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Research article

PHOTOSYNTHETIC STUDIES IN FOUR RED GRAM (CAJANUS CAJAN) CULTIVARS UNDER DROUGHT CONDITIONS

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ABSTRACT: Drought studies in different stages carried out from 39th day to 52nd day of plant age in natural conditions in four cultivable red gram genotypes. Among them PRG58 is showing drought resistant when induced drought stress and the remaining three cultivars are drought sensitive. The physiological parameters such as P_N, gs, E and C_i were measured and IRGA-LICOR and chlorophyll content with SPAD meter. The same PRG58 cultivar showing drought resistant against three sensitive cultivars. It is concluded that PRG58 is drought resistant cultivar.
Key words: IRGA, P_N, gs, E and C_i

INTRODUCTION

Photosynthesis is key process occurs in green plants, whether lower or higher plants occurring in oceans or on land as well as in photosynthetic bacteria (Taiz and Zeiger 2010; Pal et al 2012). The stress environment such as salinity, drought, and high temperature (heat) caused alterations in a wide range of physiological, biochemical and molecular process in plants. Photosynthesis is severely affected by such stresses. Since the mechanism of photosynthesis involves various components including photosynthetic pigments, ETS and CO_2 reduction pathways any change at any level caused by a stress may reduce the overall photosynthetic capacity of green plants (Ashiaf and Harris 2013). Diffusive resistance of stomata to co2 entry is probably the main factor limiting the photosynthesis (Boyer 1970). The effects of droughts and salt stress have been examined in various stresses tolerant and stress sensitive crops (Cheesmen 1988) in red gram. Finding efficient resistant genotype and understanding the mechanisms to tolerate periods of water deficient having goals to plant physiologists. In the present study I tried to assess the drought tolerance capacity based on drought resistant studies, PN rate and associated parameters in four red gram cultivars differing in sensitivity to drought stress.

MATERIALS AND METHODS

Four red gram cultivars i.e. PRG 58, TRG33, BRG2 and LRG30 have been sown in earthen pots containing 4.5 kg air dried red loamy soil in 1.5 kg sand in 3:1 portion. Plants were grown 38 days under natural photo period in controlled conditions in botanical garden. Pots of each cultivar have been divided into 8 replicates in a complete randomized block design. Among the 8 pots of cultivars first four cultivars have been imposed to vegetative stage drought by withholding water and remaining four cultivars meant for terminal stage drought (Flowering stage drought). In each variety the four cultivable varieties are imposed vegetative drought stress among them the first serial number cultivar is maintained as control, the remaining genotypes were maintained as treated from 39th day to 44th day of the plant age in each cultivar. The same is repeated during anthesis stage by withholding water from 51st to 57th day of plant age. The experimental values are collected for the treated periods of the red gram plants. After the treatment the drought induced plants have been recovered.

RESULTS

Photosynthetic measurements have been taken by portable gas exchange measuring system (IRGA-LICOR 6400-20). The values are recorded from 9am to 11am hours under the irradiance 100±µ mol temperature 32± 2°c ambient CO_2 concentration in 335 to 340 µ mol under relative humidity of 70% chlorophyll content was measured with SPAD meter said atmospheric conditions.

Table 1: photosynthesis

PARAMETERS	P_N	gs	C_i	E	RWC	W U E	chl
CONTROLE	0.512238	0.444762	138.9524	0.444762	0.06747	1.379524	2.704286
V.D	0.448571	0.411905	148.0476	0.422381	0.02619	1.345238	2.364286
F.D	0.43581	0.38581	158.0952	0.420952	0.01485	1.139048	2.208095
CD	0.001717	0.001304	61.72358	0.001318	0.00213	0.002133	0.104894

Table 2: photosynthesis of varieties

VARIETIES	P_N	gs	C_i	E	RWC	W U E	chl
PRG-58	1.269833	1.117	375.8333	1.185	0.08483	3.551667	6.781667
TRG-33	1.245	1.108333	384.1667	1.165	0.08	3.418333	6.516667
BRG-2	1.213333	1.083333	392.3333	1.101667	0.1116	3.293333	6.095
LRG-30	1.16	1.04	405.5	1.056667	0.1033	3.26	6.075
CD	0.006869	0.005215	246.8943	0.000988	0.0058	0.008532	0.419575

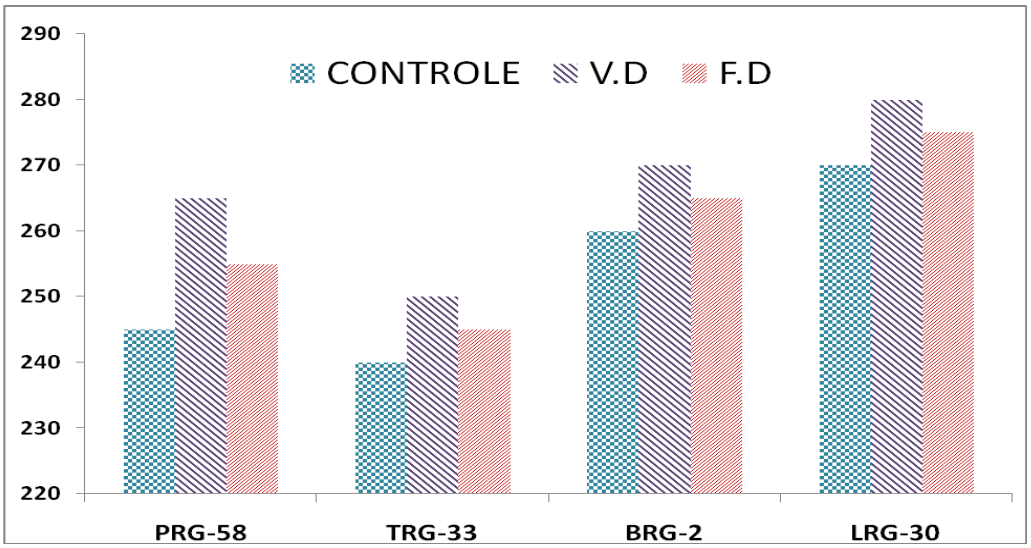

Figure 1: Total internal co2 concentration

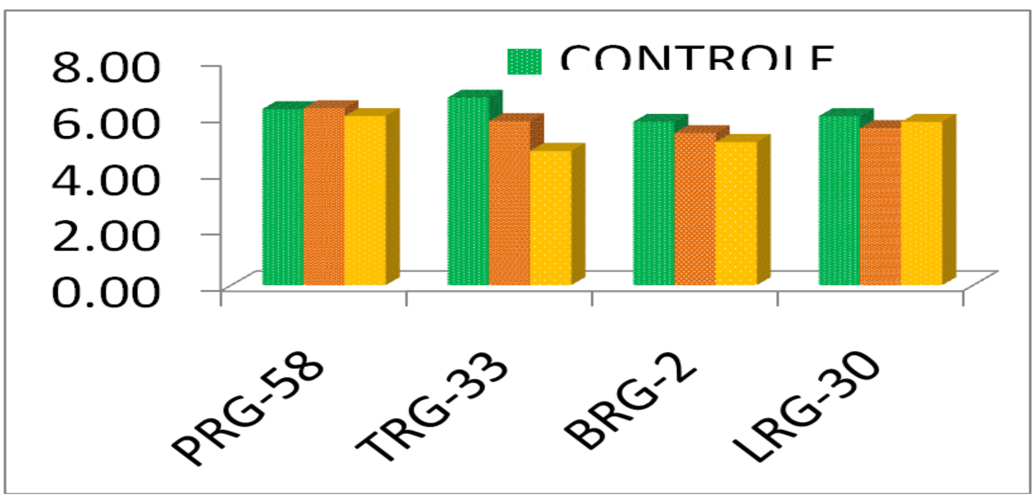

Figure 2: Transpiration

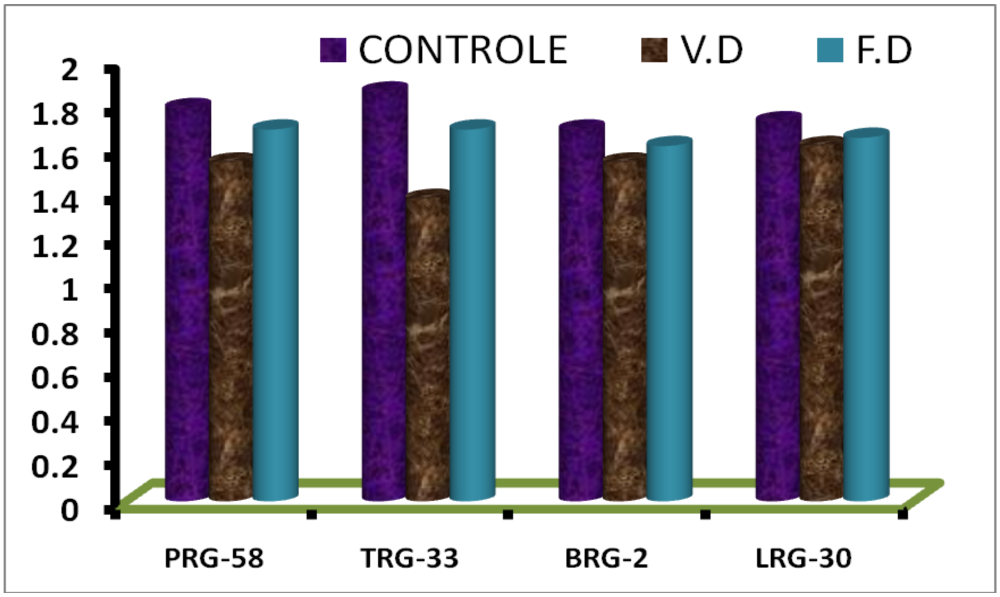

Figure 3: Water Use Efficiency

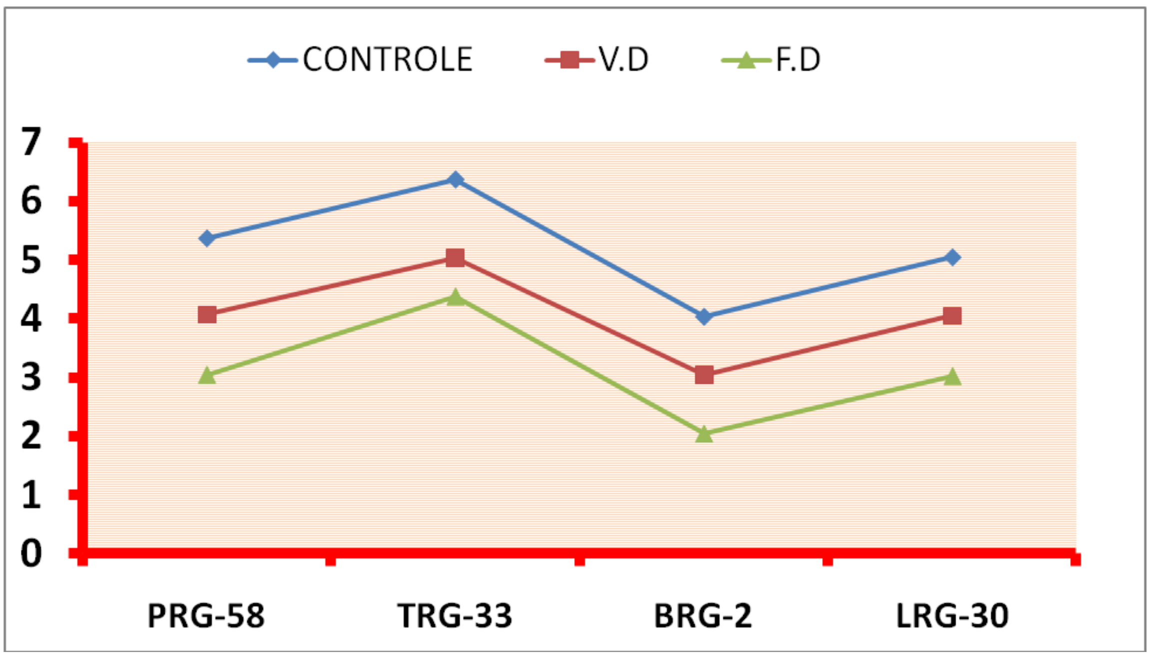

Figure 4: Chlorophyll

PN decreased with increasing drought stress in all four red gram cultivars PN decrease was large in BRG 2, TRG33, LRG30 and less in PRG58 in accordance with ANNOVA results. GS value increased with increasing drought stress the less GS value decrease observed in PRG 58. The decrease in the transpiration rate (E) was also observed in four cultivars but E values less decreased in PRG58. When compared to other inter cellular co2 concentration values (CI), CI values are high in 3 cultivars but it is less in PRG 58.

Leaf area and chlorophyll content were decreased in four genotypes under drought stress but its less decrease was observed in PRG58.

DISCUSSION

Photosynthesis is the central dogma of plant carbohydrate metabolism. It directly influences the growth and productivity of crop plants. Photosynthesis and gas exchange of leaves are affected by many stresses including drought, salinity, flooding, chilling, high temperature, soil composition and inadequate nutrition.

Water stress is one of the major environmental constraints which limit photosynthesis and consequently productivity in plants. Reduction in plant growth due to stress is often associated with decreasing photosynthetic activity which is revealed by Cronic et al., 1992. Water stress reduced the yield is through reduction of photosynthetic surface area and also the reduction of photosynthetic rate per unit leaf area.

The decrease in photosynthetic assimilation in angiosperm plant species have been demonstration in many plant species. It is one of the indices to determine the genotypic tolerance to drought. A positive correlation was established with decreased photosynthetic rate and drought toleranance potential in wheat genotype (Sai ram 1994).

The same was observed in mulberry (Ramamjulu et al., 2002 and Thimma naik et al., 2002). The decreased in P_N under drought stress was accompanied by decrease in corboxylation effiency in four red gram cultivars. In the present study when compared to control P_N decrease was large in treated plants. Never the less P_N decreased was less in PRG58 the reasons attributed are stomatal closure and reduction of carboxylation efficiency. The cultivar variation of P_N of stressed crop plants was evidenced from studies of Kicha et al., 1994.

The stomatal conductance is one of the first responses of soil drying and parallel decline in photosynthesis. When the water status in leaf failed below a threshold value, stomata respond by closing, with the consequent reduction in transpiration as well as co_2 reduction. In the present study when compared to controlled plants, the drought induced have shown less stomatal conduction. In agreement of this among the four cultivars PRG58 has shown the high decrease in stomatal conductance

Intercellular co_2 concentration (C_i) is non stomatal limitation under water stress. A decline in photosynthesis due to changes in C_i has been absorbed in chloroplast under water stress conditions. A significant increase in C_i has been absorbed in water stress due to decrease in carboxylation effiency. When compared to controlled plants the treated have shown the rise in C_i value. Among the treated PRG58 has shown significant reduction in C_i values. The occurrence of increased C_i values at reduced stomatal conduction under water stress condition is an indication of mesophyll limitation to photosynthesis, which ultimately decreased the carboxyation efficiency.

Transpiration (E) is the result of interaction of environmental factors under stress E declined along with P_N, gs and WUE. The percentage of increase in the rate of transpiration is dependent on severity and duration of stress. When compared to controlled plants, the treated have shown less transpiration rate. Among the treated PRG58 has shown the less decrease in E.

Water use efficiency (WUE) indicated the performance of crop growing under environmental constraints. At the leaf level, it is the rate of photosynthesis rate to transpiration rate. A variety of changes during water stress depends on relative increase in stomatal mesophyll resistance. WUE has significantly decreased in treated plants than the controlled. In The present study PRG58 has shown less decrease in WUE than other cultivars.

A decrease in gs and P_N content without corresponding decline in C_i has usually been interpreted as non stomatal effect on water stress on photosynthesis (Basu 2004 et al.,). As PRG58 has shown decrease in P_N, gs, and E and lower C_i and higher WUE when compared to other drought induced cultivars.

REFERENCES

[1] M.Ashiaf and P.J.C.Harris. 2013. Photosynthesis under stressful environments: An overview Photosynthetica. 51 (2): 163-190.

[2] Zlatko Zlatev and Fernando Cebola Lidon 2012. An overview on drought induced changes in plant growth, water relations and photosynthesis Emir. J. Food Agric. 24 (1): 57-72.

[3] W. Tezara, V. J. Mitchell, S. D. Driscoll and D. W. Lawlor 1999. Water stress inhibits plant photosynthesis by decreasing coupling factor and ATP Nature 401:914-917.

[4] Trevor Keenan, Santi Sabatea, Carlos Graciaa, 2010. Soil water stress and coupled photosynthesis–conductance models: Bridging the gap between conflicting reports on the relative roles of stomatal, mesophyll conductance and biochemical limitations to photosynthesis. Agricultural and Forest Meteorology.150(3):443–453.

[5] Zlatko Zlatev and Fernando Cebola Lidon 2012. An overview on drought induced changes in plant growth, water relations and photosynthesis Emir. J. Food Agric. 24 (1): 57-72.

[6] Sándor Dulai Istvan Molnar, Judit Pronay, Agota Csernak, Reka Tarnai, Marta Molnar-Lang 2006. Effects of drought on photosynthetic parameters and heat stability of PSII in wheat and in Aegilops species originating from dry habitats Acta Biologica Szegediensis. 50(1-2):11-17.

[7] A. H. C. M. Schapendonk, C. J. T. Spitters and P. J. Groot 1989. Effects of water stress on photosynthesis and chlorophyll fluorescence of five potato cultivars Potato Research 32:17-32.
[8] M.G. Santos, R.V. Ribeiro, E.C. Machado and C. Pimentel 2009. Photosynthetic parameters and leaf water potential of five common bean genotypes under mild water deficit 15 AuBiologia Plantarum 53 (2): 229-236.
[9] A. Mafakheri, A. Siosemardeh, B. Bahramnejad, P.C. Struik, Y. Sohrabi (2010) Effect of drought stress on yield, proline and chlorophyll contents in three chickpea cultivars AJCS 4(8):580-585.
[10] Rui Guo, Wei Ping Hao, Dao Zhi Gong, Xiu Li Zhong and Feng Xue Gu 2013. Effects of Water Stress on Germination and Growth of Wheat, Photosynthetic Efficiency and Accumulation of Metabolites. Soil Processes and Current Trends in Quality Assessment.367-80.
[11] A. Elizabete Carmo-Silvaa, Michael A. Gorea, Pedro Andrade-Sanchezb, Andrew N. Frencha, Doug J. Hunsakera, Michael E. Salvuccia 2012. Decreased CO2 availability and inactivation of Rubisco limit photosynthesis in cotton plants under heat and drought stress in the field Environmental and Experimental Botany 83:1–11.
[12] Maharaj Singh, J.S. Chauhan and S. S. Meena 2009. Drought induced changes in water use efficiency and other morpho-physiological characters in Indian mustard (Brassica juncea L.) 16th Australian Research Assembly on Brassicas. Ballarat Victoria.
[13] Shahniyar M. Bayramov, Hesen G. Babayev, Minakhanim N. Khaligzade, Novruz M. Guliyev 2010. Effect of Water Stress on Protein Content of Some Calvin Cycle Enzymes in Different Wheat Genotypes Proceedings of ANAS (Biological Sciences), 65(5-6): 106-111.
[14] Qing-Ming Li1, Bin-Bin Liu, Yang Wu and Zhi-Rong Zou 2008. Interactive Effects of Drought Stresses and Elevated CO2 Concentration on Photochemistry Efficiency of Cucumber Seedlings. J. Integr. Plant Biol.1-11.