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# Dry Matter Production and Allocation in Groundnut Under Drought and Foliar Nutrition

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**ABSTRACT**

*The impact of drought stress and foliar nutrition on dry matter accumulation in different parts of soybean plant was studied at Dryland Farm of S.V. Agricultural College, Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Tirupati during rabi season, 2014-15. The experiment was conducted as a Randomized Block Design with three replications. In this research, Groundnut crop was imposed to mid-season moisture stress from 45 DAS to 75 DAS (pod formation to pod filling stage). Treatments included Foliar application of chemical nutrients (8 treatments) along with two checks (one control irrigated and one control stress) were imposed at 60 days after sowing (15 days after imposing moisture stress). The results revealed that, significant variations for morphological, physiological, drought tolerance, biochemical and yield attributes were observed. Among the foliar spray treatments at harvest, the foliar spray treatment* $KNO_3$ *@ 0.5% recorded significantly higher stem, leaf and pod dry weight and also total drymatter partitioning followed by NPK -19:19:19 @ 0.5% and KCl @ 1% compared to control stress treatment. Among the foliar spray treatments NPK- 19:19:19 @ 0.5%, at 75 and 90 DAS was found to be superior in increasing the LAI followed by KNO3 @ 0.5% and KCl @ 1%.*

***Key words:*** *Drought stress, Dry matter, Leaf area index, Groundnut.*

## INTRODUCTION

Groundnut is planted in arid and semi arid areas and is very rich in protein and oil of good quality. Drought is one of the limiting factors to groundnut yield in many countries[8]. In recent years, due to drought groundnut yield has declined. El-Boraie *et al*[3]., concluded that groundnut yield is reduced under water stress. Drought stress reduces the stabilization in leguminous plants[5], especially in groundnut[13]. The groundnut, often called as "The King of Oilseeds", is botanically known as *Arachis hypopgaea* and belongs to family Leguminosae. Groundnut is resistant to water stress conditions but drought conditions have adverse effects on the pod yield and seed quality[10].

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The effect of drought on the chemical composition of the groundnut seeds has been reported to be limited in the mid-season drought but significant in end-season drought[2]. Umar[15] reported that groundnut may be cultivated under drought conditions along with potassium fertilization in order to minimize the adverse effects of water stress. In this regard, groundnut is a valuable crop which may be a good source of income not only for the irrigated regions but also from the arid zones. Foliar fertilization has advantages of low application rates, uniform distribution of fertilizer materials and quick response to nutrients. When root activity is reduced due to drought, foliar fertilization is more advantageous in absorption compared to soil application. To counteract cyclic droughts, foliar fertilization with K for groundnut in Gujarat, India is considered beneficial[6]. Umar and Bansal[14] indicated that the best results of groundnut plants were achieved with foliar application of 1% KCl. Potassium application improved the total drymatter and leaf area. The main aim of this study is evaluation of foliar application of chemical nutrients on LAI and dry matter accumulation in different parts of groundnut plant under drought stress conditions.

## MATERIAL AND METHODS

A field experiment was conducted at S.V. Agricultural College Farm, Tirupati campus of Acharya N.G. Ranga Agricultural University, during *rabi* season, 2014-15 which is geographically situated at 13.5°N latitude and 79.5°E longitude, with an altitude of 182.9 m above the mean sea level in the Southern Agro-Climatic Zone of Andhra Pradesh. Groundnut variety 'Dharani' was selected for the study whose duration was 110 days. The experiment was laid out in a Randomized block design with 12 treatments replicated thrice. The following treatments were foliar applied at 60 days after sowing (15 days after imposition of moisture stress). Treatments consists of $T_1$ - Control (Irrigated), $T_2$ - Control (Stress), $T_3$- Water spray, $T_4$- 2 % Urea, $T_5$- 2 % Di Ammonium Phosphate (DAP), $T_6$ - 1 % KCl, $T_7$ - 0.5 % $ZnSO_4$, $T_8$- 0.5 % $FeSO_4$, $T_9$ - 1 % Urea + 0.5 % Zn $SO_4$ + 0.5 % $FeSO_4$ , $T_{10}$- NPK 19:19:19 @ 0.5 % (water soluble fertilizers), $T_{11}$- NPK 17:17:17 @ 0.5 % (water soluble fertilizers) and $T_{12}$ - Potassium Nitrate @ 0.5 %.

The experiment was conducted in a sandy loam soil with a plot size of 3 x 3 m. The crop was sown on 18th December, 2014 with a spacing of 22.5 X 10 cm. Nitrogen was applied as basal dose @ 20 kg N $ha^{-1}$ in the form of urea. Phosphorus and potash were given @ 40 kg $P_2O_5$ and 50 kg $K_2O$ per ha basally. Gypsum was applied at 35 DAS @ 500 kg $ha^{-1}$. Hand weeding and hoeing was done twice at 20 days' interval after sowing. Prophylactic measures were taken up to protect the crop from all insect pest and diseases throughout the crop growth period. Need based irrigations were given, however, the crop was irrigated to field capacity at 40 DAS and then there was no irrigation provided between 45-75 DAS. Treatments were foliar applied on 60th day after sowing *i.e*. 15 days after imposition of moisture stress.

The dry weights of oven dried stems, leaves and pods were recorded at 15, 30, 45, 60, 75, 90 DAS and at harvest and expressed as g $plant^{-1}$.

**Leaf Area Index (LAI):**

Leaf area was recorded by destructive sampling at 15, 30, 45, 60, 75, 90 DAS and at harvest, using Li-COR model, LT-300 portable leaf area meter with transparent conveyor belt and electronic digital display. Leaf area index was computed taking into account, the area occupied by each plant as per the following formula[17]. The leaf area index was calculated by dividing the total leaf area with the corresponding ground area.

$$\text{LAI} = \frac{\text{Leaf area}}{\text{Ground area}}$$

## RESULTS AND DISCUSSION

The results of present investigation revealed existence of sufficient treatment variability among the treatments tested for dry matter and LAI. The data pertaining to dry matter and LAI at 75 DAS in response to foliar spray treatments were mostly discussed and presented here.

**Stem dry weight (g plant$^{-1}$)**

Stem dry weight of groundnut variety Dharani at 15, 30, 45, 60, 75, 90 and at harvest stage influenced by foliar spray treatments were recorded and presented in Table 1.

The stem dry weight increased continuously up to harvest. There were no significant differences between the treatments up to 60 DAS. Significant differences were observed among the treatments for stem dry weight at 75, 90 and at harvest stages of crop growth. Stem dry weight at 75 DAS was significantly higher under control irrigated treatment with 26 per cent higher stem dry weight, compared to control stress treatment.

Among foliar spray treatments at 75 DAS, NPK -19:19:19 @ 0.5% (9.4 g plant$^{-1}$) recorded significantly 23 per cent higher stem dry weight compared to control stress treatment followed by KCl @ 1% with 19 per cent higher stem dry weight. El- habbasha *et al*[4]., reported that in groundnut, zinc foliar application levels show significant differences in stems dry weight plant$^{-1}$. Zinc helps in plant metabolism by influencing the activities of hydrogenase and carbonic anhydrase, stabilization of ribosomal fractions and synthesis of cytochrome.

**Leaf dry weight (g plant$^{-1}$)**

Leaf dry matter denotes the leaf area and leaf density, which quantifies chloroplast apparatus. The data pertaining to the changes in leaf dry weight were recorded at 15, 30, 45, 60, 75, 90 and at harvest stage of crop growth and presented in the Table 1.

Leaf dry matter was gradually increased up to 90 DAS and there after decreased at harvest. Significant differences for leaf dry weight among the treatments were found from 60 DAS to harvest stage.

In groundnut, leaf dry matter was decreased by decreasing applied irrigation water, or by setting groundnut plants under water stress conditions. Deficit irrigation is usually accompanied by reduced accumulation of aerial organs and the production of photosynthesis substances which seemed to be due to reduced absorption of nutrients and the production and transfer of processed substances[7].

Due to imposition of moisture stress there was no gradual increase in leaf dry weight at 60 DAS except for control irrigated treatment. At 75 DAS, the treatment control stress showed 29 per cent reduction in leaf dry matter compared to control irrigated treatment.

At 75 DAS, among foliar spray treatments $KNO_3$ @ 0.5% recorded significantly 16 per cent higher leaf dry weight followed by NPK -19:19:19 @ 0.5% and KCl @ 1% with 13 per cent higher leaf dry weight compared to control stress treatment. Pradeep and Elamathi[11] reported that in greengram foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ one per cent at 30 and 60 DAS recorded significantly 15 per cent higher dry matter per plant at harvest. Higher dry matter might be due to the role of boron in cell division, cell differentiation, development, calcium utilization, translocation of photosynthates and growth regulators from source to sink, thus helping in maintaining higher leaf area, leaf area index and higher number of pods and pod weight per plant.

**Pod dry weight (g plant $^{-1}$)**

Data on pod dry weight recorded during crop growth period at 15, 30, 45, 60, 75, 90 and at harvest stage were recorded and presented in Table 1.

Pod dry weight was gradually increased from 60 DAS to harvest. At 75 DAS, after imposition of different foliar sprays highest pod dry matter was found in control irrigated treatment recorded 39 per cent reduction in pod dry matter compared to control stress treatment.

Pod dry weight was significantly affected by moisture stress applied at 45-75 DAS. An appraisal of the data showed that irrespective of irrigated treatments, the treatment NPK-19:19:19 @ 0.5%, $KNO_3$ @ 0.5 % and KCl @ 1% recorded highest pod yields. At 60 DAS, there was no significant variation among the foliar spray treatments. At 75 DAS, among different foliar sprays, 57 per cent increased pod dry matter was observed in foliar spray treatment $KNO_3$ @ 0.5 % compared to control stress treatment followed by KCl @ 1% and NPK-19:19:19 @ 0.5% with 50 per cent and 48.5 per cent high pod dry matter.

In soybean, foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ 1 per cent at 30 and 60 DAS enhanced the number of pods per plant and test weight by 28.94 and 22.60 per cent higher over control respectively and might be due to the significant effect of nutrient sprays enhancing number of pods per plant and the role of boron in increasing dry matter and efficiency of translocation of translocation of assimilates to developing sink leading to increased pod yields[9].

**Total dry matter (TDM) (g plant$^{-1}$)**

All the physiological processes result in to a net balance and accumulation of dry matter and hence, the biological productivity of plant is judged from their actual ability to produce and accumulate dry matter. In general soil moisture determines the distribution and accumulation of dry matter in different plant parts. Also dry matter accumulation and distribution is an important factor indicating partitioning efficiency influenced by foliar spray treatment.

Total dry matter of groundnut variety Dharani during the crop growth period at 15, 30, 45, 60, 75, 90 and at harvest stages influenced by foliar spray treatments for drought mitigation are shown in Table 1.

In the study of groundnut, among the treatments total dry matter in terms of dry weight of stem and pod increased up to harvest except leaf dry weight which increased up to 90 DAS and thereafter decreased. Dry matter production and its distribution in component parts of plant increased progressively with the advancing age of the groundnut crop. The rate becomes rapid up to 80 DAS and rather slow after 80 to 100 DAS and 100 DAS to harvest[1].

The data indicated that significant differences were observed for total dry matter at 60, 75, 90 DAS and harvest stage. At 15, 30 and 45 DAS, total dry matter showed no significant differences among the treatments. At 75 DAS, total dry weight per plant was higher in control irrigated treatment by 37 per cent compared to control stress treatment.

Total dry weight plant$^{-1}$ was significantly enhanced by all the foliar spray treatments. At 75 DAS, among foliar spray treatments, $KNO_3$ @ 0.5% and NPK-19:19:19 @ 0.5% showed significantly 23 per cent high total dry matter and KCl @ 1% showed 21 per cent high total dry matter compared to control stress treatment.

From the results, it is evident that all the treatments varied significantly for total dry matter of the plants, irrespective of growth stages. Among the various foliar spray treatments, NPK-19:19:19 @ 0.5% and $KNO_3$ @ 0.5% recorded higher total dry weight at all growth stages followed by KCl @ 1% foliar spray. In groundnut, total dry matter production was 19.63 g plant$^{-1}$ in absolute control, significantly increased to 22.91 g plant$^{-1}$ due to only foliar spray of nutrients (Nitrogen, Phosphorus, Potassium, Calcium and Sulphur) at 60 days after sowing (DAS)[16]. From the results, it is evident that all the treatments varied significantly for total dry matter of the plants, irrespective of growth stages. Among the various foliar spray treatments, NPK-19:19:19 @ 0.5% and $KNO_3$ @ 0.5% recorded higher total dry weight at all growth stages followed by KCl @ 1% foliar spray.

**Leaf Area Index (LAI)**

Leaf Area Index (LAI) is an important plant factor in determining the dry matter accumulation and hence the crop yield.

Variability in leaf area index due to foliar spray treatments under moisture stress condition of groundnut variety Dharani were recorded at 15, 30, 45, 60, 75, 90 DAS and at harvest and presented in Table 1.

After an initial lag period, there was a rapid increase in LAI up to 90 DAS followed by a decrease in LAI, similar to leaf area, which continued till harvest in all treatments. Prathima *et al*[12]., reported that in groundnut, gradual increase in LAI was observed from 15 DAS to 75 DAS and thereafter, it was decline at harvest. The increase or decrease however varied with the growth stages, depending on coincidence of moisture stress with the growth stage.

Significant difference was not found for LAI among treatments at 15, 30 and 45 DAS, whereas it was significant from 60 DAS to harvest. Control irrigated treatment recorded 40 per cent high in LAI compared to control stress treatment at 75 DAS.

Among the foliar spray treatments to mitigate moisture stress, significant differences were found from 75 DAS to harvest stage of crop. At 75 DAS after imposition of foliar spray treatments, the maximum LAI was noticed under foliar application of $KNO_3$ @ 0.5% followed by NPK-19:19:19 @ 0.5% and KCl @ 1% with significantly 35, 33 and 30 per cent high LAI compared to control stress treatment respectively. Gowthami and Rama Rao[9] also stated that, the leaf area index of soybean as influenced by foliar application of potassium, boron and zinc at 30 and 60 DAS increased upto 60 DAS and then it declines up to 90 DAS. The decline in LAI after 60 DAS might be due the senescence and abscission of leaves. Foliar application of potassium nitrate @ 2 per cent + boric acid @ 50 ppm + zinc sulphate @ one per cent at 30 DAS and 60 DAS recorded 37 per cent higher leaf area index at 60 DAS over control due to, the fact that those plants maintained higher leaf area, leaf drymatter and crop growth rate by utilizing the foliar applied nutrients[11]. This might be due to potassium enhancing the enzymatic system of plants.

From the present results, it is evident that all the treatments varied significantly for LAI of the plants, irrespective of growth stages. Among the various foliar spray treatments, NPK-19:19:19 @ 0.5% and $KNO_3$ @ 0.5% recorded higher LAI at all growth stages followed by KCl @ 1% foliar spray due to, increased net photosynthesis and chlorophyll content.

**Table 1: Effect of foliar application of nutrients on Leaf, Stem, Pod, Total dry weight (g plant$^{-1}$) and LAI of groundnut (var. Dharani) under moisture stress conditions**

| S. No. | Treatments | At 75 DAS | | | | |
|---|---|---|---|---|---|---|
| | | LAI | Stem dry weight (g plant$^{-1}$) | Leaf dry weight (g plant$^{-1}$) | Pod dry weight (g plant$^{-1}$) | Total dry weight (g plant$^{-1}$) |
| 1. | Control (Irrigated) | 4.75 | 9.65 | 9.50 | 3.90 | 23.05 |
| 2. | Control (Stress) | 3.21 | 7.67 | 6.74 | 2.37 | 16.78 |
| 3. | Water spray | 3.74 | 8.10 | 7.11 | 3.02 | 18.23 |
| 4. | 2% Urea | 3.91 | 8.18 | 6.96 | 3.01 | 18.15 |
| 5. | 2% DAP | 4.02 | 8.11 | 7.10 | 3.13 | 18.34 |
| 6. | 1 % KCl | 4.31 | 9.14 | 7.58 | 3.55 | 20.27 |
| 7. | 0.2% $ZnSO_4$ | 4.11 | 8.65 | 7.07 | 2.69 | 18.41 |
| 8. | 0.5% $FeSO_4$ | 4.07 | 8.59 | 7.02 | 3.32 | 18.93 |
| 9. | 1% Urea+0.2% $ZnSO_4$+0.5% $FeSO_4$ | 4.17 | 8.82 | 7.61 | 2.89 | 19.32 |
| 10. | N:P:K- 19:19:19 @0.5% | 4.40 | 9.40 | 7.63 | 3.52 | 20.55 |
| 11. | N:P:K- 17:17:17 @ 0.5% | 4.02 | 8.66 | 7.30 | 3.34 | 19.30 |
| 12. | 0.5% $KNO_3$ | 4.46 | 9.05 | 7.80 | 3.73 | 20.58 |
| | **MEAN** | **4.10** | **8.67** | **7.45** | **3.20** | **19.32** |
| | **CD (P=0.05)** | **0.14** | **0.693** | **0.594** | **0.452** | **1.00** |
| | **SEm ±** | **0.05** | **0.236** | **0.202** | **0.154** | **0.342** |

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