Article AR2162a

DOI: HTTPS://DOI.ORG/10.23910/1.2020.2162a

International Journal of Bio-resource and Stress Management

Crossref

December 2020

Print ISSN 0976-3988
Online ISSN 0976-4038

IJBSM 2020, 11(6):585-589

Research Article

Natural Resource Management

Response of Groundnut (*Arachis hypogaea* L.) to Lime and Different Levels of Sulphur

Imnatemjen Aier and D. Nongmaithem*

Dept. of Agronomy, SASRD: Nagaland University, Medziphema, Nagaland (797 106), India

Open Access

Corresponding Author

D. Nongmaithem
e-mail: debikanong@gmail.com

Citation: Aier and Nongmaithem, 2020. Response of Groundnut (*Arachis hypogaea* L.) to Lime and Different Levels of Sulphur. International Journal of Bio-resource and Stress Management 2020, 11(6), 585-589. HTTPS://DOI.ORG/10.23910/1.2020.2162a.

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, authors have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

Conflict of interests: The authors have declared that no conflict of interest exists.

Abstract

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. Groundnut variety ICGS-76 was sown @ 70 kg ha^{-1} for 60×20 cm^2 spacing. The experiment was laid in split plot design with three replications. The main plot treatments consisted of two lime levels: lime @ 0 t ha^{-1} and lime @ 3 t ha^{-1} while the sub- plot treatments consisted of five sulphur levels: sulphur @ (0 kg ha^{-1}, 10 kg ha^{-1}, 20 kg ha^{-1}, 30 kg ha^{-1} and 40 kg ha^{-1} along with recommended dose of fertilizer at 20:60:40 kg N, P_2O_5 and K_2O ha^{-1} respectively in the form of diammonium phosphate and murate of potash. The results showed that application of lime @ 3 t ha^{-1} gave higher growth and yield attributes compared to no lime and also application of sulphur @ 40 kg ha^{-1} gave higher growth and yield attributes compared to lower doses of sulphur though there was only slight increase in the attributes between each successive doses of sulphur. Overall application of lime and sulphur increased all the yield attributes of groundnut, where the highest number of pods $plant^{-1}$, seeds pod^{-1}, 100 kernels weight, pod yield, kernel yield and stover yield were recorded when treatment was done with lime @ 3 t ha^{1} and sulphur @ 40 kg ha^{-1}.

Keywords: Groundnut, lime, sulphur

1. Introduction

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. Rice, maize and potato are the main crops of this region. 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 930 ha producing 960 MT and yield of about 1032 kg ha^{-1} (Nagaland economic survey 2015-2016).

The global production and use of synthetic nitrogenous fertilizers had increased considerably since 1960, which resulted in a significant increase in crop production and severe negative environmental and agronomic consequences for soil health, e.g., nitrate-N leaching and soil acidification (Smil, 2002). Acid soils are considered soils with a pH < 5.5 in their surface horizons (0–20 cm). About 3950 million hectares

Article History

RECEIVED in 28th October 2020 RECEIVED in revised form 12th December 2020 ACCEPTED in final form 28th December 2020

of land area has been estimated to be affected by acidity, occupying nearly 30% of the global land surface (Sumner and Noble, 2003) and accounting for approximately 50% of the global arable land area (Dai et al., 2017). Soil acidity is one of the most yield limiting factors that affect crop productivity (McLaren and Cameron, 1996; Sumner and Noble, 2003; Fageria and Nascente, 2014). 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. In India, about one-third of the cultivated land is affected by soil acidity (Mandal, 1997). Most of these soils are concentrated in north-east region of India, with nearly 65% of its area being under high level of soil acidity (< 5.5pH) (Sharma and Singh, 2002). 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. Every crop requires a preferred pH level in the soil so it can grown properly this adjustment in pH levels can be done by liming when the soil is acidic. Lime application along with integrated nutrient management is often recommended to increase the phyto-availability of essential nutrients and ameliorate the other acidity-induced fertility constraints on such soils (Haynes, 1984; Kumar et al., 2012). Liming also helps increase the nutrient availability, improves the soil structure and also increases the rate of infiltration. Management of soil acidity and improvement on productivity of crop on such soils therefore proves to be important in strengthening food security globally and regionally.

Development of modern agricultural technology has attracted the attention of scientists on sulphur nutrition owing to cultivation of high yielding varieties, adoption of intensive cropping systems particularly involving oil seeds and pulses, use of high analysis fertilizers and decreased usage of organic manures (Jaggi, 2004). Indian groundnut sellers and processors are steadily growing aware and concern for the quality of groundnut. Arranging and categorizing according to quality are becoming a practice. Indian manufacturer have the means to prepare and supply edible groundnuts conforming to highest standards. Among the various factors known to determine the groundnut yield and quality, balanced nutrition is an essential and basic factor contributing to high yield. 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, it is increasingly being recognised as the fourth major nutrient after nitrogen, phosphorus and potassium (Tandon and Messick, 2002). Sulphur is an important element for oil synthesis and formation of sulphur containing amino acids. It is the master nutrient for oilseed production as each unit of sulphur fertilizer generates 3-5 units of edible oil. In oilseeds sulphur plays a vital role in the development of seed and improving the quality (Naser et al., 2012). Sulphur helps in the synthesis of cysteine, methionine, chlorophyll, vitamins (B, biotin and thiamine), metabolism of carbohydrates, oil content, protein content and also associated with growth and metabolism, especially by its effect on the proteolytic enzymes (Najar et al., 2011). Sulphur is identified as a key element for increasing the production of oilseeds by increasing the uptake of various macro and micronutrients in groundnut (Singh, 1999). Sulphur deficiency results in poor flowering, fruiting, cupping of leaves, reddening of stems, petiole and stunted growth. Since groundnut is rich both in oils and protein, requirement of sulphur for this crop is substantial high. Sulphur improves the chlorophyll, nodulation, increases the availability of other nutrients (Singh, 2007).

2. Materials and Methods

2.1. Study site

Experimental Research Farm, School of Agricultural Sciences and Rural Development (SASRD), Nagaland University, Medziphema, Nagaland.

2.2. Treatment details

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.

2.3. General information

Groundnut variety ICGS-76 was sown @ 70 kg ha^{-1} for 60×20 cm^2 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 and 180.46 kg ha^{-1} available potassium. Recommended dose of fertilizer at 20:60:40 kg N, P_2O_5 and K_2O ha^{-1} respectively were applied in the form of diammonium phosphate and murate of potash at the time of sowing.

2.4. Data collection

For determining the vegetative growth characters, five plants from each plot were randomly selected and tagged excluding the border rows. Total numbers of pods were counted from five randomly selected plants and the average number of pods $plant^{-1}$ was worked out.

2.5. Data analysis

The data obtained are analyzed statistically by analysis of variance (F-test) as per the methods recommended by Gomez and Gomez (1984). The critical difference (CD) at 0.05 level of probability was calculated.

3. Results and Discussion

3.1. Effect of lime and levels of sulphur on growth attribute of groundnut at different days of sowing.

The data recorded in Table 1 shows that application of lime and sulphur levels influenced a significant variation in plant

Table 1: Effect of lime and levels of sulphur on growth attribute of groundnut at different days of sowing

Treatments	Plant height			Crop growth rate (g m^{-2} d^{-1})		Relative growth rate (g g^{-1} d^{-1})	
	30 DAS	60 DAS	At harvest	30-60 DAS	60 DAS At harvest	30-60 DAS	60 DAS At harvest
Lime levels							
L_0: lime @ 0 kg ha^{-1}	16.58	42.31	50.33	9.53	6.70	0.14	0.10
L_1: lime @ 3 t ha^{-1}	17.82	46.27	52.93	11.65	6.83	0.16	0.10
SEm±	0.49	0.62	0.37	0.26	0.06	0.003	0.001
CD (p=0.05)	NS	3.75	2.26	1.58	NS	0.02	NS
Sulphur levels							
S_0: sulphur @ 0 kg ha^{-1}	16.03	40.93	47.62	9.42	5.39	0.13	0.08
S_1: sulphur @ 10 kg ha^{-1}	16.82	42.55	50.23	9.85	5.80	0.14	0.09
S_2: sulphur @ 20 kg ha^{-1}	17.07	44.56	51.07	10.53	6.48	0.15	0.10
S_3: sulphur @ 30 kg ha^{-1}	17.28	45.16	53.28	11.45	7.40	0.17	0.11
S_4: sulphur @ 40 kg ha^{-1}	18.81	48.24	55.96	11.71	8.76	0.18	0.13
SEm±	0.71	1.30	1.41	0.23	0.12	0.004	0.004
CD (p=0.05)	NS	3.89	4.22	0.69	0.35	0.01	0.01

height at 60 DAS and at harvest. However, plant height at 30 DAS showed no significant effect. Application of lime @ 3 t ha^{-1} gave highest plant height at 60 DAS (46.27 cm) and at harvest (52.93 cm) compared to unlimed condition, while application of sulphur @ 40 kg ha^{-1} gave the highest plant height at 60 DAS (48.24 cm) and at harvest (55.96 cm) over lower doses of sulphur. The result is in conformity with the findings of Das et al. (2017) and Noman et al. (2015). Crop grow rate on application of lime during the period of 60 DAS to harvest showed no significant variation while the period between 30 DAS to 60 DAS had significant variation. There was also a significant variation in crop growth rate at 30 DAS – 60 DAS and 60 DAS to harvest for sulphur levels as shown in Table 1. On application of lime the highest crop growth rate was recorded between 30 DAS – 60 DAS when the crop was treated with lime @ 3 t ha^{-1} (11.65 g m^{-2} d^{-1}) and as for sulphur, application of sulphur level @ 40 kg ha^{-1} gave higher CGR (11.71 g m^{-2} d^{-1}) compared to lower doses. The result is in conformity with the findings of Rao et al. (2013). The data in Table 1 also shows that application of lime @3 t ha^{-1} recorded highest relative growth rate (0.16 g g^{-1} d^{-1}) between 30 DAS – 60 DAS and as for sulphur, application of sulphur level @ 40 kg ha^{-1} gave highest RGR (0.18 g g^{-1} d^{-1}) between 30 DAS – 60 DAS compared to lower doses. The result is in conformity with the findings of Das et al. (2017) and Pancholi (2014). The increase in growth attribute when lime was added may be because liming increases the pH levels in soil thus increasing alkalinity which provides a source of calcium and magnesium essential for plant growth. As for the increase in growth attribute when sulphur was applied may be because sulphur is essential for nitrogen-fixing nodules on legumes and in the formation of chlorophyll. In the process plants uses the synthesized chlorophyll for producing proteins, amino acids, enzymes and vitamins which aids in growth, and in seed formation.

3.2. Effect of lime and levels of sulphur on yield attributes and yield of groundnut

There was significant variation in number of pods $plant^{-1}$, kernel yield (kg ha^{-1}), stover yield (kg ha^{-1}) and harvest index (%) with the application of lime. The data in table 2 showed that the highest pods $plant^{-1}$ (30.87), kernel yield (1398.14 kg ha^{-1}), stover yield (2865.29 kg ha^{-1}) and harvest index (39.17%) was recorded when lime was applied @ 3 t ha^{-1}. 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 due to the effect of liming which increases the growth attributes of crop due to favorable soil condition and also lime acting as source of Ca and Mg essential for plant growth. On application of sulphur there was a significant variation in number of pods $plant^{-1}$, kernel yield (kg ha^{-1}) and stover yield (kg ha^{-1}) whereas harvest index (%) was found insignificant. The highest pods $plant^{-1}$ (28.50), 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 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.

4. Economics

The data collected on the economics under the effects of lime and levels of sulphur is presented in Table 3. The highest cost of cultivation (₹ 36458.17) was recorded under the treatment L_1S_4 (lime @ 3 t ha^{-1} and sulphur @ 40 kg ha^{-1}) while the lowest was obtained under L_0S_0 (lime @ 0 t ha^{-1} and sulphur @0

Table 2: Effect of lime and levels of sulphur on yield attribute of groundnut

Treatments	No. of pods plant^{-1}	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index (%)
Lime levels				
L_0: lime @ 0 kg ha^{-1}	20.27	833.56	2106.50	34.15
L_1: lime @ 3 t ha^{-1}	30.87	1398.54	2865.29	39.17
SEm±	0.08	7.76	20.71	0.33
CD (p=0.05)	0.50	47.22	126.00	2.02
Sulphur levels				
S_0: sulphur @ 0 kg ha^{-1}	24.17	1061.89	2381.25	36.54
S_1: sulphur @ 10 kg ha^{-1}	23.67	1122.01	2483.11	36.24
S_2: sulphur @ 20 kg ha^{-1}	24.83	1100.05	2514.16	36.35
S_3: sulphur @ 30 kg ha^{-1}	26.67	1135.85	2499.58	37.11
S_4: sulphur @ 40 kg ha^{-1}	28.50	1160.46	2551.36	37.07
SEm±	0.41	14.08	20.53	0.41
CD (p=0.05)	1.22	42.21	61.54	NS

Table 3: Effect of lime and levels of sulphur on economic parameter of groundnut

Treatments	Cost of cultivation (₹ ha^{-1})	total gross return (₹ ha^{-1})	net return (₹ ha^{-1})	B:C ratio
L_0S_0	23658.17	51224.08	27565.91	1.17
L_0S_1	23858.17	53502.68	29644.51	1.24
L_0S_2	24058.17	54668.38	30610.21	1.27
L_0S_3	24258.17	56171.4	31913.23	1.32
L_0S_4	24458.17	57098.87	32640.69	1.33
L_1S_0	35658.17	88943.72	53285.54	1.49
L_1S_1	35858.17	90392.72	54534.54	1.52
L_1S_2	36058.17	91702.28	55644.11	1.54
L_1S_3	36258.17	93780.85	57522.68	1.59
L_1S_4	36458.17	96465.47	60007.29	1.65

kg ha^{-1}), with ₹ 23658.17. Highest gross return per hectare (₹ 96465.47) was recorded under the treatment L_1S_4 (lime @ 3 t ha^{-1} and sulphur @ 40 kg ha^{-1}) while the lowest was obtained under L_0S_0 (lime @ 0 t ha^{-1} and sulphur @ 0 kg ha^{-1}), with ₹ 51224.08. The highest net income (₹ 60007.29) and B: C ratio (1.65) was obtained under treatment L_1S_4 (lime @ 3 t ha^{-1} and sulphur @ 40 kg ha^{-1}) compared to all the other treatments, lowest net was recorded in L_0S_0 with ₹ 27565.91 having a B:C ratio of 1.17. These results are in conformity with the findings of Dash et al. (2013) where they reported that applying sulphur @ 34 kg ha^{-1} gave a significantly higher economic in pod yield over lower levels. Dutta and Mondal (2006) observed a 17.19% of yield increment compared to 100% RDF alone.

5. Conclusion

It has been observed that treatment with lime @ 3 t ha^{-1}+sulphur @ 40 kg ha^{-1} resulted in highest kernel and stover yield with net return (₹ 60007.29) and BC ratio (1.65) followed by liming @ 3 t ha^{-1}+sulphur @ 30 kg ha^{-1} with net return (₹ 57522.68) and BC ratio (1.59). Thus it can be concluded that liming @ 3 t ha^{-1} along with sulphur @ 40 kg ha^{-1} along with recommended dose of NPK (20:60:40) gave best result for the growth and yield of groundnut.

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