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A Comparative Study on the Effect of Foliar Application of Nitrogen, Phosphorus, Potassium, Iron and Zinc on Proline Content, Yield and Cost- Benefit ratio of groundnut Plants Grown under Water Stress Conditions

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ABSTRACT

Proline is a potential osmoprotectant to alleviate adverse effects of abiotic stresses on plants. Nutrient management is one of the most important factors in successful cultivation of plants. In order to study the effects of foliar nutrition on grain yield, shelling percentage and proline content of groundnut genotype, an experiment was conducted using a Randomized Block Design with three replications at Dryland Farm of S.V.Agricultural College, Regional Agricultural Research Station, Acharya N.G. Ranga Agricultural University, Tirupati during rabi season, 2014-15. 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 to mitigate moisture stress, significant difference was found at 75- 90 DAS of crop growth period. At 75 DAS, the foliar spray treatments, NPK- 19:19:19 @ 0.5%, KCl @ 1% and KNO_3 @ 0.5% recorded only moderate (645.7, 673.9 and 670.0 µg g^{-1} respectively) proline content values compared to other foliar treatment. NPK- 19:19:19 @ 0.5% showed 28 per cent higher pod yield followed by KNO_3 @ 0.5% and KCl @ 1 % and with 26, 23 per cent higher pod yield, respectively compared to control stress treatment. Among the foliar spray treatments, NPK- 19:19:19 @ 0.5% showed significantly 36 per cent highest B:C Ratio (2.16) followed by KNO_3 @ 0.5% and KCl @ 1 % showed 30 per cent and 23 per cent highest B:C Ratio (2.06 and 1.96 respectively) compared to other treatments.*

Key wards: *Groundnut, Moisture stress, Nutrients, Foliar application.*

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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*[5]., concluded that groundnut yield is reduced under water stress. Nuts are a good source of oil containing higher amounts of unsaturated fatty acids as compared to saturated fatty acids. Drought stress reduces the stabilization in leguminous plants[7], especially in groundnut[15]. 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. 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[4]. Umar[17] 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. Groundnuts and groundnut butter are energy rich and nutritious foods, providing a valuable supply of a wide range of vitamins, minerals and dietary fiber[9].

Foliar fertilization has advantages of low application rates, uniform distribution of fertilizer materials and quick response to nutrients. To counteract cyclic droughts, foliar fertilization with K for groundnut in Gujarat, India is considered beneficial. Umar and Bansal[16] indicated that the best results of groundnut plants were achieved with foliar application of 1% KCl. Stress at a pod formation stage produced the least yield and yield components' values. On the other hand, water stress had a stimulating effect on proline and crude protein contents.

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.

Leaf Proline Content (µg g^{-1}):

Proline is a basic amino acid found in higher percentage in basic proteins. Free proline is said to play a role in plants under stress conditions. Though the molecular mechanism has not yet been established for the increased level of proline. One of the hypotheses refers to breakdown of proteins into amino acids and conversion to proline for storage. Many workers have reported several fold increase in proline content under physiological and pathological stress conditions. Hence, the analysis of proline in plants has become routine in pathology and physiology divisions of agricultural sciences. Proline accumulation was determined as described by Bates *et al*[1].

Pod yield (kg ha^{-1}):

Pods from the net plot area were separated from haulms, sun dried till constant weight was attained and expressed in kg ha^{-1}.

Benefit –Cost ratio (B:C Ratio):

The total cost of cultivation ha^{-1} was calculated for each treatment on the basis of input cost. Gross returns hectare^{-1} was computed by considering the prevailing market price of the output. Net returns ha^{-1} were arrived at by deducting the cost of cultivation of respective treatments from gross returns for the corresponding treatments. Benefit-cost ratio was worked out for each treatment by using the following formula

$$\text{Benefit: Cost ratio} = \frac{\text{Gross returns (Rs. ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs. ha}^{-1}\text{)}}$$

RESULTS AND DISCUSSION

The results of present investigation revealed existence of sufficient treatment variability among the treatments tested for Proline content and Pod yield. The data pertaining to Proline content at 75 DAS and pod yield, B:C Ratio at harvest stage in response to foliar spray treatments were mostly discussed and presented here.

Proline content (μg g^{-1})

Proline content of groundnut variety Dharani influenced by foliar spray treatments for drought mitigation were recorded at four stages at 75 DAS and given in Table 1.

Accumulation of proline has been advocated as a parameter of selection for stress tolerance. Proline accumulation can be met with the moisture stress. High levels of proline enabled the plant to maintain low water potentials. Plants are known to withstand the prevailing drought stress by synthesizing and accumulating compatible solutes like sugars,polyols, betaines and proline which play a pivotal role in stress tolerance[13]. Proline accumulation is often considered to be involved in stress resistance mechanisms[14]. Proline accumulated in plants as a response of various environmental stresses[19].

Due to moisture stress at pod development to maturation stage *i.e*. from 45-75 DAS, proline content increased significantly in control stress treatment. There was no significance difference for proline content with 330 - 365 μg g^{-1} proline among the treatments at 45 DAS. At 75 DAS, the control irrigated treatment recorded 30 per cent lower proline content compared to control stress treatment.

In Bambara groundnut proline levels were increased by water stress mostly during the pod filling stage. Water stress significantly increased ($p<0.05$) proline concentration in bambara groundnut plants water stressed at the vegetative, flowering and pod filling stages compared to non-stressed plants. Rewatering significantly ($p<0.05$) reduced proline concentrations in all the water stressed plants at different stages of growth and development[20].

Among the foliar spray treatments to mitigate moisture stress, significant difference was found at 75- 90 DAS of crop growth period. At 75 DAS, the foliar spray treatments, NPK- 19:19:19 @ 0.5%, KCl @ 1% and KNO_3 @ 0.5% recorded only moderate (645.7, 673.9 and 670.0 μg g^{-1} respectively) proline content values compared to other foliar treatment.

Nisha Kataria *et al*[12]., reported that in mungbean under stress condition, the decrease in osmotic potential was mainly due to the accumulation of solutes like proline and soluble carbohydrates. Potassium application improves physiological characteristics such as stomatal resistance, RWC, and proline contents which might improve the overall plant water status and metabolism in groundnut under water stress condition[18].

Pod yield (kg ha^{-1})

Bootang *et al*[2]., reported that number of matured pods in groundnut was slightly decreased from 23.7 to 22.1 pods plant^{-1} and pod yield was decreased from 3011.3 to 2289.8 kg ha^{-1} due to water stress.

Present data showed that, pod yield varied significantly among the treatments studied under moisture stress condition. Treatment variability of 1668-3149 kg ha^{-1} was recorded in groundnut variety Dharani. Among the treatments control stress treatment recorded 48 per cent reduction in pod yield compared to control irrigated treatment. Among foliar spray treatments NPK- 19:19:19 @ 0.5% showed 28 per cent higher pod yield followed by KNO_3 @ 0.5% and KCl @ 1 % and with 26, 23 per cent higher pod yield, respectively compared to control stress treatment.

El-Habbasha and Taha[6] concluded that in groundnut, foliar Zinc application at seed filling stage tended to increase the Nitrogen Use Efficiency (NUE). The increased yield may be due to the role of nitrogen fertilizer in increasing photosynthetic rate, synthesis of metabolites and translocation of assimilates to the seed as zinc is the activator of several enzymes in the plants. Naveen kumar *et al*[11]., stated that in groundnut, higher dry pod yield (4361 kg ha^{-1}) was obtained with better fertilizer management involving basal application of 20 kg N, 60 kg P_2O_5 and 25 kg K_2O ha^{-1} with foliar application of 7 kg N ha^{-1} through urea at 45 and 60 days after sowing due to, the additional amount of nitrogen supplied though the foliar application.

Benefit- Cost Ratio (B:C Ratio)

Dixit and Elamathi[3] reported that, significantly higher gross returns (Rs 52,900 ha^{-1}), net returns (Rs 35,431 ha^{-1}) and B:C ratio (3.03) were noticed in RDF + foliar spray of 40 ppm NAA + 0.5 % chelated micronutrient + 2% DAP compared to control, but it was on par with RDF + foliar spray of 2% DAP + 0.5 % chelated micronutrient. The higher gross returns, net returns and B:C ratio obtained with these sprays were ultimately due to higher productivity in terms of yield in these treatments.

From the present study, B:C Ratio varied significantly among the treatments studied under moisture stress situation. Among the treatments, control irrigated treatment recorded 86 per cent higher B:C Ratio (2.97) compared to control stress treatment (1.59). Among the foliar spray treatments, NPK- 19:19:19 @ 0.5% showed significantly 36 per cent highest B:C Ratio (2.16) followed by KNO_3 @ 0.5% and KCl @ 1 % showed 30 per cent and 23 per cent highest B:C Ratio (2.06 and 1.96 respectively) compared to other treatments.

Narendra Kumar Pareek and Bhanwer Lal Poonia[10] stated that in groundnut, combining the application of FYM (Farm Yard Manure) at 15 t ha^{-1}, nitrogen at 60 kg ha^{-1} in three splits and foliar spray of 1% $FeSO_4$ integrated with 0.1 per cent citric acid improved benefit to cost ratio (B:C ratio) and recorded the highest net returns (60,159 Rs. ha^{-1}) that was higher by 274 per cent over absolute control.

Table 1: Effect of foliar application of nutrients on Proline content (µg g^{-1}), pod yield (kg ha^{-1}) and B:C ratio of groundnut (var. Dharani) under moisture stress conditions.

S. No.	Treatments	At 75 DAS	At Harvest	
		Proline Content (µg g^{-1})	Pod yield (kg ha^{-1})	B:C ratio
1.	Control (Irrigated)	460.5	3149	2.97
2.	Control (Stress)	665.0	1668	1.59
3.	Water spray	690.3	1815	1.72
4.	2% Urea	680.2	1700	1.57
5.	2% DAP	693.8	1844	1.55
6.	1 % KCl	673.9	2154	1.96
7.	0.2% $ZnSO_4$	738.2	1903	1.76
8.	0.5% $FeSO_4$	733.8	1815	1.62
9.	1% Urea+0.2% $ZnSO_4$+0.5% $FeSO_4$	711.8	1885	1.61
10.	N:P:K- 19:19:19 @0.5%	645.7	2335	2.16
11.	N:P:K- 17:17:17 @ 0.5%	730.7	2048	1.89
12.	0.5% KNO_3	670.0	2190	2.06
	MEAN	**674.5**	**2042**	**1.87**
	CD (P=0.05)	**86.5**	**285**	**0.265**
	SEm ±	**29.5**	**97**	**0.09**

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