PRODUCTIVITY OF IRRIGATED GROUNDNUT AS INFLUENCED BY POTASSIUM AND SULPHUR NUTRITION IN SANDY CLAY LOAM SOIL

ABSTRACT

Field experiments were conducted during the Kharif and rabi season of 2021 in the farmer's field of Perampattu Village, Tirupattur Taluk & District, TN, India to study the effect of K and S management in groundnut. The soil of the experiment field belongs to sandy clay loam, available nitrogen (133.4 kg ha^{-1}), phosphorus (16.8 kg ha^{-1}), potassium (113.1 kg ha^{-1}), and sulfur (4.80 mg kg^{-1}), respectively. The experiments were laid out in Randomized Block Design (RBD) with eight treatments *viz.*, T_1-Control, T_2–RDF (Blanket Recommendation as 25:50:75 kg NPK ha^{-1}), T_3- RDF + Add 0.25 % of K through MOP (Foliar Application), T_4– RDF + Add 0.5 % of K through MOP (Foliar Application), T_5– RDF + Add 0.25 % of K through SOP (Foliar Application), T_6– RDF + Add 0.5 % of K through SOP (Foliar Application), T_7– RDF + Add 0.25 % of K through KNO_3 (Foliar Application), T_8– RDF + Add 0.5 % of K through KNO_3 (Foliar Application) and replicated thrice. Higher yield of groundnut in Kharif & rabi 3103 Kg ha^{-1} & 2895 Kg ha^{-1}, respectively, and percent of yield increase in T_4 was 3.9 and 5.63 over other treatments and also maximum gross income, net income, and benefit-cost ratio were obtained in RDF + Add 0.5 % of K through MOP (T_4) applied treatment in both seasons. The lowest gross income, net income, and benefit-cost ratio were achieved in T_1.

Keywords: Economics, Foliar, Groundnut, Potassium, Sulphur , nutrient management

INTRODUCTION:

Groundnut is a significant food legume crop in tropical and subtropical regions. Groundnut alone contributes 70 percent of the total edible oil production. It is a valuable crop for marginal farmers largely grown during summer and Kharif season. Groundnut can be grown under a wide range of climatic conditions however the best-suited temperature is range between 22^0C to 37^0C (Ashok, 2018). India is the world's second-largest importer of vegetable oils, right after China. The domestic use of edible oils has significantly increased over the past few years. To meet the vegetable oil demand in 2020, it is projected that groundnut production has to reach 14.8 m tons, which is an increase of 5.3 m tons from the current production of 9.47 m tons (ICRISAT, 2014). India, therefore, depends on imports it is necessary to meet its need. Because the current supply is insufficient to meet demand, oil is imported from other nations. Therefore, efforts should be made to increase the total production of groundnuts to meet the growing demand.

Awareness growing among people about the nutritional and medicinal benefits of peanuts. Groundnut consumption is significantly associated with reduced risk of cancer, cardiovascular, respiratory, infectious, renal, and liver disease mortality (Amba *et al.,* 2019). Most biochemical and physiological processes that affect plant development and metabolism need potassium (K), an important mineral. Additionally, it helps plants survive biotic and abiotic stressors such as disease, pests, salt, cold, frost, and waterlogging (Wang *et al.,* 2013). The application of additional potassium in deficit soil may respond well to the growth and development of the groundnut crop. Though the recommendation of K in the manurial schedule is high still it requires some extra percentage of nutrients as it purely depends on the initially available status of soil K. Besides, the mode of application is more important than the amount of nutrient application to the crop to enhance the use efficiency of any nutrient. To reveal the above points the study was framed to identify the viable potassium and sulfur nutrient management with optimum levels and sources of irrigated groundnut.

MATERIALS AND METHODS

The field experiments were conducted in the Kharif and rabi season of 2021 at the farmer's field of Perampattu Village, Tirupattur Taluk & District, TN, India (12.38' N latitude, 78.58 'E longitude to study the effect of K and S management in groundnut(variety VRI 8). The soil of the experiment field belongs to sandy clay loam, available nitrogen (133.4 kg ha^{-1}), phosphorus (16.8 kg ha^{-1}), potassium (113.1 kg ha^{-1}), and sulfur (4.80 mg kg^{-1}), respectively.

The experiment was laid out in Randomized Block Design (RBD) with the following treatments *viz.*, T_1-Control, T_2–RDF (Blanket Recommendation as 25:50:75 kg NPK ha^{-1}), T_3- RDF + Add 0.25 % of K through MOP (Foliar Application), T_4– RDF + Add 0.5 % of K through MOP (Foliar Application), T_5– RDF + Add 0.25 % of K through SOP (Foliar Application), T_6– RDF + Add 0.5 % of K through SOP (Foliar Application), T_7– RDF + Add 0.25 % of K through KNO_3 (Foliar Application), T_8– RDF + Add 0.5 % of K through KNO_3 (Foliar Application) and replicated thrice. The varieties were sown by hand in the fields. Spacing adopted between the rows and plants was 30 cm and 10cm, respectively. Care was taken to ensure uniform depth of planting. Sound, mature, and good-quality kernels were only selected for sowing. The recommended dose of 25:50:75 kg NPK ha^{-1} in the form of Urea (46 % N), DAP (46 % P_2O_5& 18 % N), and Murate of potash (60 % K_2O) were applied to the groundnut crop. 50 % N, 100 % P_2O_5 and 50 % K_2O were applied as basal. The remaining 50 % N and 50 % K were applied as a top dressing in two equal splits at 25 and 40 DAS. Gypsum @ 400 kg ha^{-1} was applied 40 DAS. The foliar application of potassium through MOP, SOP and KNO_3 during the crop growth stage of 25 DAS and 60 DAS @ 0.25 & 0.5 percent at each fertilizer as per the treatment schedules.

Biometric observations were obtained by selecting five representative sample plants from each plot at random the growth characters (plant height, leaf area index and DMP) were recorded at 60 DAS and at harvest, the yield components (the number of pegs $plant^{-1}$, number of pods $plant^{-1}$, pods yield, kernel yield, and haulm yield) were recorded at harvest stage and also the economics of irrigated groundnut were obtained in the experiments.

Plant Height

The plant height of the crop was measured by randomly selecting one square meter area with the help of the measuring scale at 60 DAS and at the time of harvest.

Leaf Area Index

Leaf area was measured on 60 DAS and at harvest; leaf area measurement was taken in the terminal leaflet of the fourth compound leaf of the central shoot. The leaf area was worked out without removing the leaves by using the formula proposed by Saxena *et al.,* (1972).

$$\textbf{LAI} = \frac{L \times W \times K \times \text{Number of leaves plant}^{-1}}{\text{Spacing (cm}^2)} \quad \ldots\ldots(1)$$

Where,

L = Maximum length of terminal leaflet of 4th Component leaf from the top (cm)

W = Maximum width of the same leaf (cm)

K = Correction factor (0.77)

Number of pods plants^{-1}

The number of pods plants^{-1} per square metre area of crop was counted by randomly uprooting the plants in the selected one square metre area at the time of harvest.

Pod Yield

Plants in the middle four rows of each plot were harvested and the pods pricked from the roots and dried in the sun on a concrete floor for a sufficient number of days and then weighed using a digital balance.

100-Seed Weight

In order to determine the average seed size/weight, about 100 pods were randomly selected per treatment, shelled and the seeds were mixed and from this number 100 seeds were picked and weighed to estimate the average seed size/weight.

Haulm Yield

After removing the pods from the plants harvested from the four inner rows, the leaves and the roots were removed from the plants and the remaining stuff was weighed and recorded as field weight.

Statistically analysis

The experimental data were statistically analyzed as suggested by Gomez and Gomez (1994). For significant results, the critical difference was worked out at 5 percent level.

RESULTS AND DISCUSSION

GROWTH COMPONENTS

The plant height, leaf area index, and dry matter production were significantly influenced by the soil applications of the recommended dose of fertilizer (RDF) combined with foliar application of potassium through MOP, SOP and KNO_3. Data indicated that (Table 1) various treatments, RDF +

Add 0.5 % of K through MOP (T_4) recorded the maximum mean plant height, leaf area index, and dry matter production, of 33.5 and 40.1 cm, 5.93 and 4.82, 4705.5 and 6300.7 kg ha^{-1} on 60 DAS and harvest stage. In the second season, RDF + Add 0.5 % of K through MOP (T_4) recorded the maximum mean plant height, leaf area index, and dry matter production, of 33.3 and 39.7 cm, 5.63 and 4.42, 4413 and 5446 kg ha^{-1} on 60 DAS and harvest stage. Which were statistically similar to season 1. The Application of additional Potassium @ 0.5 percent of RDF significantly increased the growth and growth components of groundnut. Nitrogen, phosphorus, and potassium are concerned with different plant growth functions *viz*., cell enlargement, greater photosynthetic activity, formation of carbohydrates, and translocation of solutes. Potassium plays an important role in the hormonal balance, influencing the increase in the level of auxin, an important hormone for plant growth (Karthikeyan *et al*., 2021). These might be the reasons for increased plant height in the present investigation. These findings were in line with the results of Mangesh *et al.* (2013). Furthermore, potassium plays a pivotal role in leaf development by way of enhancing auxin transport, patterning, and signaling in dark portions of leaves than exposed to light areas helps in cell division and cell differentiation (Yuanyan Xiong and YulingJiao, 2019)**.** The improvement in plant height and leaf area index by K application was also reported by Rubio *et al*., (2009) and Hemeid (2015).

The increase in DMP is due to the role played by potassium either direct or indirect in major plant processes such as photosynthesis, respiration, protein synthesis, CHO metabolism, and building resistance in plants against pests and diseases thus resulting in improvement in growth by accelerating dry matter production. Increased dry matter due to an increase in K application in groundnut crops has been reported by Karthikeyan *et al*., (2021). The improvement in DMP by K application was also reported by Chandra *et al.,* (2006).

YIELD COMPONENTS

The number of pegs $plant^{-1}$, number of pods $plant^{-1}$, pods, kernel, and haulm yield were significantly influenced by the soil applications of the recommended dose of fertilizer (RDF) combined with foliar application of potassium through MOP, SOP and KNO_3. Data indicated that (Table 2 & Fig 1.) various treatments, RDF + Add 0.5 % of K through MOP (T_4) recorded the number of pegs $plant^{-1}$, the number of pods $plant^{-1}$, pods yield, kernel yield, haulm yield of 32, 24, 3103 Kg ha^{-1}, 2165.9 Kg ha^{-1} and 4200 Kg ha^{-1} of groundnut. In the second season, RDF + Add 0.5 % of K through MOP (T_4) recorded the number of pegs $plant^{-1}$, number of pods $plant^{-1}$, pods yield, kernel yield, haulm yield of 29, 22, 2895 Kg ha^{-1}, 2015 Kg ha^{-1} and 3709 Kg ha^{-1} at harvest stage of groundnut This might be due to marked influence on no of pods $plant^{-1}$, test wt and shelling percentage under additional application of K @ 0.5% along with a recommended dose of fertilizer could be pivoted to the overall improvement in vigor and crop growth as reflected in the growth parameters including nodule number per plant. This could also be on credit for its profound influence in enhancing the adequate supply of metabolites and nutrient supply demands of reproductive structures for their growth and development in comparison to K with other treatment combinations. Similar findings were reported by Mekki (2015). Besides that, an improvement in vegetative structures that root to shoot ratio for nutrient absorption and photosynthesis, and robust partitioning of assimilates from source to sink denies the development of reproductive structures. These results are following the findings of Chaudhary *et al.,* (2015).

The higher haulm yield and pod yield in groundnut crops were ascribed due to the beneficial effect of readily available forms of nutrients especially N, K, and S to the crop which was supplied through the foliar spray. These nutrients were directly absorbed by the plant either through cuticle or stomata and might have participated in photosynthesis activity in the leaves of the plant leading to increased haulm yield. Further, it enhances the ability to fix atmospheric nitrogen through the formation of effective root nodules and mobilizes the phosphorus and potassium as well as other beneficial hormones, enzymes, and siderophores which might have helped in better uptake of nutrients, optimum growth, and higher yields. These results are in line with the findings of Chandra *et al.,* (2006). Supply of K in addition to NPK as recommended dose of fertilizer might have an influential role on the increased pod, haulm, and oil yield. The supply of an adequate amount of K and S helps in the development of floral primordia in groundnut plants which results in the development of pods and kernels that too sound matured kernels (SMK) Hemeid *et al.,* (2015).

The shelling percentage was not much more influenced by the different levels and sources of potassium and it was found non-significant.

ECONOMICS

Higher gross income (Rs. 1, 88,424 ha^{-1}; Rs. 1, 75,554.5 ha^{-1}), net income (Rs.1, 15,112 ha^{-1}; Rs.1, 02,242.5 ha^{-1}) and benefit-cost ratio (2.57; 2.39) in S1 and S2 respectively were recorded in the treatment T_4 (RDF + Add 0.5 % of K through MOP) shown in (Table 3). This may be primarily due to the higher pod and haulm yield with the less additional cost of K compared to additional yield under this treatment resulting in a higher net return per rupee invested of groundnut. The application of potassium at appropriate growth stages leads to increased nutrient availability and increased rate of photosynthesis which resulted in higher biomass, dry matter production, enhanced nutrient uptake thus higher yields. Similar findings were earlier reported by Shah *et al.,* (2013). Among the treatment, the control treatment (T_1) registered the least gross income of Rs. 64840.5 ha^{-1}, net income of Rs.2026.2 ha^{-1} and benefit-cost ratio of 1.03 & Rs. 54612 ha^{-1}, net income of (Rs.-10202.3) ha^{-1} and benefit-cost ratio of 0.84 in season 1& season 2 respectively.

CONCLUSION

Groundnut crops significantly responded to the application of K and S at different levels. From the present investigation, it can be concluded that the application of RDF + Add 0.5 % of K through MOP was established as the best nutrient management practice as it recorded the maximum mean plant height, leaf area index, dry matter production, the number of pegs $plant^{-1}$, the number of pods $plant^{-1}$, pods yield, kernel yield, haulm yield and economic parameters of groundnut in sandy clay loam. The result confirmed significant growth, the yield of groundnut, and economic benefits. Hence the application of RDF + Add 0.5 % of K through MOP for irrigated groundnut, can be recommended to groundnut growers.

Table.1 Effect of different sources and levels of K and S on growth components of groundnut

TREATMENTS	SEASON 1						SEASON 2					
	Plant Height (cm)		Leaf Area Index (LAI)		Dry Matter Production (DMP) Kg ha^{-1}		Plant Height (cm)		Leaf Area Index (LAI)		Dry Matter Production (DMP) Kg ha^{-1}	
	60 DAS	Harvest	60 DAS	Harvest	60 DAS	Harvest	60 DAS	Harvest	60 DAS	Harvest	60 DAS	Harvest
T_1	17.6	23.8	2.97	2.78	1667.9	2322.2	17.3	22.6	2.57	2.38	1427	1774
T_2	20.4	26.6	3.98	3.56	4138.2	5301.6	19.8	25.4	3.68	2.86	3916	4575
T_3	26.3	32.5	4.93	4.08	4409.7	5785.1	25.8	31.5	4.43	3.68	4128	5049
T_4	33.5	40.1	5.93	4.82	4705.5	6300.7	33.3	39.7	5.63	4.42	4413	5446
T_5	23.3	29.5	4.49	3.88	4315.7	5626.0	22.7	28.4	4.09	3.48	4053	4883
T_6	30.8	36.8	5.42	4.46	4543.4	6063.7	30.6	36.1	5.12	4.06	4281	5264
T_7	23.1	29.4	4.44	3.79	4239.5	5499.7	22.6	28.3	4.02	3.39	4020	4766
T_8	29.6	33.5	5.37	4.37	4449.4	5959.9	29.3	35.0	5.07	3.97	4212	5246
SEm±	**0.79**	**1.25**	**0.16**	**0.07**	**38.85**	**70.38**	**0.7**	**1.2**	**0.14**	**0.07**	**35**	**67**
CD (P=0.05)	**1.69**	**2.68**	**0.34**	**0.16**	**83.15**	**150.62**	**1.49**	**2.55**	**0.29**	**0.15**	**74.95**	**143.9**

T_1-Control

T_2–RDF (Blanket Recommendation as 25:50:75 kg NPK ha^{-1})

T_3- RDF + Add 0.25 % of K through MOP (Foliar Application)

T_4– RDF + Add 0.5 % of K through MOP (Foliar Application)

T_5– RDF + Add 0.25 % of K through SOP (Foliar Application)

T_6– RDF + Add 0.5 % of K through SOP (Foliar Application)

T_7– RDF + Add 0.25 % of K through KNO_3 (Foliar Application)

T_8– RDF + Add 0.5 % of K through KNO_3 (Foliar Application)

Table.2 Effect of different sources and levels of K and S on yield components of groundnut

Treatments	SEASON 1							SEASON 2						
	Number of pegs plant^{-1}	Number of pods plant^{-1}	100 Kernel Weight (g)	Pod yield (Kg ha^{-1})	Shelling Percentage (%)	Kernel Yield (Kg ha^{-1})	Haulm Yield (Kg ha^{-1})	Number of pegs plant^{-1}	Number of pods plant^{-1}	100 Kernel Weight (g)	Pod yield (Kg ha^{-1})	Shelling Percentage (%)	Kernel Yield (Kg ha^{-1})	Haulm Yield (Kg ha^{-1})
T_1	16	9	45.63	1100	68.56	754.2	1561	12	7	45.23	900	68.37	615.3	1224
T_2	18	11	45.70	2479	68.64	1701.6	3485	15	9	45.70	2279	68.5	1560.8	3076
T_3	25	17	45.74	2800	68.88	1928.6	3850	21	15	45.59	2600	69.12	1797.0	3432
T_4	32	24	45.98	3103	69.80	2165.9	4200	29	22	45.88	2895	69.60	2015.0	3709
T_5	23	15	45.61	2673	69.00	1844.4	3700	19	12	45.41	2473	68.79	1701.2	3289
T_6	30	22	45.86	2982	69.57	2074.6	4050	27	19	45.66	2812	69.47	1953.5	3605
T_7	22	14	45.39	2596	68.94	1789.7	3620	18	11	45.29	2396	68.74	1646.9	3211
T_8	29	21	45.81	2919	69.49	2028.4	4018	26	18	45.61	2732	69.43	1897.1	3588
SEm±	**0.7**	**0.5**	**-**	**51.40**	**-**	**39.32**	**61.84**	**0.6**	**0.4**	**-**	**37.85**	**-**	**27.35**	**49**
CD (P=0.05)	**1.5**	**1**	**NS**	**110**	**NS**	**84.15**	**132.35**	**1.3**	**1**	**NS**	**81**	**NS**	**58.53**	**104.9**

T_1-Control

T_2–RDF (Blanket Recommendation as 25:50:75 kg NPK ha^{-1})

T_3- RDF + Add 0.25 % of K through MOP (Foliar Application)

T_4– RDF + Add 0.5 % of K through MOP (Foliar Application)

T_5– RDF + Add 0.25 % of K through SOP (Foliar Application)

T_6– RDF + Add 0.5 % of K through SOP (Foliar Application)

T_7– RDF + Add 0.25 % of K through KNO_3 (Foliar Application)

T_8– RDF + Add 0.5 % of K through KNO_3 (Foliar Application)

Table.3 Effect of different sources and levels of K and S on Economics of groundnut

TREATMENTS	SEASON 1				SEASON 2			
	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	Return per rupee invested	Cost of cultivation (Rs. ha^{-1})	Gross income (Rs. ha^{-1})	Net income (Rs. ha^{-1})	Return per rupee invested
T_1	64814.3	66840.5	2026.2	1.03	64814.3	54612	-10202.3	0.84
T_2	72930.4	150579.5	77649.1	2.06	72930.4	138278	65347.6	1.90
T_3	73121.2	170056.0	96934.8	2.33	73121.2	157716	84594.8	2.16
T_4	73312.0	188424.0	115112	2.57	73312.0	175554.5	102242.5	2.39
T_5	74832.4	162362.5	87530.1	2.17	74832.4	150024.5	75192.0	2.00
T_6	76734.5	181090.5	104356	2.36	76734.5	170522.5	93788	2.22
T_7	73881.4	157696.5	83815.1	2.13	73881.4	145365.5	71484.1	1.97
T_8	74832.4	177270.5	102438.1	2.37	74832.4	165714	90881.5	2.21

T_1-Control

T_2–RDF (Blanket Recommendation as 25:50:75 kg NPK ha^{-1})

T_3- RDF + Add 0.25 % of K through MOP (Foliar Application)

T_4– RDF + Add 0.5 % of K through MOP (Foliar Application)

T_5– RDF + Add 0.25 % of K through SOP (Foliar Application)

T_6– RDF + Add 0.5 % of K through SOP (Foliar Application)

T_7– RDF + Add 0.25 % of K through KNO_3 (Foliar Application)

T_8– RDF + Add 0.5 % of K through KNO_3 (Foliar Application)

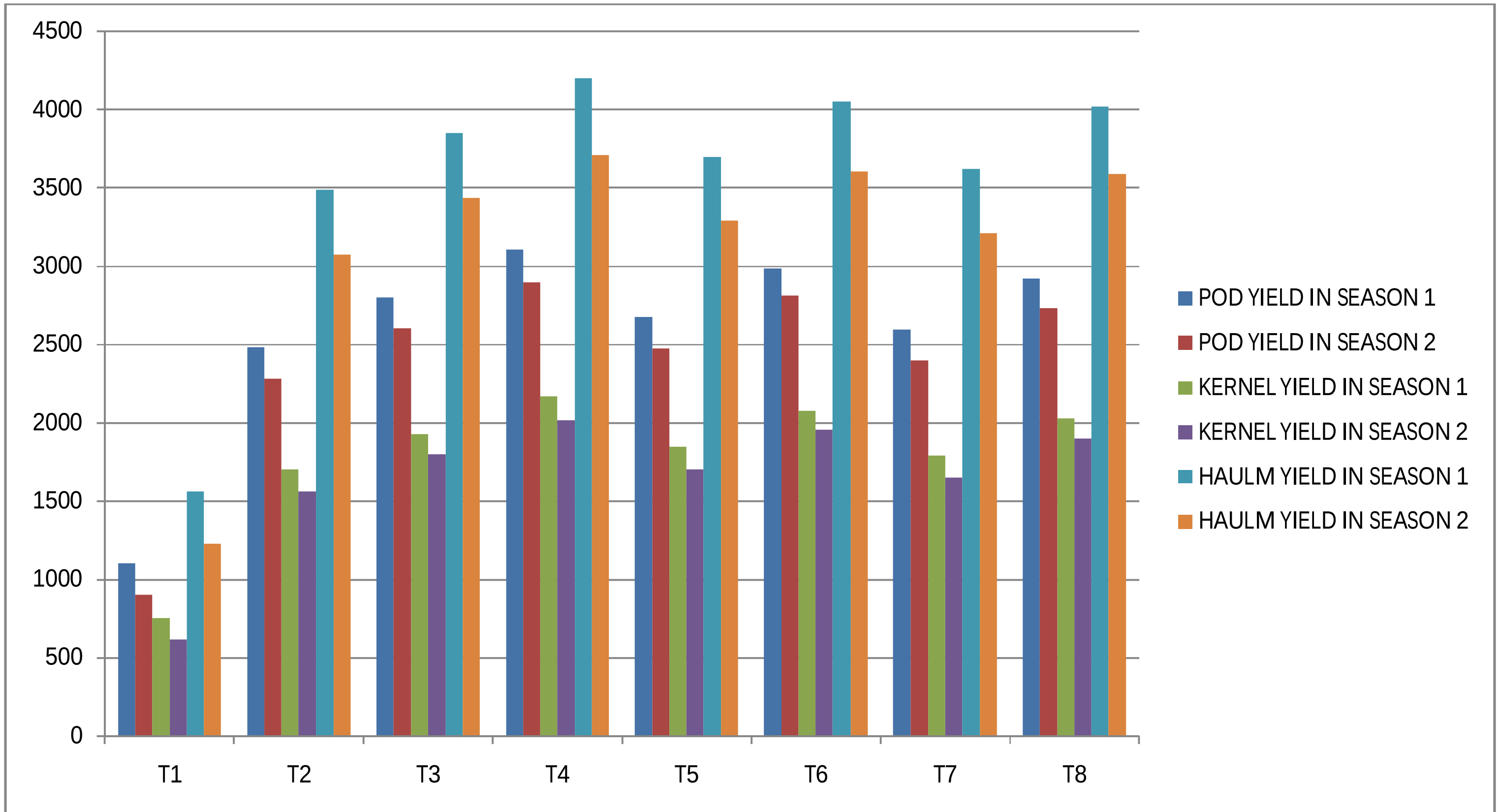

Fig 1: Effect of Different Sources and Levels of K and S Pod Yield, Seed Yield and Haulm Yield of Groundnut

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