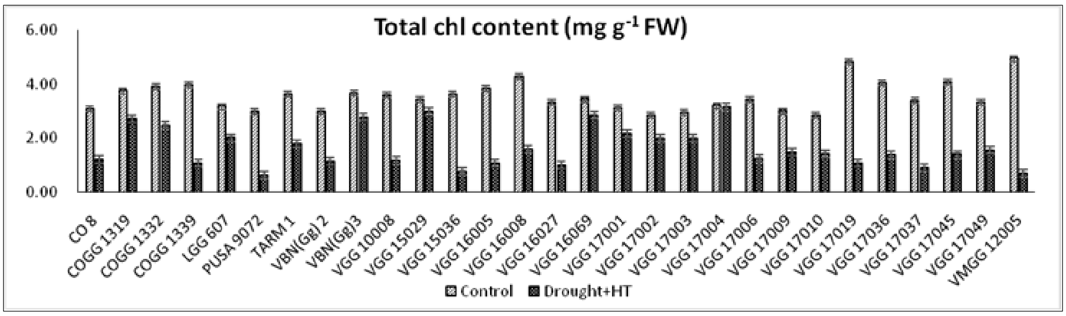

Fig 4: Total chlorophyll content in greengram genotypes under drought and high temperature stress

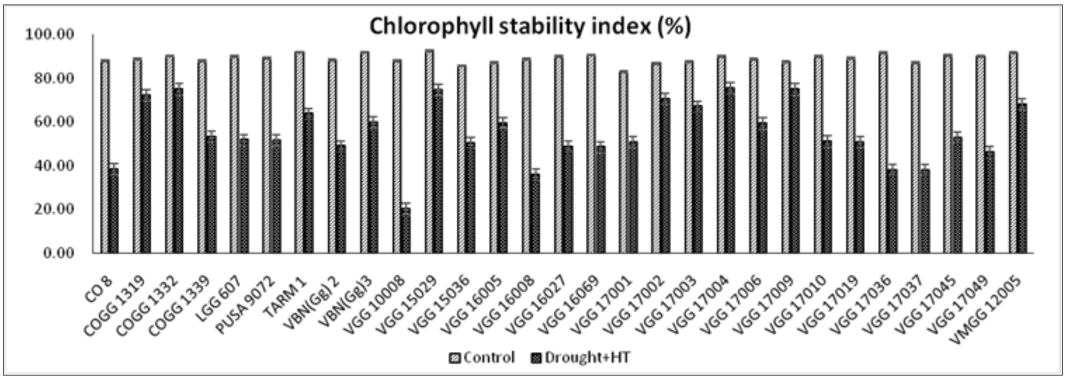

Fig 5: Chlorophyll stability index (CSI) in greengram genotypes under drought and high temperature stress

4. Conclusion

The present study revealed that under combined drought and high temperature stress the relative water content, photosynthetic pigments such as chl *a*, chl *b*, total chl content and chlorophyll stability index were increased in tolerant greengram genotypes when compared with the susceptible greengram genotypes under drought and high temperature stress. Therefore the tolerant genotypes such as COGG 1332, VGG 15029, VGG 16069, VGG 17003 and VGG 17004 were showed tolerant traits to withstand under drought and high temperature stress.

5. Acknowledgement

We thank Department of Science and Technology (DST) - Science and Engineering Research Board (SERB), New Delhi for financial support. We would like to thank National Pulses Research Centre (NPRC), Vamban, Pudukottai for providing the greengram seed material.

6. References

1. Abdalla MM, El-Khoshiban NH. The influence of water stress on growth, relative water content, photosynthetic pigments, some metabolic and hormonal contents of two *Triticium aestivum* cultivars. Journal of Applied Sciences Research. 2007; 3(12):2062-2074.
2. Barrs HD, Weatherley PE. A re-examination of the relative turgidity technique for estimating water deficits in leaves. Australian Journal of Biological Sciences. 1962; 15(3):413-428.
3. Camejo D, Jiménez A, Alarcón JJ, Torres W, Gómez JM, Sevilla F. Changes in photosynthetic parameters and antioxidant activities following heat-shock treatment in tomato plants. Functional Plant Biology. 2006; 33(2):177-187.
4. Deivanai S, Devi SS, Rengeswari PS. Physiochemical Traits as Potential Indicators for Determining Drought Tolerance during Active Tillering Stage in Rice (*Oryza sativa* L.). Pertanika Journal of Tropical Agricultural Science, 2010, 33(1).
5. Farooq M, Wahid A, Kobayashi N, Fujita D, Basra SMA. Plant drought stress: effects, mechanisms and management. In Sustainable agriculture. Springer, Dordrecht, 2009, 153-188.
6. Farooq M, Wahid A, Lee DJ, Cheema SA, Aziz T. Drought stress: comparative time course action of the foliar applied glycinebetaine, salicylic acid, nitrous oxide, brassinosteroid and spermine in improving drought resistance of rice. Journal of Agronomy and Crop Science. 2010; 196(5):336-345.
7. Fu J, Huang B. Involvement of antioxidants and lipid peroxidation in the adaptation of two cool-season grasses to localized drought stress. Environmental and Experimental Botany. 2001; 45(2):105-114.
8. Lawlor DW, Cornic G. Photosynthetic carbon assimilation and associated metabolism in relation to water deficits in higher plants. Plant, cell & environment. 2002; 25(2):275-294.
9. Liu Y, Fiskum G, Schubert D. Generation of reactive oxygen species by the mitochondrial electron transport chain. Journal of neurochemistry. 2002; 80(5):780-787.
10. Monakhova OF, Chernyadev II. Protective role of kartolin-4 in wheat plants exposed to soil draught. Applied Biochemistry and Microbiology. 2002; 38(4):373-380.
11. Murthy KS, SK. Majumdar: Modification of the technique for determination of chlorophyll stability index in relation to studies of drought resistance in rice. Current Science. 1962; 31:470-471.
12. Nahar K, Hasanuzzaman M, Alam M, Fujita M. Glutathione-induced drought stress tolerance in mung bean: coordinated roles of the antioxidant defence and methylglyoxal detoxification systems. AoB Plants, 2015, 7.
13. Prasad PVV, Pisipati SR, Momčilović I, Ristic Z. Independent and combined effects of high temperature and drought stress during grain filling on plant yield and chloroplast EF-Tu expression in spring wheat. Journal of Agronomy and Crop Science. 2011; 197(6):430-441.
14. Ranawake AL, Dahanayaka N, Amarasingha UGS, Rodrigo WDRJ, Rodrigo UTD. Effect of water stress on growth and yield of mung bean (*Vigna radiata* L.). Tropical agricultural research and extension. 2011; 14(4):76-79.
15. Sayed SA. Effects of lead and kinetin on the growth, and some physiological components of safflower. Plant growth regulation. 1999; 29(3):167-174.
16. Wahid A, Gelani S, Ashraf M, Foolad MR. Heat tolerance in plants: an overview. Environmental and experimental botany. 2007; 61(3):199-223.
17. Wise RR, Olson AJ, Schrader SM, Sharkey TD. Electron transport is the functional limitation of photosynthesis in field-grown Pima cotton plants at high temperature. Plant, Cell & Environment. 2004; 27(6):717-724.
18. Yoshida S, Forno DA, Cock JH. Laboratory manual for physiological studies of rice. Laboratory manual for physiological studies of rice, 1971.