Physiological Response Of Groundnut (*Arachis hypogaea L.*) Genotypes Under Moisture Stress Condition

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Abstract

Groundnut (*Arachis hypogaea* L.) is an important oil seed crop and can be affected by moisture stress during critical stages. Moisture stress is most important factor which can limit crop growth and yield by altering various physiological processes. In the current study physiological response of groundnut genotypes were studied on both moisture stress and moisture stress free condition. Pot experiment was conducted with three replication in Complete randomized block design with factorial arrangement at Sananandal village in the Thiruvannamalai district, of Tamilnadu (March to June 2020) to evaluate the physiological response of 10 released groundnut varieties (VRI 2, VRI 6, VRI 8, TMV 7, TMV 13, TMV 14, K 6, JL 24, DHARANI, CO 3) and three cultures (VG 19721, VG 18089, VG 17008) under moisture stress free and moisture stress condition. Physiological response was assessed in terms of Relative water content (RWC %), Membrane stability index (MSI) and Drought tolerance efficiency (DTE %). The moisture stress was imposed by withholding the irrigation from flowering to pod initiation stage for stressed pot and regular irrigation was given for non-stressed pots. Observations were recorded for Relative water content (RWC %), Membrane stability index (MSI) and Drought tolerance efficiency (DTE %) for pod yield. Among the genotypes TMV 7 and VRI 6 is found to be superior and CO 3 recorded the lowest values on RWC (%), MSI, and DTE (%) respectively.

Key word: Groundnut, Moisture stress, RWC, MSI, DTE,.

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) belongs to the botanical family Leguminosae, is an important legume and oil seed crop for resource poor farmers in Asia and Africa. It is among the most nourishing foods that are accessible today. Groundnuts have significant therapeutic potential in addition to their nutritional value. It is ingested in a variety of ways and forms. It is regarded as healthier than saturated oils and is resistant to rancidity because of its high monosaturated concentration. A key benefit of groundnut is their 26% protein content. Like most other legumes, groundnut harbor symbiotic nitrogen-fixing bacteria in root nodules. The capacity to fix nitrogen means groundnut plant require less nitrogen-containing fertilizer and improve soil fertility, making them valuable in crop rotations. Groundnuts are cultivated on 30.82 million hectares of land globally, with a yield of 50.31 million tonnes and an average productivity of 1630 kg ha^{-1} (USDA, 2022). India is ranked first in the world for both area and production after China. According to the FAO and USDA report for 2022, India's groundnut crop area climbed from 4.14 million hectares in the previous year (2019-2020) to 5.60 million hectares in 2021–2022. In a similar manner, production and productivity are projected to be 6.80 million tonnes and 1210 kg per year, respectively, as opposed to 5.275 million tonnes and 1269 kg ha^{-1} in the previous year (USDA and FAO, 2022). Tamilnadu is one of the state with the highest groundnut production with an area, production, and productivity of 0.41 lakh hectare, 0.94 million tonnes and 2310 kg ha^{-1}, respectively (Agricultural Statistics at a Glance., GOI, 2021.).

Abiotic stresses are crucial component of "climate change," which can alter the soil-plant-atmosphere continuum and impact agricultural output (Ahmad and Prasad, 2012). One of the most significant abiotic stresses is drought, which can have varying degrees of severity and is likely to occur more than 35% of the time in india's agricultural area (Bhandari *et al*., 2007). A variety of physiological processes are triggered by drought (Gilbert *et al*., 2011) and some of these responses allow plants to survive and adapt to such conditions with little loss in crop output. It is crucial to examine physiological features in order to discover tolerant genotypes of groundnut because these changes differ between genotypes of the same crop and environmental conditions.

MATERIALS AND METHODS

In this experiment, the physiological response of ten released groundnut genotypes (VRI 2, VRI 6, VRI 8, TMV 7, TMV 13, TMV 14, K 6, JL 24, DHARANI, CO 3) and three cultures (VG 19721, VG 18089, VG 17008) to moisture stress conditions were examined at Sananandal village in the Thiruvannamalai district of Tamil Nadu. These genotypes were assessed in both non-stressed and stressed conditions during the summer of 2020. The experiment was designed using a factorial arrangement in completely randomized block design (CRD), and it was replicated thrice. The pot experiment was carried out using 15" x 15" High Density Polyethylene grow bags loaded with soil. For sowing, seeds that had already been fungicide and rhizobium treated were used. Five seeds were evenly sown in each pot. Seedlings were thinned on 15 days after emergence in order to maintain 4 homogeneous seedlings per pot. During the growing season, normal cultural procedures were followed, with the exception of the irrigation schedule for stressed pots. By withholding irrigation for the stressed pots from the flowering to pod initiation stages, the moisture stress was imposed.The physiological response of each genotype were quantified through Relative water content (RWC %) (Gonzalez and Gonzalez-vilar, 2001), Membrane stability index (MSI) (Premachandra *et al*., 1990) and Drought tolerant efficiency (DTE %) (Fisher and Wood , 1981) for pod yield by using the following formula

RWC (%) = $(FW - DW)/(TW - DW) \times 100$

Where, FW is the fresh weight of the sample, TW is the sample turgid weight and DW is the sample dry weight.

MSI = $[1 - C_1/C_2] \times 100$

Where C_1 is one set of sample were kept at 40^0 C in a boiling water bath for 30 minutes and electrical conductivity of the sample was measured using a conductivity meter.

C_2 is another set of sample were incubated at 100^0 C in the boiling water bath for 15 minutes and their electrical conductivity was measured.

DTE (%) = $\frac{Y_s}{Y_p} \times 100$

where, Ys is yield of the *i*th genotype under stress conditions, Yp is yield of the *i*th genotype under non stress condition.

RESULTS AND DISCUSSION

Relative water content (RWC %) and Membrane stability index

Effect of moisture stress imposed to groundnut genotypes caused significant changes in relative water content and membrane stability index on 60 DAS, it ranges from 50.4 to 90.8 and 62.5 to 98.7 and were furnished in table 1.

With respect to moisture stress, significant changes in relative water content and membrane stability index (60 DAS) among different genotypes were noticed in moisture stress free condition compared to moisture stress. The percent reduction in relative water content and membrane stability index due to moisture stress was 34.7 and 25.7.

With regard to genotypes, there existed significant difference in relative water content and membrane stability index (60 DAS) among groundnut genotypes and it ranges from 63.0 to 73.4 and 71.8 to 83.5. The highest relative water content and membrane stability index were observed on groundnut genotype was K 6 and least recorded on groundnut genotype was CO 3.

Interaction effect between moisture stress and groundnut genotype was found to be significant. With respect to moisture stress, the maximum reduction in relative water content and membrane stability index (60 DAS) was noticed on genotype dharani (41.6 % & 33.6 %) and minimum reduction noticed on genotype TMV 7 (25.0 % & 14.5 %), With respect to above result, relative water content and membrane stability index was lower in moisture stress compared to moisture free condition.

The moisture stress considerably reduced Relative water content and considerable difference among groundnut genotypes were observed. Relative water content was decreased remarkably in response to declining soil water availability. The values of RWC are often considered as the appropriate measure of plant water status and considered to be the sensitive index of plant water content especially when plants are exposed to cellular water deficit conditions (Painawadee *et al*., 2009). This might be due to reduction in water availability, stomata opening and closing is more affected. Similar results have been reported in groundnut (Madhusudhan and Sudhakar, 2014).

Table 1: Effect of moisture stress on relative water content (RWC %) and membrane stability index (MSI) at 60 DAS among groundnut genotypes

GENOTYPES	RWC %			MSI		
	MOISTURE LEVELS					
	I_1	I_0	MEAN	I_1	I_0	MEAN
T1- VRI 2	79.6	51.4	65.5	85.5	63.1	74.3
T2-VRI 6	83.4	62.3	72.9	89.8	76.3	83.1
T3- VRI 8	79.1	50.7	64.9	85.1	62.8	74.0
T4-TMV 7	78.5	58.9	68.7	84.8	72.5	78.7
T5-TMV13	79.3	52.3	65.8	85.3	63.8	74.6
T6-TMV14	82.5	51.6	67.1	89.5	63.2	76.4
T7-K6	90.8	56.0	73.4	98.7	68.3	83.5
T8-JL24	83.5	55.4	69.5	90.1	68.1	79.1
T9- DHARANI	87.9	51.3	69.6	94.9	63.0	79.0
T10- CO3	75.6	50.4	63.0	81.1	62.5	71.8
T11- VG19721	83.9	55.2	69.6	90.3	67.5	78.9
T12-VG18089	83.7	51.8	67.8	90.2	63.5	76.9
T13-VG 17008	82.8	52.1	67.5	89.7	63.7	76.7
MEAN	82.4	53.8		88.8	66.0	
	G	M	G x M	G	M	G x M
SEd	1.00	0.39	1.42	1.28	0.50	1.81
CD(p=0.05)	2.02	0.79	2.86	2.57	1.01	3.64

The genotypes with higher MSI have better adaptations under drought stress (Tas and Tas, 2007). Earlier records on groundnut also showed significant effect of drought stress on MSI, the groundnut varieties WEST- 44 showed higher MSI over control under drought stress conditions (Shinde *et al*., 2010). The plasma membrane is generally protected from desiccation-induced damage by the presence of membrane compatible solutes, such as sugars and amino acids. Therefore, a link may exist between the capacity for osmotic adjustment and the degree of membrane protection from the effect of dehydration (Shinde and Laware, 2014).A major impact of drought stress is usually on cellular membrane modification, which results in total dysfunction and it is generally accepted that the maintenance of integrity and stability of membranes under drought stress is a major component of drought tolerance in plants (Vaidya *et al*., 2015).

Drought tolerance efficiency (DTE %)

Effect of moisture influenced the values of DTE which ranged from 20 % to 68 %. However highest DTE recorded on TMV 7 (68 %) followed by VRI 6 (62 %) and lowest DTE recorded on CO 3 (20 %) is presented in figure 1.

These results revealed that the genotypes TMV 7 followed by VRI 6 have more drought tolerant efficiency under moisture stress condition. This may be due to the mechanisms adopted to drought tolerance are maintenance of turgor through osmotic adjustment, increased cell elasticity and decreased cell size as well as desiccation tolerance by protoplasmic resistance (Pereira *et al*., 2016).

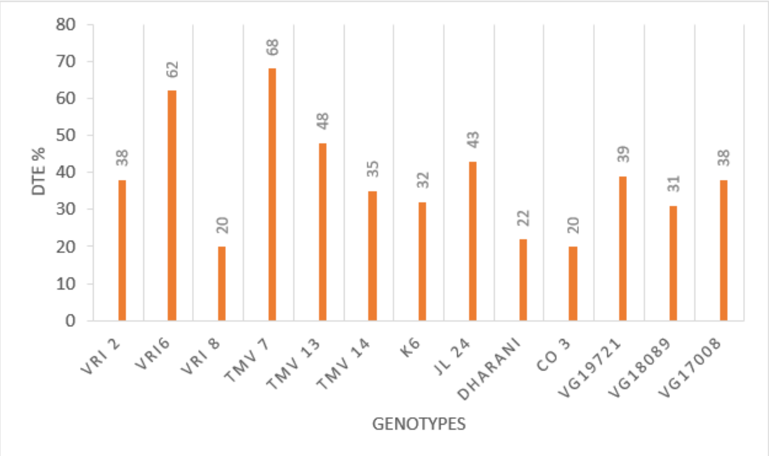

Figure 1: Effect of moisture stress on drought tolerant indices among groundnut genotype

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