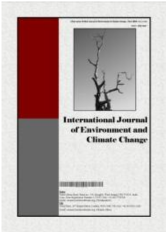

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Effect of Moisture Regimes and Gypsum Levels on Growth and Yield of Rabi Groundnut (*Arachis hypogea* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

A Field experiment was conducted in groundnut at Krishi vignan Kendra, Palem, Nagarkurnool district, Telangana state, India during *rabi* 2021 to study the influence of three moisture regimes *viz* 0.6, 0.8 and 1.0 IW/CPE ratios and five gypsum levels *viz* G_0- Control, G_1- 300 kg ha^{-1}, G_2- 400 kg ha^{-1}, G_3- 500 kg ha^{-1} and G_4- 600 kg ha^{-1} and was replicated thrice. Experiment was laid out in split plot design. Among different moisture regimes and gypsum levels, significantly higher values of plant height (26.2 cm) at 90 DAS, drymatter production (1803.4 and 3262.3 kg ha^{-1}) at 90 DAS and at harvest were recorded with I_3 (1.0 IW/CPE) and with G_4- gypsum @ 600 kg ha^{-1} (plant height- 27.4 cm) at 90 DAS, drymatter production (2092.7 and 4327.9 kg ha^{-1}) at 90 DAS and at harvest. Similarly yield attributes- number of filled pods $plant^{-1}$- (60) and shelling percentage- (67.1%) and yield- pod and halum yield- (1977.4, 3253.4 kg ha^{-1} respectively) was also

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significantly higher with I_3 (1.0 IW/CPE), whereas unfilled pods plant^{-1} was higher (6.1) with I_1 (0.6 IW/CPE). 100-kernel weight found to be non-significant. Among gypsum levels highest yield and yield attributes was recorded with G_4 *i.e.,* gypsum @ 600 kg ha^{-1}. The interaction effect also found to be significant with respect to drymatter production, filled and unfilled Pods plant^{-1}.

Keywords: Moisture regimes; gypsum levels; groundnut.

1. INTRODUCTION

Groundnut is an important oil and protein source to a large portion of the population in India. It is an annual, herbaceous legume and considered as king of vegetable oilseed crops in India and occupies a pre-eminent position in the national edible oil economy. Groundnut seed contains 47-53% oil, 26% protein and 11.5% starch. It is currently growing in an area of 21.8 million hectares throughout the globe (2021). India, China and the United States of America have been the leading producers for the last 25 years and account for 70% of the area in the world. In India it is grown on an area of about 4.82 million ha with a total production of 9.95 million tonnes and productivity of 2.06 tonnes ha^{-1} during 2019-20. In Telangana it occupies an area of 0.11 m ha with total production of 0.26 million tonnes and productivity of 2.39 tonnes ha^{-1} in 2019-20 Indiastat [1].

Cultivation of groundnut under rainfed conditions and imbalanced nutrient management are the main reasons for low productivity of groundnut. Irrigation water, a crucial input in crop production, is scarce and expensive. Resource efficient use of this input is essential, which can be achieved through judicious water management practices. Adequate and timely supply of water is essential for higher yields. Keeping the total quantity of irrigation water constant, increasing the frequency of irrigation would maximize the yields of several crops. There is a possibility to double the groundnut yields during the of *rabi* season over *kharif* with a limited number of irrigations Because of high productivity under assured irrigation, a climatological approach based on IW/CPE ratio (IW-irrigation water, CPE - cumulative pan evaporation) in irrigation scheduling has been found most appropriate as it integrates most of the weather parameters which determine the water requirement of a crop and increases production by at least 15 to 20%. Scheduling of irrigation based on IW/CPE depends on both available water holding capacity of soil and climatic parameters.

To ensure increased yields *of rabi* groundnut in traditional areas of Telangana, it is necessary to have a thorough understanding of the changes in the soil-plant-water relations and various morpho-physiological processes in relation to the scheduling of irrigation water. Studies on various aspects of groundnut nutrition are limited, particularly under varied soil moisture regimes, hence efforts are needed to quantify the crop response *vis-a-vis* at different nutrient levels.

Sulphur is essential to plant nutrition, and the fourth major plant nutrient next to nitrogen (N), phosphorus (P) and potassium (K), especially for oilseed crops. It is essential for synthesis of oil, in addition to protein production and activation of enzymes. It is a constituent of the aminoacids like cysteine, cystine and methionine and also involved in the formation of glucosides or glucosinolates, which on hydrolysis increase the oil content. It also plays an important role in chlorophyll and vitamin formation Gosh [2].

Calcium is required by groundnut plants from the time when pegs begin to appear in fruit formation, until the pods are mature. Calcium deficiency leads to a high percentage of aborted seeds (empty pods) and improperly filled pods Islam [3].

Gypsum is a moderately soluble source of the essential plant nutrients *viz*., calcium and sulphur, and improves overall plant growth. Gypsum amendments can also improve soil physical properties, prevent crust formation, promote seedling emergence, increase water infiltration rates and movement through the soil profile.

Keeping this point in view, an experiment was designed on groundnut to study the effect of growth and yield of *rabi* groundnut for a profitable approach to realizing the maximum yield potential.

2. MATERIALS AND METHODS

An experiment was conducted during *rabi* season 2021 at Krishi vignan Kendra, Palem, Nagarkurnool, India. The experimental site is 478 meters above mean sea level and is located at 16°31'07.4"N latitude and 78°15'04.6"E longitude. The present research work is framed with an objective to study the effect of moisture regimes and gypsum levels on growth and yield of *rabi* groundnut variety kadiri lepakshi - 1812.The experiment was laid out in split plot design. The soil samples were drawn from 0-30 cm depth and analysed for their physical and chemical properties by adopting standard procedures shows pH of 7.1, Medium in available nitrogen (260 kg ha^{-1}) by alkaline permanganate method, phosphorus (25.3 kg ha^{-1}) by olsen's method, Potassium (201 kg ha^{-1}) by neutral ammonium acetate and sandy loam in texture. The experiment consisted of 15 treatment combinations *viz.,* three moisture regimes (0.6 IW/CPE, 0.8 IW/CPE and 1.0 IW/CPE), and five gypsum levels (G_0- control, G_1- 300 kg ha^{-1}, G_2- 400 kg ha^{-1},G_3- 500 kg ha^{-1} and G_4- 600 kg ha^{-1}) applied at flower initiation stage. Fertilizers urea and DAP (for N and P), MOP for K_2O were applied to supply 30 kg N, 40 kg P_2O_5 and 50 kg ha^{-1}. Entire phosphorus and potash, half of the nitrogen (urea) were uniformly broadcasted before sowing and incorporated into the soil. Remaining half dose of nitrogen was top-dressed by band placement between 25-30 days after sowing depending on irrigation dates as per schedule of treatments. Crop was sown at a row distance of 30cm and plant to plant of 10cm. The crop was sown during 4^{th} week of December and harvested at 4^{th} week of april. During the crop growing period the weekly mean maximum temperature ranged between 29°C and 38.9°C with an average of 34.2°C in 2021- 22 while the weekly mean minimum temperature ranged from 15°C and 24.8°C with an average of 19.6°C, rainfall with average of (0.6 mm) and mean evaporation with average of (6.6 mm day^{-1}) was recorded. Five plants were randomly selected in each net plot area for taking observations on growth and yield attributing parameters. The samples were first dried under shade and then in electric oven at temperature of 60°C till attaining constant weight, on the basis of weight of these samples, then converted into dry matter production (kg ha^{-1}). Total number of pods (filled and unfilled pods) from ten labelled plants in each treatment was counted, averaged and expressed as number of pods $plant^{-1}$. Three separate random samples (250 g) of pods were drawn, kernels separated and weights recorded. The percentage of kernel weight to pod weight was worked out for each treatment to know the shelling percentage. To know the test weight, sample of pods with unknown weight was selected from the net plot produce, pods were shelled and kernels were separated to estimate the weight of hundred sound kernel weight. To estimate pod and haulm yield (kg ha^{-1}) pods and haulm were sun dried from the net plot area produce and then weighed and expressed in kg ha^{-1}. Data on growth parameter *i.e*., drymatter production (kg ha^{-1}), yield attributes and yield (kg ha^{-1}) was noted. Data obtained was statistically analyzed as suggested by Panse and Sukhatme [4].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Moisture regimes

Drymatter production (1803.4 and 3262.3 kg ha^{-1}) at 90 DAS and at harvest was significantly higher with I_3 (1.0 IW/CPE) over other treatments. Whereas at before gypsum application stage was found to be non-signifcant which was depicted in Table 1. Adequate accessible soil moisture in the root zone depth of soil, along with frequent irrigations may have improved nutrient availability, improving cell division and cell expansion which resulted in increasing the total dry-matter. This findings were in close confirmity with Padmalatha [5] and Pawar [6].

3.1.2 Gypsum levels

Drymatter accumulation (2092.7 and 4327.9 kg ha^{-1}) 90 DAS and at harvest showed significantly higher values with gypsum @ 600 kg ha^{-1} compared to other treatments, while lowest values recorded with (G_0- control. More dry matter at (G_4) could be linked to chloroplast protein synthesis stimulated by sulphur availability to plant, resulting in better chloroplast synthesis, greater photosynthetic efficiency and higher dry matter production. Similar results were documented by Longkumer & Gohain [7].

3.2 Yield Attributes

3.2.1 Moisture regimes

Number of filled Pods $plant^{-1}$ and shelling percentage showed significantly higher values with I_3 (1.0 IW/CPE) *i.e.,* (60 and 67.1% respectively) over other treatments, whereas unfilled pods are higher (6.1) with I_1 (0.6 IW/CPE). 100-kernel weight found to be non-significant.Table 2.These findings were similar with Katre [8], Taha and Gulati [9] and Patel [10].

Pod yield and halum yield (kg ha^{-1}) (1977.4 and 3253.4 kg ha^{-1}) is significantly higher with I_3 (1.0 IW/CPE). while lower values of pod and haulm yields with I_1 (0.6 IW/CPE). Yield attributes and yield increase is due to increase in irrigation which ascribed to adequate moisture availability in turns have favored congenial conditions for the luxurious growth of crop. These findings were in close confirmity with Rathode and Trivedi [11] and Naresha [12] and Kumaran [13].

3.2.2 Gypsum levels

Number of filled pods $plant^{-1}$ and shelling percentage of groundnut showed significantly higher values (76 and 70.2%) with G_4 @ 600 kg ha^{-1} compared to other gypsum treatments. Unfilled pods $plant^{-1}$ higher with G_0- control. 100-kernel weight found to be non-significant. Among varied levels of gypsum *i.e.,* G_4- gypsum @ 600 kg ha^{-1} showed significantly higher values of pod and halum yield (2194.5 and 3436.1 kg ha^{-1}) compared to other treatments. Least value of pod and halum yield (1666.6 and 2944.5 kg ha^{-1}) with G_0- control. Gypsum application might have ensured adequate supply of calcium and sulphur, have favoured not only in pod formation but also in better filling of the pods thus would have increased number of filled pods and consequently increased the weight of 100 kernels. These findings are in close proximity with Pasala Ramya and Rajesh Singh [14], Ransing [15] and Rout and Jena [16].

Data regarding interaction between moisture regimes and gypsum levels on number of unfilled pods $plant^{-1}$ showed higher value (6.1) with I_1G_0 (0.6 IW/CPE and G_0 – Control) while least value with I_3G_4 (1.0 IW/CPE and Gypsum @ 600 kg ha^{-1}). Table 3. Highest unfilled pods $plant^{-1}$ was obtained with I_1G_0 (0.6 IW/CPE and G_0 – Control) treatment which might be due to decreased nutrient availability under conductive soil environment with decrease in the frequency of irrigation. These findings were similar with Naresh [12]. It was observed that increase in yield attributes which might be due to balanced nutrition showed marked improvement in greater pod number and test weight. The reason might be efficient and greater portioning of metabolites and translocation of nutrients to the reproductive parts. These results are in close proximity with the findings of Rout and Jena [16].

Table 1. Drymatter production (kg ha^{-1}) of *rabi* groundnut as influenced by moisture regimes and gypsum levels at different crop growth stages

Treatments	Drymatter production (kg ha^{-1})			
	Before gypsum	60 DAS	90 DAS	At harvest
Moisture regimes (I)				
I_1- 0.6 IW/CPE	547.2	913.4	1699.6	2874.7
I_2- 0.8 IW/CPE	552.3	920.4	1766.5	3239.4
I_3- 1.0 IW/CPE	557.2	930.1	1803.4	3262.3
SEm ±	4.4	4.7	7.4	10.4
CD (P=0.05)	NS	NS	29.9	40.9
Gypsum levels (G)				
G_0- Control	527.8	852.7	1466.3	1754.6
G_1- Gypsum at 300 kg ha^{-1}	540.3	903.8	1572.5	2314.9
G_2- Gypsum at 400 kg ha^{-1}	552.3	931.2	1728.1	3358.7
G_3- Gypsum at 500 kg ha^{-1}	562.5	951.2	1922.8	3871.4
G_4- Gypsum at 600 kg ha^{-1}	578.2	967.6	2092.7	4327.9
SEm±	5.3	6.4	9.4	30.4
CD (P=0.05)	NS	NS	27.8	88.9
Interaction (I X G)				
Sub treatment at same level of main treatment				
SEm±	10.0	10.71	16.5	52.8
CD (P= 0.05)	NS	NS	NS	109.0

Treatments	Drymatter production (kg ha^{-1})			
	Before gypsum	60 DAS	90 DAS	At harvest
Main treatment at same or different level of sub treatment				
SEm±	9.3	11.01	16.4	23.3
CD (P=0.05)	NS	NS	NS	64.7

Table 2. Yield attributes and yield of *rabi* groundnut as influenced by moisture regimes and gypsum levels at different crop growth stages

Treatments	Number of pods plant^{-1}		100 kernel weight	Shelling percentage	Yield	
	Filled pods	Unfilled pods			Pod yield (kg ha^{-1})	Halum yield (kg ha^{-1})
Moisture regimes (I)						
I_1- 0.6 IW/CPE	53	6.10	33.9	64.9	1892.0	3165.0
I_2- 0.8 IW/CPE	57	4.50	33.4	64.9	1913.0	3198.3
I_3- 1.0 IW/CPE	60	2.42	33.5	67.1	1977.4	3253.4
SEm ±	0.2	0.02	0.1	0.4	12.9	12.3
CD (P=0.05)	0.9	0.11	NS	1.6	52.1	49.8
Gypsum levels (G)						
G_0- Control	36	5.10	33.0	62.6	1666.6	2944.5
G_1- Gypsum at 300 kg ha^{-1}	47	4.70	33.2	63.6	1825.6	3070.3
G_2- Gypsum at 400 kg ha^{-1}	57	4.34	33.4	65.1	1922.6	3240.2
G_3- Gypsum at 500 kg ha^{-1}	67	3.96	33.7	66.7	2028.0	3336.6
G_4- Gypsum at 600 kg ha^{-1}	76	3.60	33.9	70.2	2194.5	3436.1
SEm±	0.5	0.03	0.2	0.4	14.4	22.8
CD (P=0.05)	1.6	0.10	NS	1.3	42.5	67.1
Interaction (I X G)						
Sub treatment at same level of main treatment						
SEm±	0.9	0.06	0.2	0.9	28.9	27.6
CD (P= 0.05)	1.9	0.19	NS	NS	NS	NS
Main treatment at same or different level of sub treatment						
SEm±	0.5	0.06	0.4	0.8	25.8	37.5
CD (P=0.05)	1.4	0.19	NS	NS	NS	NS

Table 3. Unfilled pods per plant of rabi groundnut at harvest as influenced by interaction between moisture regimes and Gypsum levels

Gypsum levels	Moisture regimes			
	I_1 (0.6 IW/CPE)	I_2 (0.8 IW/CPE)	I_3 (1.0 IW/CPE)	MEAN
G_0- Control	6.8	5.1	3.4	5.1
G_1- Gypsum at 300 kg ha^{-1}	6.3	4.8	2.9	4.7
G_2- Gypsum at 400 kg ha^{-1}	6.1	4.5	2.4	4.3
G_3- Gypsum at 500 kg ha^{-1}	5.8	4.2	1.9	3.9
G_4- Gypsum at 600 kg ha^{-1}	5.4	3.9	1.5	3.6
Mean	6.1	4.5	2.4	
Sub treatment at same level of main treatment				
SEm±				0.06
CD (P=0.05)				0.19
Main treatment at same or different level of sub treatment				
SEm±				0.06
CD (P=0.05)				0.19

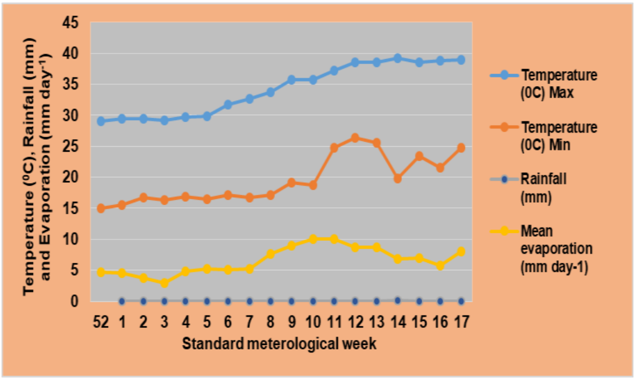

Fig. 1. Maximum and minimum temperatures (°C), Rainfall (mm), Mean evaporation (mm day^{-1}) during the crop growth period

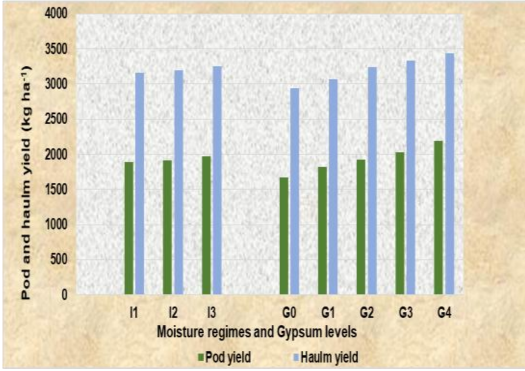

Fig. 2. Pod and haulm yield (kg ha^{-1}) of groundnut as influenced by moisture regimes and gypsum levels

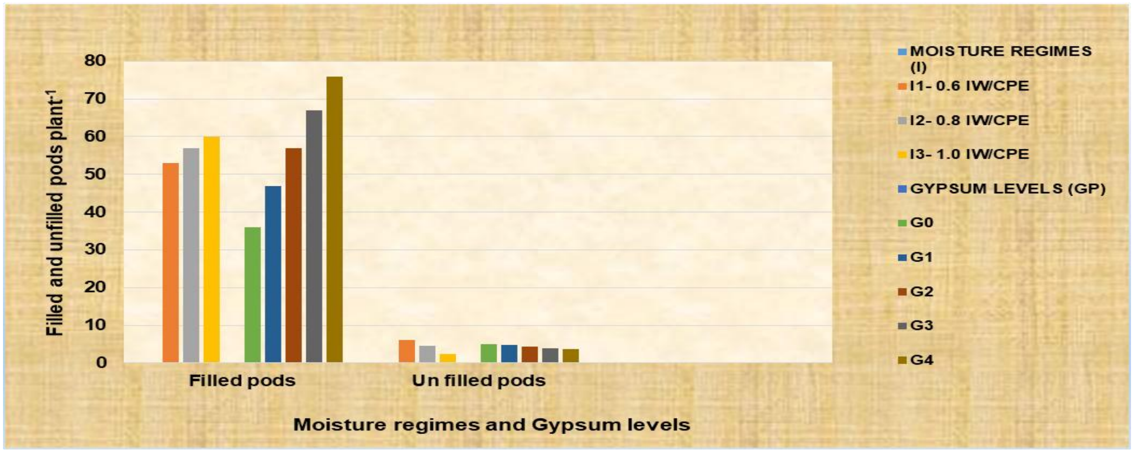

Fig. 3. Filled and unfilled pods plant^{-1} by the effect of moisture regimes and gypsum levels

4. CONCLUSION

This field experiment inferred that moisture regime I_3 (1.0 IW/CPE) and Gypsum level (G_4 at 600 kg ha^{-1}) showed the highest values of growth parameters, yield attributes and yield which can be cultivated for realizing higher pod yields under *rabi* conditions on the sandy loam soils of Telangana region.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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