Original Research Article

Influence of Sulphur and Molybdenum on Growth, Yield and Economics of Groundnut (*Arachis hypogaea* L.)

ABSTRACT

A research trail was conducted in *Kharif* 2022, at Crop research form, SHUATS, Prayagraj. To study the "Influence of Sulphur and Molybdenum on Growth, Yield and Economics of Groundnut (*Arachis hypogaea* L.)" The treatments consist of three levels of Sulphur (30. 35 and 40 kg/ha) and three levels of Molybdenum (0.5 %, 1% and 1.5 %). Experiment were laid out in randomized block design with 10 treatments each replicated thrice. The result showed that *viz:* higher plant height (52.17 cm), No. of nodules/plant (68.50), Plant dry weight (50.67 g), No. of branch/plant (9.05), No. of pods/plant (15.80), No of grain/pod (3.00), Higher Seed yield (2.71 t/ha), Stover Yield (4.30 t/ha), Gross returns (1,46,255.73 INR/ha), Net return (98,838.73 INR/ha) and Benefit cost ratio (1.91) recorded in treatment 9 Sulphur 40kg/ha + Molybdenum (1.5%).

Key words: Sulphur, Molybdenum, Growth, Yield, Economics and Groundnut

Introduction:

"Groundnut (*Arachis hypogea* L.) it belongs to Leguminosae family is one of the most important edible oilseed crop in the world India occupying two third areas under oilseeds which constitute the second major agricultural crop in the country. It is premier oilseed crop of India popularly known as peanuts. The crop grows best on sandy loam and loamy soil and in black soil with good drainage. Heavy and stiff clays are unsuitable for groundnut cultivation. The percentage of oil content is about 50%, 25% to 30% protein 20 % carbohydrateand 5% ash and fibre. It is valuable sources of vitamins E, K and B. It is richest source of thiamine and also rich in niacin which is low in cereals". [17] "Groundnut provides raw material for industrial serving as concentrated Animal feed and organic manure. It contributed to sustainable Agriculture being a legume and cultivated in both *Kharif* and Summer season by farmer. Globally the crop is raised on 26.4 million hectares with a total production of 37.1 million tonnes in India. It is cultivated over an area of 4596.33 in hectares with production of 6733.33 MT. The average productivity is 1400 Kg/ha" **(Anonymous) [1].**

“Sulphur is a constituent of protein and plays an important role in oil synthesis. Since groundnutis rich both in oils and protein, requirement of sulphur for this crop is substantial. In addition, application of sulphur significantly increased photosynthesis rate thereby increased the haulm yield and it is also increased the pod yield. Sulphur deficiency and consequent crop response, particularly in oilseed crops like groundnut are quite ostensible” **(Schonhof *et al*., 2007) [2]. “**Deficiency of sulphur has been frequently observed due to a number of reasons like increased removal of sulphur by the crop, high yielding fertilizer responsive crop varieties, increasing cropping intensity and extensive use of Sulphur free fertilizers”. (**Ramdevputra, 2010) [3].**

“Molybdenum has been considered as one of the essential micronutrients regulating various physiological and biochemical phenomena in plants, especially in case of legume crops” **(Bandyopadhyay *et al*., 2008) [5] and (Rajesh et al., 2008) [4]. “**Molybdenum is crucial for synthesis as well as activities of molybdoenzymes like nitrogenase and nitrate reductase, which regulate root nodulation and symbiotic N fixation in grain legumes by synchronizing rhizobial activity” **(Gonzalez-Guerrero *et al*., 2014) [6]. “**Molybdenum involves in nitrogenase an enzyme which is responsible for the nitrogen fixation process by bacteria symbiotically with legumes crops. It also plays a key role in nitrogen metabolism, protein synthesis and sulphur metabolism. Molybdenum is required in pollen formation so Mo deficient plant will cause effect in their fruits and pollen grains formation. It is also important for the absorption and translocation of iron in the plants” **(Subba Rao and Adinarayan, 1995) [7]. “**The increase in

nitrogen uptake and protein content in groundnut plant was found consequently when plants treated with molybdenum" (**Chatterjee *et al*., 1985) [8]. "**Molybdenum plays a significant role innodulation and N content of nodules in groundnut plant" (**Kene *et al*., 1988) [9].**

MATERIALS AND METHODS:

Experimental site

"The field experiment was conducted during *kharif* season 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.6), organic carbon level in medium condition (0.87%), medium available N (225 Kg/ha), high in available P (41.8 kg/ha) and medium available K (261.2 kg/ha)". [18]

Experimentation and crop husbandry

The treatments consist of three levels of Sulphur (30. 35 and 40 kg/ha) and three levels of Molybdenum (0.5 %, 1% and 1.5 %). The experiment was laid out in Randomized Block Design with 10 treatments each replicated thrice. The treatment combinations are T 1 – Sulphur 30kg/ha + Molybdenum (0.5%), T 2 - Sulphur 30kg/ha + Molybdenum (1%), T 3 - Sulphur 30kg/ha + Molybdenum (1.5%), T 4 – Sulphur 35kg/ha + Molybdenum (0.5%), T 5 - Sulphur 35kg/ha + Molybdenum (1%), T 6 - Sulphur 35kg/ha + Molybdenum (1.5%), T 7 – Sulphur 40kg/ha + Molybdenum (0.5%), T 8 - Sulphur 40kg/ha +Molybdenum (1%), T 9 - Sulphur 40kg/ha + Molybdenum (1.5%), T 10 - Control (NPK 20:60:40 kg/ha.).

Data collection

All agronomic practices are followed in order in the crop period. (Plant height, plant dry weight, Numbers of nodules/plant, Number of branchs/plant, Number of pods/plant, Number of grain/pod, seed yield, Stover yield, Harvest index)

Statistical analysis

"Experimental data collected was subjected to statistical analysis by adopting Fisher's method of analysis of variance (ANOVA) as outlined by Gomez and Gomez (1984). Critical Difference(CD) values were calculated wherever the 'F' test was found significant at 5 percent level". **[10].**

RESULT AND DISSCUSSION:

Growth parameters

Plant height (cm)

At 80 DAS the significantly and higher plant height (52.17 cm) was recorded in treatment 9 [Sulphur 40kg/ha and Molybdenum 1.5%], however significantly superior all over the treatments and treatments with Sulphur 35kg/ha + Molybdenum 0.5%, Sulphur 35kg/ha + Molybdenum 1%, Sulphur 35kg/ha + Molybdenum 1.5%, Sulphur 40kg/ha + Molybdenum 0.5% and Sulphur 40kg/ha + Molybdenum 1% was statically at par with treatment Sulphur 40kg/ha + Molybdenum 1.5%.(Table 1) Increased growth components observed under gypsum might be by attributed to readily available sulphate form of sulphur, enhanced uptake of nutrients even at initial stages of crop growth. Similar findings were earlier reported by **(Rao *et al.*, 2013)**

Numbers of nodules/plant

At 80 DAS, (Table 1) treatment with Sulphur 40 kg/ha + Molybdenum 1.5% was recorded maximum number of nodules (68.50) which is significantly superior all over the treatments and treatmentwith Sulphur 35 kg/ha + Molybdenum 0.5%, Sulphur 35 kg/ha + Molybdenum 1%, Sulphur 35 kg/ha + Molybdenum 1.5%, Sulphur 40 kg/ha + Molybdenum 0.5% and Sulphur 40 kg/ha + Molybdenum 1% were statically at par with treatment Sulphur 40 kg/ha + Molybdenum 1.5%. **Balachandar *et al.* (2003)** reported that "application of Mo (50 mg kg^{-1}), B (0.2%), Co (50 mg kg^{-1}) and S (0.2%) increased the number of nodules per plant, weight per plant, plant height, biomass production and grain yield of black gram".

Plant dry Weight (g/plant)

At 80 DAS, (Table 1) treatment with Sulphur 40 kg/ha + Molybdenum 1.5% was recorded maximum plant dry weight (50.67 g) which is significantly superior all over the treatments and treatmentwith Sulphur 35kg/ha +Molybdenum 0.5%, Sulphur 35kg + Molybdenum 1%, Sulphur 35 kg/ha + Molybdenum 1.5%, Sulphur 40 kg/ha + Molybdenum 0.5% and Sulphur 40 kg/ha + Molybdenum 1% were statically at par with treatment Sulphur 40 kg/ha + Molybdenum 1.5%. **Duyingqiong *et al.* (2002)** conducted "pot culture experiment and reported that, application of S or Mo or both significantly increased chlorophyll content, photosyntheticactivity of the leaves, dry matter accumulation".

Number of branchs/plant

At 80 DAS, (Table 1) treatment with Sulphur 40 kg/ha + Molybdenum 1.5% was recorded maximum number of branch (9.05) which is significantly superior all over the treatments and treatment with Sulphur 40 kg/ha + Molybdenum 0.5% and Sulphur 40 kg/ha + Molybdenum 1% were statically at par with treatment Sulphur 40 kg/ha +Molybdenum 1.5%. **Duyingqiong *et al.* (2002)** conducted "pot culture experiment and reported that, application of B or Mo or both significantly increased chlorophyll content, photosynthetic activity of the number of branch".

Yield parameters:

Number of pods/plant

At 80 DAS, Treatment with application of Sulphur 40 kg/ha + Molybdenum1.5% (Table 2) was recorded maximum number of pods per plant (15.80) which was significantly superior over all the treatments. However, treatment with application of Sulphur 40 kg/ha + Molybdenum 0.5%, Sulphur 40 kg/ha + Molybdenum 1% was statistically on par with treatment with Sulphur 40 kg/ha + Molybdenum 1.5% molybdenum as compared to other treatments.

Number of grain/pod

At 80 DAS, Treatment with application of Sulphur 40 kg/ha + Molybdenum 1.5% (Table 2) was recorded maximum No. of kernels per pod (3.00) and treatment control recorded minimum No.of kernels per pod (1.13) were no statically at par value.

Seed yield (t/ha)

At 80 DAS (Table 2) The data showed the highest grain yield treatment 9 with application of Sulphur 40kg/ha + Molybdenum 1.5% was recorded maximum seed yield (2.71 t/ha) which was significantly superior over all the treatments. However, treatment with application of Sulphur 35 kg/ha + Molybdenum 1.5%, Sulphur 40 kg/ha + Molybdenum 0.5%, Sulphur 40 kg/ha + Molybdenum 1% was statistically on par with treatment with Sulphur 40 kg/ha + Molybdenum 1.5% as compared to other treatments. **Caries and Rosolam (2000)** found that application of 0.5, 1.0, 1.5 kg/ha Mo increased pod yield over control of margins of 292, 522, 5964 kg/ha (or) 15.1, 27.1, 30.8% similarly there was increase in biological and haulm yields due to increase in Mo application.

Stover yield (t/ha)

At 80 DAS, Treatment with application of Sulphur 40 kg/ha + Molybdenum 1.5% (Table 2) was recorded maximum stover yield (4.30 t/ha) which was significantly superior over all the treatments. However, treatment with application of Sulphur 35 kg/ha + Molybdenum 1% Sulphur 35 kg/ha + Molybdenum 1.5% Sulphur 40 kg/ha + Molybdenum 0.5%, Sulphur 40 kg/ha + Molybdenum 1% was statistically on par with treatment with Sulphur 40 kg/ha + Molybdenum 1.5% as compared to other treatments. **Somayeh *et al.* (2012)** conducted "field experiment to study the effect of sulphur on morphological, biochemical, and physiological properties of groundnut. The findings suggested that $FeSO_4$ (100 mg/kg) increased seed production, stover yield and yield attribute. However, higher concentrations of $FeSO_4$ reduced yield parameters. It was also observed that antioxidant enzymes activity in growth and yield gradually increased with an increase in $FeSO_4$ concentration".

Harvest Index (%)

Treatment with application of Sulphur 40 kg/ha + Molybdenum 1% was recorded maximum Harvest Index (38.55 %) and treatment Sulphur 40 kg/ha + Molybdenum 0.5% (Table 2) recorded lowestharvest index are no statically at par values.

Economics:

The result showed that [Table 3] the maximum Gross returns (1,46,255.73 INR/ha), Net return(98,838.73 INR/ha) and Benefit cost ratio (1.91) was recorded in treatment 9 [Sulphur 40 kg/ha + Molybdenum 1.5%] as compared to other treatments.

CONCLUSION:

The influence of sulfur and molybdenum on growth, yield and economics was highly significant on the groundnut (*Arachis hypogaea* L.) crop. This study showed evidence that the application of sulfur and molybdenum offers agronomic and economic benefits. Based on the results obtained, it can be concluded that for higher productivity and economy, the groundnut crop should be fed with the application of sulfur 40 kg/ha + Molybdenum 1.5% as it provides a higher yield and has proved economically viable with higher net returns and benefit/cost ratio.

REFERENCES:

1. Anonymous. Annual Report, All India Coordinated Research Project on Groundnut. Agriculture Research Station, Durgapura, Jaipur 2009.
2. Balachandar, D., Nagarajan, P. and Gunasekaran; 2003, Effect of micronutrients on nodulation and yield of in acid soil condition. Legume Research, 26(2): 153-154.
3. Bandyopadhyay, S., B. Bhattacharya, K. Ghosh, and C. Varadachari. 2008. New slow-releasing molybdenum fertilizer. Journal of Agricultural and Food Chemist.
4. Caires, E.F. and Rosolam, C.A. 2000. Nodulation and nitrogen uptake by groundnut in response to lime, cobalt and molybdenum. Cientia Agricola. 57: 337-341.
5. Chatterjee, C., Nautiyal, N. and Agarwal, S. C., 1985, Metabolic changes in groundnut (Aracchis hypogaea L.) plants associated with molybdenum deficiency. Indian J. PlantNutr., 3: 79-86.
6. Duyingqiong, Q., Liao Xinrong. He Jianghua., Hiang Zhoyao and Zhou Xiaohong, 2002, Effect of B and Mo on the growth, development and yield of peanut. Plant Nutr.Fert: Scl, 8(2): 233-235.
7. Duyingqiong, Q., Liao Xinrong. He Jianghua., Hiang Zhoyao and Zhou Xiaohong,

2002, Effect of B and Mo on the growth, development and yield of peanut. *Plant Nutr. Fert: Scl*, **8** (2): 233-235.

8. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd Ed. New York: John Wiley and Sons. 1984;680.

9. Gonzalez-Guerrero, M., A. Matthiadis, A. Saez, and T. A. Long. 2014. Fixating on metals, new insights into the role of metals in nodulation and symbiotic nitrogen fixation. Frontiers in Plant Scence 5 (45).doi: 10.3389/fpls. 2014.00045

10. Kene, D. R., Poathy, M. K. and Thakare, K. K., 1988, Effect of graded levels of nitrogen and molybdenum on root nodulation and nitrogen fixation by Rhizobium in groundnutgrown in vertisols. PKV Res. J., 12(2): 152-155.

11. Rajesh, N., and V. K. Paulpandi. 2013. Review of foliar nutrition in Redgram enhancing the growth and yield characters. American International Journal of Research in Formal,Applied and Natural Sciences 13 (142):9–13.

12. Ramdevputra MV, Akbari KN, Sataria GS, Vora VD, Padmani DR. Effect of Sulphur application on yield of groundnut and soil fertility under rainfed conditions. Legume Research 2010;33(2):143-145.

13. Rao KT, Rao AU, Sekhar D. Effect of sources and levels of sulphur on groundnut. Journal of Academia and Industrial Research 2013;2(5):268-270.

14. Schonhof I, Blankenburg D, Muller S, Krumbein A. Sulphur and nitrogen supply influence growth, product appearance, and glucosinolates concentration of broccoli. Journal of Plant Nutrition and Soil Science 2007; 170:65- 72.

15. Somayeh Pooladv and., Mahlagha Ghorbanli and Mozhgan Farzami Sepehr, 2012, Effect of various levels of iron on morphological, biochemical, and physiological properties of Glycine max. Iranian Journal of Plant Physiology., **2**(4): 31-538.

16. Subba, R. and Adinarayana, V., 1995, Molybdenum Research in Agricultural production. FDCO, New Delhi. pp. 115-117

17. Rajanarasimha M, Singh R, Singh E. Effect of sulphur and calcium on growth and yield of groundnut (Arachis hypogea L.). The Pharma Innovation Journal. 2021;10(9):1685-8.

18. Jakhad A, Debbarma V. Influence of biofertilizer and zinc on growth, yield and economics of sorghum (Sorghum bicolor L.). International Journal of Plant & Soil Science. 2023;35(8):90-7.

Table 1. Influence of Sulphur and Molybdenum on growth parameters of Groundnut

S. No.	Hybrids	Growth parameters			
		Plant height (cm)	No. of Nodules/plant	Plant dry weight (g)	No. of branch/plant
1.	Sulphur 30kg/ha + Molybdenum (0.5%)	43.70	59.50	42.20	5.49
2.	Sulphur 30kg/ha + Molybdenum (1%)	45.00	59.90	43.50	5.87
3.	Sulphur 30kg/ha + Molybdenum (1.5%)	46.03	60.03	44.53	6.35
4.	Sulphur 35kg/ha + Molybdenum (0.5%)	46.87	64.00	45.37	6.58
5.	Sulphur 35kg/ha + Molybdenum (1%)	48.00	65.23	46.50	6.92
6.	Sulphur 35kg/ha + Molybdenum (1.5%)	49.03	66.80	47.53	7.56
7.	Sulphur 40kg/ha + Molybdenum (0.5%)	50.00	67.17	48.50	8.53
8.	Sulphur 40kg/ha + Molybdenum (1%)	50.97	67.20	49.47	8.87
9.	Sulphur 40kg/ha + Molybdenum (1.5%)	52.17	68.50	50.67	9.05
10.	Control (NPK 20:60:40 kg/ha.)	42.17	58.57	40.67	5.03
	F-test	S	S	S	S
	SEm±	1.82	3.72	1.82	0.34
	CD (p=0.05)	5.41	8.17	5.41	1.02

Table 2. Influence of Sulphur and Molybdenum on yield attributes and yield of Groundnut

S. No.	Treatment combination	Yield and yield attribute					
		No. of pod/Plant	**No. of grain/pod**	**Seed index (g)**	**Seed yield (t/ha)**	**Stover yield (t/ha)**	**Harvest index (%)**
1.	Sulphur 30kg/ha + Molybdenum (0.5%)	12.23	1.43	33.40	2.15	3.71	36.61
2.	Sulphur 30kg/ha + Molybdenum (1%)	12.33	1.90	33.94	2.20	3.72	37.26
3.	Sulphur 30kg/ha + Molybdenum (1.5%)	12.60	1.93	34.87	2.24	3.75	37.43
4.	Sulphur 35kg/ha + Molybdenum (0.5%)	13.07	2.23	35.79	2.31	3.85	37.53
5.	Sulphur 35kg/ha + Molybdenum (1%)	13.60	2.33	36.12	2.42	4.01	37.63
6.	Sulphur 35kg/ha + Molybdenum (1.5%)	14.13	2.47	36.45	2.48	4.06	37.91
7.	Sulphur 40kg/ha + Molybdenum (0.5%)	14.60	2.60	37.20	2.59	4.20	38.14
8.	Sulphur 40kg/ha + Molybdenum (1%)	15.23	2.83	38.03	2.66	4.29	38.27
9.	Sulphur 40kg/ha + Molybdenum (1.5%)	15.80	3.00	40.83	2.71	4.30	38.55
10.	Control (NPK 20:60:40 kg/ha.)	12.03	1.13	32.70	2.10	3.65	36.58
	F-test	S	S	S	S	S	NS
	SEm (±)	0.55	0.04	1.48	0.87	1.08	0.00
	CD (p=0.05)	1.65	1.25	4.42	2.59	0.32	-

Table 3. Influence of Sulphur and Molybdenum on Economics of Groundnut

S. No.	Treatment combination	Economics			
		Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C Ratio
1.	Sulphur 30kg/ha + Molybdenum (0.5%)	46477	116447.73	69970.73	1.49
2.	Sulphur 30kg/ha + Molybdenum (1%)	46947	119206.67	71429.67	1.50
3.	Sulphur 30kg/ha + Molybdenum (1.5%)	47417	121153.33	73176.33	1.52
4.	Sulphur 35kg/ha + Molybdenum (0.5%)	47777	124913.33	77966.33	1.65
5.	Sulphur 35kg/ha + Molybdenum (1%)	47977	130833.33	82136.33	1.68
6.	Sulphur 35kg/ha + Molybdenum (1.5%)	48697	133840.00	84393.00	1.69
7.	Sulphur 40kg/ha + Molybdenum (0.5%)	49167	139720.00	90303.00	1.83
8.	Sulphur 40kg/ha + Molybdenum (1%)	49417	143826.67	94659.67	1.90
9.	Sulphur 40kg/ha + Molybdenum (1.5%)	49447	146255.73	98838.73	1.91
10.	Control (NPK 20:60:40 kg/ha.)	45607	113753.33	68146.33	1.48