Effects of Moisture Stress on Growth and Yield of Selected Groundnut (Arachis hypogaea L.) Cultivars Effects of Moisture Stress on Growth and Yield of Selected Groundnut (Arachis hypogaea L.) Cultivars

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Abstract - Groundnut is grown in the Batticaloa district of Sri Lanka to a limited extent; the yield is vulnerable to moisture stress especially during the 'Yala' season. This experiment was conducted at the Agronomy farm of the Eastern University, Sri Lanka during the 'Yala' 2017. Studies were made to determine the effects of moisture stress on growth and yield of selected groundnut cultivars; 'Lanka jumbo', 'Tissa' and 'Indi'.Stress was imposed during the flowering stage to find out the most suitable groundnut cultivar which can resist drought and produce substantial yield under water limited situation. Hundred and ninety two groundnut plants of the selected cultivars were raised in polyethylene pots (as one plant per pot). Moisture stress was imposed for a period of ten days during the flowering stage (T2, T4 and T6) and the control plants (T1, T3 and T5) were watered once in two days to maintain at Field Capacity. This experiment was laid out in the Randomized Complete Block Design with six treatments and four replications and the treatments were arranged in 3 × 2 factor factorial manner. There were significant ($p<0.05$) differences between treatments in the measured parameters. The highest Leaf Area Index (0.78), plant dry weight (1.8g), yield (1.0tha-1) and shelling percentage (59.5%) were obtained in 'Indi' groundnut cultivar under stressed condition whereas the lowest Leaf Area Index (0.33), plant dry weight (0.9g), yield (0.33tha-1) and shelling percentage (38.6%) were found in 'Tissa' under the same condition. Hence, considering the measured growth attributes, 'Indi' groundnut cultivar could withstand drought better than the rest of the cultivars. As such, this cultivar could be suggested for cultivation in the drought prone areas of the Batticaloa district.

Keywords: Groundnut, Leaf Area Index, Moisture stress, Yield

I. INTRODUCTION

Groundnut is a traditionally cultivated major oil crop under subsistence farming system mainly in highlands, dry and intermediate zones in Sri Lanka. It is rich in protein, fatty-acid, vitamins and minerals. Water deficit affects every aspect of groundnut growth including anatomy, morphology, physiology and biochemistry. Due to erratic rain fall and frequent drought condition during growing seasons, groundnut yields are generally low and unstable under rain-dependent conditions [1].

There are significant genotypic variations in response to drought and their tolerance levels in groundnut. It is necessary to screen the selection of tolerant groundnut lines for breeding purposes and better understanding of the stress induced responses of physiological and biochemical traits can prove to be very useful to screen drought tolerant genotypes [2]. Groundnut cultivation of Batticaloa district was heavily affected due to drought recently. It has become important to study the performance of different groundnut cultivars under moisture stress condition.

Hence, the present study was conducted to determine the effects of drought stress on the growth and yield selected groundnut cultivars and to find out the most drought tolerant groundnut cultivar which can thrive and produce substantially well under water limited condition.

II. MATERIALS AND METHODS

This experiment was conducted at the Agronomy farm of the Eastern University, Sri Lanka where the climate was warm (28-320 C) with an average annual rainfall of 1250 mm. A number of 192 polyethylene pots each having the capacity of 1300cm3 were prepared. Three groundnut cultivars viz; 'Lanka jumbo', 'Indi' and 'Tissa' were tested for moisture stress tolerance. The potting mixture was prepared by using topsoil, red soil and compost at the ratio of 1:1:1. Only one vigorous seedling was allowed to grow in each pot. The fertilizers Urea, MOP and TSP were added as basal and Urea was applied once again as top dressing as recommended by the Department of Agriculture [3].

Gypsum blocks were inserted into the soil and the soil moisture contents were recorded on the 10th day from the commencement of the stress by a soil moisture meter (Model 5910, Soil Moisture Equipment Corp.). Rain shelters were erected using bamboo sticks and polyethylene (1000 gauge) sheets for the experimental area to prevent the entry of rain water into the experimental field.

Moisture stress was imposed for the tested groundnut cultivars for a period of 10 days during the flowering stage. Moisture stress was imposed by withholding water completely at once. This experiment was arranged in a 3×2 factor, factorial and was laid out in the Randomized Complete Block Design with six treatments and four replications. The treatments were as follows; moisture stress treatments (T2, T4 and T6). Control treatments (T1, T3 and T5). Regular watering was practiced at two days interval to the control treatments to maintain the controls at Field Capacity.

1. Leaf Area Index

Four plants were randomly selected from each replicate of the treatments on the 10th day from the commencement of the stress and the plants form controls. These plants were uprooted and leaves were separated. The total leaf area of the individual plant was measured by a leaf area meter (LI-3100C). The Leaf Area Index was calculated as follows:

$$LAI = \frac{\textit{Total leaf area of the individual plant}}{\textit{Soil area occupied by the plant}}$$

2. Plant dry weight

Plants selected for Leaf Area Index was used for dry weight measurments. Plant dry weights were determined by keeping at 80o C for two days.

3. Yield and yield component

A number of four plants were randomly selected and were uprooted from each replicate of the treatments on the day of harvest. The pods were collected and the yield was determined.

The seeds were separated and the shelling percentage was calculated as follows:

$$\text{Shelling percentage} = \frac{\text{Fresh weight of seeds}}{\text{Fresh weight of pods}} \times 100$$

4. Analysis of data

The data were statistically analyzed using SAS 9.1 portable package and the difference between treatments means was compared using DMRT.

III. RESULTS AND DISCUSSION

The average soil moisture contents of the polyethylene bags at a depth of 10, 20 and 30 cm from the surface of the soil were 6.5, 7.2 and 8.5 % respectively.

1. Leaf Area Index (LAI)

There were significant ($p<0.05$) differences between treatments in the LAI of groundnut cultivars 'Lanka jumbo', 'Tissa' and 'Indi' when the stress was imposed during the flowering stage (Table 1).

TABLE 1

Effects of moisture stress on the Leaf Area Index of selected groundnut cultivars during the flowering stage

Cultivars	Dry weight(g)	
	Stress (g)	Control(g)
Lanka jumbo	1.3 b	11.6 b
Tissa	0.9 c	10.8 b
Indi	1.8 a	13.0 a

Values in the same column followed by the same letter do not differ significantly ($p< 0.05$)
Values are the means of 16 plants in four replications.

The highest LAI was obtained in the 'Indi' groundnut cultivar and the lowest was found in 'Tissa'. Moisture stress reduced the LAI of all the tested groundnut cultivars. Water deficit reduces the number and size of leaves of plants. Diminished leaf area was attributed to the negative effect of stress on the rate of cell elongation which resulted in leaves reduced in cell volume and cell number [4].

2. Plant dry weight

There were significant ($p<0.05$) differences between treatments in the plant dry weights of groundnut cultivars 'Lanka Jumbo', 'Indi' and 'Tissa' on the 10th day from the commencement of the stress during the flowering stage (Table 2). The highest plant dry weight was obtained in the 'Indi' groundnut cultivar and the lowest was found in 'Tissa' under moisture stress condition.

Moisture stress therefore has reduced the plant dry weights of tested groundnut cultivars. Reduction in plant dry weight would have been due to the reduced production of photosynthates on account of stress. As indicated by [5], with moisture deficit condition, dry matter production and root to shoot ratio were highly affected in groundnut.

TABLE 2

Effects of moisture stress on the dry weight of selected groundnut cultivars during the flowering stage

Cultivars	Leaf Area Index	
	Stress	Control
Lanka jumbo	0.52 b	0.84 a
Tissa	0.3 c	0.61 b
Indi	0.78 a	0.87 a

Values in the same column followed by the same letter do not differ significantly ($p< 0.05$)
Values are the means of 16 plants in four replications.

3. Yield

There were significant ($p<0.05$) differences between treatments in the yield of groundnut cultivars.(Table 3). The highest yield was obtained in the 'Indi' groundnut cultivar and the lowest was found in 'Tissa'. From these results it was found that moisture stress has reduced the yield of tested groundnut cultivars. Reduction in yield is associated with the reduced in seed size and seed number per plant under moisture stress condition. Reduction in seed yield was associated with the reduction in seed size and a number of seeds per plant under moisture stress in groundnut [6]

TABLE 3

Effects of moisture stress on the yield of selected groundnut *(Arachis hypogaea L.)* cultivars during the flowering stage

Cultivars	Yield (tha^{-1})	
	Stress	Control
Lanka Jumbo	0.7 b	2.3 a
Tissa	0.3 c	1.0 c
Indi	1.0 a	1.7 b

Values in the same column followed by the same letter do not differ significantly ($p< 0.05$)
Values are the means of 16 plants in four replications

4. Shelling Percentage

There were significant ($p<0.05$) differences between the treatments in the shelling percentage of groundnut cultivars 'Lanka Jumbo', 'Indi' and 'Tissa' when the stress was imposed during the flowering stage (Table 4).
The highest shelling percentage was obtained in 'Indi' and the lowest was found in 'Tissa' under moisture stress condition. However,there was no significant ($p>0.05$) difference in the shelling percentage between 'Lanka Jumbo' and 'Indi' groundnut cultivars.[7] has indicated a decrease in shelling percentage with increased moisture stress.

TABLE 4

Effects of moisture stress on the Shelling Percentage of selected groundnut (Arachis hypogaea L.) cultivars during the flowering stage

Cultivars	Shelling Percentage(%)	
	Stress (%)	Control (%)
Lanka Jumbo	56.4 a	76.2 a
Tissa	38.6 b	67.7 b
Indi	59.5 a	70.3 b

Values in the same column followed by the same letter do not differ significantly ($p< 0.05$)
Values are the means of 16 plants in four replications

IV. CONCLUSIONS

Moisture stress has reduced the growth attributes and yield of selected groundnut cultivars. 'Indi' cultivar exhibited the highest growth habit and yield compared to the others. Hence 'Indi' could be considered as the most drought tolerant groundnut genotype among the tested ones for the arid region of the Batticaloa district of Sri Lanka.

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