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Influence of Pre Flowering Drought on Physiological Parameters and Yield in Groundnut

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WGroundnut (*Arachis hypogaea* L.) is one of the world's most important legumes. Groundnut provides one of the largest sources of edible oils proteins and also rich source of vitamins, minerals, anti-oxidants, flavonoids and isoflavonoids and commonly called as poor man's nut. Drought is one of the major factors for groundnut as it is grown in the areas where there is less rainfall. This investigation was conducted to study the physiological parameters in association with groundnut yield under drought with four genotypes namely CO 7, COGn 4, TMV 7, TMVGn 13. Drought was imposed at Pre flowering stage 15-30 DAS by withholding water and control was also maintained with irrigation to field capacity for comparison. Physiological parameters like leaf area, chlorophyll Index, photosynthetic rate, were high in pre-flowering drought recovery plants of CO 7 which contributes to higher pod yield (21.18 %) compared to control plants. In this study the effects of soil moisture deficit on groundnut have been extensively studied and it has been concluded that water stress at pre flowering stage increases the yield.

Key words: Groundnut, Pre flowering drought, Physiological parameters, Pod yield

Groundnut, an important oil and food crop is currently grown approximately in 42 million acres worldwide. It is the third major oilseed of the world next to soybean and cotton. India, China and the United States have been the leading producers for over 25 years and growing about 70 % of the world crop. In India, about 75% of the groundnut area lies in a low to moderate rainfall zone (parts of peninsular, western and central regions) with a short period of distribution (90-120 days). Low rainfall and prolonged dry spells are the main reason for lowering the yield in groundnut. More than half of the production of groundnut obtained from the arid and semi arid regions are subjected to drought (Reddy *et al.,* 2003). Leaf area is an important factor which contributes to better photosynthesis, but drought affects leaf area due to reduction in cell elongation. According to Puangbut *et al*. 2013, pre flowering drought reduced number of leaves and leaf area, re-watering of the stress treatment, in general, resulted in the increase of leaf area. Enhanced leaf area and nitrogen fixation after recovery may contribute to high biomass production, resulting in enhanced reproductive growth and development (Puangbut *et al*., 2010; Awal and Ikeda, 2002). The photosynthesis is fundamental in both biomass accumulation and productivity. Reddy *et al*. (2003) found that, canopy photosynthesis is reduced by moisture stress. Enhanced physiological traits after recovery may compensate for the physiological drought injury to promote overall plant growth and reproduction (Awal and Ikida, 2002, Jongrungklang *et al*., 2010). Richardson *et al*. (2002), reported that SPAD chlorophyll meter reading (SCMR) is an indicator of the photosynthetically active light-transmittance characteristics of the leaf, which is dependent on the unit amount of chlorophyll per unit leaf area (chlorophyll density). SPAD chlorophyll meter reading also reduced during PFD and recovered after stress recovery. The present investigation is proposed to find out the physiological response and reproductive efficiency of groundnut to water stress during pre flowering drought (PFD) with the objective, of studying the physiological and biochemical responses of groundnut genotypes during water deficit at pre flowering stage and subsequent post stress recovery.

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Material and Methods

A pot culture experiment was conducted during *Kharif* 2015 in rain out shelter at the Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore. The experiment was conducted with four groundnut genotypes *viz.,* CO 7, COGn 4, TMV 7 and TMVGn 13 for their relative tolerance to water stress at pre flowering drought (PFD) between 15-30 DAS, by withholding irrigation and control maintained at field capacity for comparison. Leaf area was measured by using leaf area meter (LICOR Model 3100) and expressed as cm^2 $plant^{-1}$. SPAD readings were recorded using chlorophyll meter (SPAD 502) designed by the Soil Plant Analytical Development (SPAD) section, Minolta, Japan. Photosynthetic rate recorded using an advanced portable photosynthesis system (LI-6400 XT, Licor Inc, Nebraska, USA). Photosynthetic rate expressed as μmol CO_2 m^{-2} s^{-1}.

Results and Discussion

In the present investigation, leaf area was reduced during stress. Under PFD leaf area reduction per cent (20.78 %) was observed. Leaf area of CO 7, TMV 7, TMVGn 13 and COGn 4 were 736.5, 680.4, 650.7 and 325.17 cm^2 $plant^{-1}$ respectively after recovery at PFD.

Table 1. Effect of PFD stress on leaf area (cm^2 $plant^{-1}$) of groundnut genotypes

Genotypes	Stress		Recovery	
	Control	Stress	Control	Recovery
CO7	425.8	289.7	792.2	736.5
COGn 4	451.3	119.7	752.8	325.1
TMV 7	403.8	260.5	770.3	680.4
TMVGn 13	395.4	240.6	705.2	650.7
Mean	419.1	227.6	755.1	598.1
	G	S	G	S
SEd	4.21	3.65	18.37	15.91
CD (0.05)	8.47	7.34	36.95	32.00

Among the genotypes, CO 7 had less leaf area reduction during stress along with high recovery percentage. Turner (1986) reported that, even small lowering of the leaf water potential caused considerable inhibition in leaf area. Leaf water potential -4 bars completely suppressed leaf enlargement in groundnut. These responses are in agreement with findings of Puangbut *et al*. (2009) who reported that, drought reduced leaf area during stress and that was slightly increased after recovery.

Table 2. Effect of PFD stress on cholorophyll index (SPAD) of groundnut genotypes

Genotypes	Stress		Recovery	
	Control	Stress	Control	Recovery
CO7	32.34	25.47	35.81	38.92
COGn 4	32.11	22.37	34.13	29.15
TMV 7	31.74	23.42	33.80	36.17
TMVGn 13	30.19	21.92	32.32	31.09
Mean	31.5	23.30	34.02	33.83
	G	S	G	S
SEd	0.435	0.377	0.583	0.505
CD (0.05)	0.875	0.758	1.173	1.015

SPAD chlorophyll value is expressed as cholorophyll index. Increasing trend was observed from vegetative stage to flowering stage. In stress condition, all the genotypes recorded less chlorophyll index than control. However, soon after re-watering, PFD imposed plants recovered, compared to control. The SPAD values increased from 23.00 to 33.83. Among the genotypes, low recovery percent was observed in COGn 4 but at the same time, recovery percentage was very high in CO 7 at PFD (Table 2). Awal and Ikeda (2002) described that, limitation of the water supply induced faster degradation of chlorophyll pigments. Moreover, stressed plants failed to take up sufficient water and mineral nutrients from soil and many biochemical activities were arrested resulting in reduction of leaf chlorophyll concentrations. Spollen *et al*. (1993) explained that, higher root length and volume leads to excess uptake of nutrients from soil which corresponds to rapid chlorophyll molecules in leaves and to regain foliar water status during post stress. This might be the reason for easy recovery of plants with respect to SPAD values under PFD.

The data on photosynthesis showed significant difference between water stress imposed stage and genotypes during stress and after recovery. The photosynthetic rate was highly reduced under stress with the mean value of 15.28 µmol of CO_2. After re-watering, PFD recorded photosynthetic rate (48.67 µmol of CO_2 m^{-2} s^{-1}) equal to control (47.79 µmol of CO_2 m^{-2} s^{-1}). Among the genotypes, CO 7 performed better in all the stages of stress and also in recovery. Poorest performance was observed in COGn 4 especially during PDF. During recovery, PFD recorded photosynthetic rate equal to control. Plants stressed during the vegetative stage completely recovered their stomatal conductance after re-watering.

Recovery of stomatal conductance may result in increased carbon dioxide diffusion into the leaves to attain higher photosynthetic rates. After re-watering, plants respond to increasing trend of photosynthesis that gives rise to increase pod yield in peanut under PFD (Fig. 1).

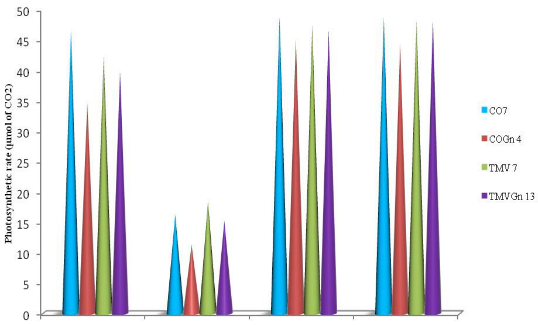

Fig. 1. Effect of PFD stress on photosynthetic rate (µmol of CO_2 m^{-2} s^{-1}) of groundnut genotypes

All the genotypes were recorded more pod yield under PFD compared to control except CoGn 4. Higher pod yield of 21.18 in CO 7, 20.11 in TMV 7, 18.67 g plant $^{-1}$ in TMVGn 13 at PFD than control. PFD showed physiological responses for the increasing pod yield and improved the assimilate portion to promote more growth and development. Puangbut *et al*. (2009) pointed out that enhanced physiological traits after recovery may compensate for the physiological drought injury to promote yield. This might be the reason for recording more pod yield under PFD than control. Among the genotypes CO 7 performed better compared to others (Fig. 2).

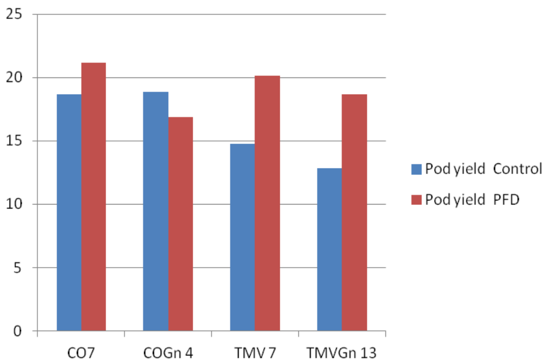

Fig. 2. Effect of PFD stress on pod yield (g plant^{-1}) of groundnut genotypes

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