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Groundnut Response to Lime and Levels of Sulphur on Nutrient Content and Uptake

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ABSTRACT

Background: Groundnut (*Arachis hypogaea* L.) is an important oilseed and an important food crop of the world, ranking in 4th place as an important source of edible oil and as an important source of vegetable protein in 3rd place. However, the preferred pH for growing of groundnut is a pH of (6.5-7) which is slightly acidic or neutral. So for the crop to grow in a favorable soil pH, liming is required. Groundnut being an oilseed crop requires fertilization for high crop production. The farmers though aware of the fertilization in crops, are confined mostly in NPK fertilizers and negligence especially in sulphur fertilizer is common, however sulphur in oilseed crop is one of the key elements required to produce protein, oil and flavored compounds as well as to ensure quality.

Methods: A field experiment was conducted in the Experimental Research Farm of School of Agricultural Sciences and Rural Development (SASRD), Nagaland University during the *kharif* season 2018 entitled "Effect of lime and levels of sulphur in nutrient content and uptake by Groundnut (*Arachis hypogaea* L.)". The experimental design was split plot design with three replications. The main plot treatments consisted of two lime levels: L_0: lime @ 0 t ha^{-1}, L_1: lime @ 3 t ha^{-1} and the sub- plot treatments consisted of five sulphur levels: S_0: sulphur @ 0 kg ha^{-1}, S_1: sulphur @ 10 kg ha^{-1}, S_2: sulphur @ 20 kg ha^{-1}, S_3: sulphur @ 30 kg ha^{-1}, S_4: sulphur @ 40 kg ha^{-1}.

Result: The study showed that application of lime and sulphur, along with recommended dose of fertilizer NPK (20:60:40) showed increased yield and an increase in N, P, K and S content in groundnut, resulting in a significant increase in the uptake of N, P, K and S by plant.

Key words: Content, Groundnut, Lime, Sulphur levels, Uptake.

INDRODUCTION

Groundnut cultivation is getting popularity among the farmers of North- Eastern Hill Region. There is ample scope to increase its productivity under upland conditions of mid-hills. (Singh *et al*., 2003.) Groundnut which on being recently introduced in the North Eastern region, is very likely to be grown widely across the region and the crop can also act as stand-in incase upland rice and maize proves uneconomical or it can be grown as an intercrop with upland rice and maize for higher productivity and return (Panwar *et al*. 2003). In Nagaland, groundnut is grown in area of 1050 ha producing 1100 mt (Anonnymous, 2021).

Among the major constraints in crop production particularly in north eastern region of India, one of the factors hindering efficient fertilizer management is acidic soil. Groundnut can be grown on many soil types including those that are highly weathered and acidic (Gascho *et al*. 1993). However, the preferred pH for growing of groundnut is a pH of (6.5-7) which is slightly acidic or neutral. So for the crop to grow in a favorable soil pH, liming is required.

Groundnut being an oilseed crop requires fertilization for high crop production. The farmers though aware of the fertilization in crops, are confined mostly in NPK fertilizers and negligence especially in sulphur fertilizer is common (Aier and Nongmaithem, 2020) however sulphur in oilseed crop is one of the key elements required to produce protein, oil and flavored compounds as well as to ensure quality. Sulphur is an important element for oil synthesis and formation of sulphur containing amino acids. Sulphur plays an important role in the metabolism of groundnut plant. It plays an important role in formation of chlorophyll and helps in biological oxidation- reduction process (Najar *et al*., 2011).

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MATERIALS AND METHODS

A field experiment was carried out at School of Agricultural Sciences and Rural Development (SASRD), Nagaland University during the *Kharif* season 2018. The experimental site was located in the foothill of Nagaland at an altitude of 310 meters above sea level with the geographical location at 25° 45′43″ North latitude and 95° 53′04″ East longitude. The climatic condition of the experimental field was categorized as sub-humid tropical zone with an average rainfall ranging from 2000- 2500 mm. The mean temperature experienced in the area varies between 21°C-30°C. The experiment comprised of two lime and five levels of sulphur, *viz.* lime @ 0 t ha $^{-1}$ and 3 t ha^{-1} and sulphur @ (0, 10, 20, 30 and 40) kg ha^{-1} respectively. The experiment was laid out by adopting split plot design (SPD) with three replications Groundnut variety ICGS-70 was sown @ 70 kg ha^{-1} at 60 cm × 20 cm spacing. Kernel treatment was done with carbendazime @ 2 g kg^{-1} of kernel. The soil was sandy loam and strongly acidic in reaction (pH 4.5). The soil contained 1.81% oxidizable organic carbon, 275 kg ha^{-1} available nitrogen, 16.2 kg ha^{-1} available phosphorus, 180.46 kg ha^{-1} available potassium and available suphur, 20.21 kg ha^{-1}.

Nitrogen content in plant samples was determined by Kjedahl distillation method. For phosphorus, plant materials were determined by digesting the materials with nitric acid (HNO_3) and perchloric acid ($HClO_4$) as outlined by Johnson and Ulrich (1959). Vandomolybdate (Chapman and Pratt. 1961) method was followed for the determination of P in the extract using colorimeter.

The below given formula was used for determining P content:

$$P\ (\%) = \frac{C \times \text{Total volume of digest} \times 100}{\text{Alipuot taken (ml)} \times \text{wt. of sample} \times 1000000}$$

Where,

C= P concentration (ppm) in aliquot as read from curve against R.

R= Colorimeter reading.

The aliquots after wet digestion for estimation of Phosphorous were distilled to the desirable limit and were analyzed for K, by direct reading using flame photometer.

The before given formula was used for determining K content:

$$K\ (\%) = \frac{R \times Kf \times \text{Volume of digest} \times 100}{100 \times \text{Wt. of sample} \times 1000000}$$

Where,

R= Flame photometer reading.

Kf= K concentration (ppm) used for setting flame photometer at 100.

Sulphur content was determined by the plant extract obtained by wet digestion with HNO_3 - $HClO_4$. This turbidity was measured with a Colorimeter which is proportional to sulphur content.

The before given formula was used for determining S content:

$$S\ (\%) = \frac{C \times \text{Total volume of digest} \times 100}{\text{Alipuot taken (ml)} \times \text{Wt. of sample} \times 1000000}$$

Where,

C= S concentration (ppm) in aliquot as read from curve against R.

R= Colorimeter reading.

Uptake of nutrients (N, P, K andS) for the plants was estimated by the below before given formula:

$$\text{Uptake (Kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (B\%/P\%/K\%/S\%)} \times \text{Dry matter (Kg ha}^{-1}\text{)}}{\times 100}$$

The data obtained were analyzed statistically by analysis of variance (F-test) as per the methods recommended by Gomez and Gomez (1983). The critical difference (CD) at 0.05 level of probability was calculated.

RESULTS AND DISCUSSION

Effect of lime and levels of sulphur on N content and uptake by groundnut

The application of lime @3t ha^{-1} resulted in significantly higher nitrogen content and uptake compared to unlimed condition (Table 1). The result is in conformity with the findings of Ranjit *et al.* (2007) and Lynrah and Nongmaithem (2017). The application of lime at 3 t ha^{-1} might have helped in increasing the pH of the soil which in turn helped in making soil nitrogen more available to plants due to increased mineralization or nitrification as microbial activity increased (Rousk *et al.* 2010).

There was significant higher nitrogen content and uptake with application of sulphur @ 40 kg ha^{-1} compared to lower doses of sulphur and control. Similar finding was recorded by Patel and Zinzala (2016). The increase in nitrogen uptake by plant on application of sulphur might be because of the favorable effect of sulphur on growth and yield of the groundnut resulting in more uptake of nutrients by the crop. Prosser *et al.* (2001) also found that a deficiency in sulphur supply depressed the uptake of nitrate.

Effect of lime and levels of sulphur on P content and uptake by groundnut

The data recorded in Table 1 showed that there was no significant variation in phosphorous content in pod and haulm when liming was done. However, the uptake of phosphorus by pod and haulm by the crop was found to be significantly higher on application of lime and sulphur where liming @3 t ha^{-1} gave higher uptake of phosphorus by crop compared to unlimed condition. This might be due to the variation in dry matter of the crop due to liming.

The application of sulphur @ 40 kg ha^{-1} showed significantly higher phosphorous content and uptake of phosphorus. Datir (2012) and Ismail *et al.* (2013) also gave similar findings. The favorable soil condition created by addition of lime with the supplement of sulphur might have given a congenial environment to the crop which helped in better uptake of nutrients by the plants. Sulphur might have shown the synergistic effect in increasing the P uptake (Haneklaus *et al.* 2007).

Effect of lime and levels of sulphur on K content and uptake by groundnut

There was a significant variation in potassium content and uptake where liming @ 3 t ha^{-1} resulted in significantly higher potassium content (Table 2). Yadav *et al.* (2020) also observed a significant increase in nutrients concentration of K due to liming. The rise in soil pH might have increased the CEC contributing potassium availability in soil.

The data showed significantly higher potassium content and uptake when sulphur level @ 40 kg ha^{-1} was applied compared to lower doses of sulphur and control. Motior *et al*. (2011) reported positive response in K uptake with sulphur fertilization.

Effect of lime and levels of sulphur on S content and uptake by groundnut

Liming @ 3 t ha^{-1} resulted in significantly higher sulphur content and uptake compared to unlimed condition (Table 2). Similar finding was recorded by Halim *et al*. (2014). The increase in soil pH due to lime application might have helped in sulphur mineralization which enabled the crop to take up more sulphur from soil leading to higher sulphur content in plants.

Application of sulphur @40 kg ha^{-1} gave higher sulphur content and uptake compared to lower doses of sulphur and control. Sulphur application enhanced the biomass production. The increase might be associated with optimum sulphur availability to groundnut crop (Raza *et al*. 2018).

Effect of lime and levels of sulphur on yield attribute of groundnut

The highest pod yield (1845.14 kg ha^{-1}), kernel yield (1398.14 kg ha^{-1}) and stover yield (2865.29 kg ha^{-1}) was recorded when lime was applied @ 3 t ha^{-1} Table 3. The result is in conformity with the findings of Das *et al*. (2017) and Dey and Nath (2015). The increase in yield attribute when liming was done may be because of increase in the growth attributes of crop due to favorable soil condition and also supplied Ca and Mg essential for plant growth.

The highest pod yield (1535.64 kg ha^{-1}), kernel yield (1160.46 kg ha^{-1}) and stover yield (2551.36 kg ha^{-1}) was recorded when sulphur was applied @ 40 kg ha^{-1}. The result

Table 1: Effect of lime and levels of sulphur on N and P content and uptake by groundnut.

Treatments	N content (%)		N uptake (kg ha^{-1})			P content (%)		P uptake (kg ha^{-1})		
	Pod	Haulm	Pod	Haulm	Total	Pod	Haulm	Pod	Haulm	Total
Lime levels										
L_0: 0 kg ha^{-1}	3.91	1.31	42.76	27.74	70.50	0.53	0.33	5.80	6.88	0.86
L_1: 3 t ha^{-1}	4.04	1.36	74.68	39.10	113.78	0.53	0.35	9.78	10.15	0.88
SEm±	0.004	0.006	0.20	0.11	0.10	0.009	0.007	0.13	0.22	0.006
CD (p=0.05)	0.025	0.036	1.19	0.68	0.60	NS	NS	0.79	1.31	NS
Sulphur levels										
S_0: 0 kg ha^{-1}	3.77	1.14	53.03	27.29	80.32	0.50	0.30	7.01	7.28	0.80
S_1: 10 kg ha^{-1}	3.86	1.24	55.77	30.90	86.67	0.51	0.32	7.36	8.00	0.83
S_2: 20 kg ha^{-1}	4.01	1.35	59.03	34.17	93.20	0.53	0.34	7.70	8.61	0.87
S_3: 30 kg ha^{-1}	4.09	1.45	61.56	36.34	97.91	0.55	0.36	8.20	9.10	0.91
S_4: 40 kg ha^{-1}	4.17	1.50	64.19	38.41	102.60	0.57	0.38	8.68	9.61	0.94
SEm±	0.013	0.005	0.32	0.25	0.43	0.003	0.002	0.05	0.08	0.003
CD (p=0.05)	0.038	0.014	0.97	0.76	1.28	0.009	0.005	0.16	0.23	0.008
Interaction (lime × sulphur)										
	NS	0.019	1.37	1.08	1.81					

Table 2: Effect of lime and levels of sulphur on Kand S content and uptake by groundnut.

Treatments	K content (%)		K uptake (kg ha^{-1})			S content (%)		S uptake (kg ha^{-1})		
	Pod	Haulm	Pod	Haulm	Total	Pod	Haulm	Pod	Haulm	Total
Lime levels										
L_0: 0 kg ha^{-1}	0.69	0.82	7.52	16.67	24.20	0.23	0.16	2.55	3.29	5.84
L_1: 3 t ha^{-1}	0.74	0.87	13.76	24.81	38.60	0.28	0.19	5.10	5.44	10.54
SEm±	0.002	0.005	0.07	0.08	0.16	0.002	0.004	0.06	0.11	0.05
CD (p=0.05)	0.011	0.030	0.41	0.51	0.97	0.014	0.022	0.39	0.69	0.33
Sulphur levels										
S_0: 0 kg ha^{-1}	0.64	0.77	9.11	18.46	27.58	0.20	0.14	2.90	3.35	6.25
S_1: 10 kg ha^{-1}	0.71	0.84	10.25	20.09	30.34	0.24	0.15	3.45	3.82	7.27
S_2: 20 kg ha^{-1}	0.73	0.86	10.81	20.99	31.80	0.26	0.17	3.86	4.41	8.27
S_3: 30 kg ha^{-1}	0.74	0.86	11.41	21.70	33.19	0.28	0.19	4.27	4.91	9.18
S_4: 40 kg ha^{-1}	0.75	0.88	11.61	22.48	34.09	0.30	0.21	4.65	5.31	9.96
SEm±	0.003	0.010	0.06	0.22	0.20	0.002	0.002	0.04	0.07	0.10
CD (p=0.05)	0.010	0.029	0.17	0.66	0.60	0.007	0.006	0.13	0.21	0.31
Interaction (lime × sulphur)										
	0.014	NS	0.24	0.93	0.85	NS	0.008	0.18	0.29	0.43

Table 3: Effect of lime and levels of sulphur on yield attribute of groundnut.

Treatments	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})
		Lime levels	
L_0: Lime @0 kg ha^{-1}	1090.66	833.56	2106.50
L_1: Lime @3 t ha^{-1}	1845.14	1398.54	2865.29
SEm±	5.19	7.76	20.71
CD (p=0.05)	31.57	47.22	126.00
		Sulphur levels	
S_0: Sulphur @0 kg ha^{-1}	1401.68	1061.89	2381.25
S_1: Sulphur @10 kg ha^{-1}	1438.95	1122.01	2483.11
S_2: Sulphur @20 kg ha^{-1}	1463.71	1100.05	2514.16
S_3: Sulphur @30 kg ha^{-1}	1499.52	1135.85	2499.58
S_4: Sulphur @40 kg ha^{-1}	1535.64	1160.46	2551.36
SEm±	5.35	14.08	20.53
CD (p=0.05)	16.03	42.21	61.54
		Interaction (lime × sulphur)	
CD (p=0.05)	22.67	59.69	NS

is in conformity with the findings of Banu *et al*. (2017) and Sisodiya *et al*. (2017). The increase in yield attributes on application of sulphur may be because of the favorable effect of sulphur on the growth of groundnut. The reason for these increments might be the availability of supplementary carbohydrates and photo assimilate due to enhanced photosynthetic capacity under optimum sulphur availability which increased the biomass and nutrient accumulation that ultimately lead to improvement in seed yield (Raza *et al.* 2018).

CONCLUSION

To make the cultivation of groundnut suitable in North-east states especially in Nagaland, there is a need to decrease the soil acidity which can be achieved by application of lime. Being an oilseed crop there should be proper supply of optimum sulphur apart from nitrogen, phosphorus and potassium fertilizer. Experimental results have shown that application of lime @ 3 t ha^{-1} and sulphur @40 kg ha^{-1} increased the plant nutrient content as well as uptake of NPKS and this can contribute towards more yield of the crop. Therefore, checking the soil acidity and reclaiming through required dose of liming material for cultivation of groundnut can ensure higher productivity in this region. The application of sulphur to this crop can also bring quality produce of the crop.

Conflict of interest: None.

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