Original Research Article

"Response of Phosphorus and Molybdenum on growth and yield of summer groundnut (*Arachis hypogea* L.)"

ABSTRACT

The experiment was carried out during the *Zaid* season, 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh. The experiment was laid out in Randomised Block Design with ten treatments which are replicated thrice with three levels of application of Phosphorus 20, 40, 60 kgha^{-1} and three levels of foliar application of Molybdenum 0.05%, 0.15%, 0.25% and, control?. Result revealed that higher plant height (67.83 cm), plant dry weight (35.27g), number of pods plant^{-1}(25.37), kernel yield (2.14 t ha^{-1}), haulm ~~halum~~ yield (3.23t ha^{-1}), gross return (INR 137458.00 ha^{-1}), net return (INR 90113.60 ha^{-1}) and B:C ratio(1.90) was found in treatment (T8)with the application of Phosphorus at60kg ha^{-1} along with Molybdenum0.15% whereas number of nodules plant^{-1} (103.67) was obtained by the application of Phosphorus at the rate 60kg ha^{-1} along with Molybdenum 0.25% in treatment (T9).

Keywords: Groundnut, phosphorus, molybdenum, growth, yield.

INTRODUCTION

Groundnut is a leguminous plant, valued for its high-oil edible seeds and as such, it is the fourth most important source of edible oil and a third most important source of vegetable protein in the world. Groundnut is an excellent source of plant nutrients and contains 45-50% oil, 27-33% protein as well as essential minerals and vitamins. They play an important role in the dietary requirements of resource-poor women and children and haulms are used as livestock feed. Groundnut oil is composed of mixed glycerides and contains a high proportion of unsaturated fatty acids, in particular, oleic(50-65%) and linoleic acid (18-30%).

Globally, Groundnut covers 295 lakh hectares with the production of 487 lakh tones with a ~~the~~ productivity of 1647 kgha-1. With annual all-season coverage of 55.6 lakh hectares, globally, India ranks first in Groundnut acreage and is the second largest producer of Groundnut in the world with 101 lakh tones with a productivity of 1816 $kgha^{-1}$ in 2020-21. Groundnut is cultivated in one or more (kharif, rabi and summer) seasons, but nearly 80% of acreage and production comes from kharif crop(**FAOSTAT 2021**).India is one of ~~among~~ the top three producing countries of Groundnuts in the world. It ranks second next to China (37% contribution to the world Groundnut production). Nearly 15% of Groundnut production ~~is~~ contributed by India to ~~the~~ world production in ~~during~~ 2018. Nigeria ranks third in world Groundnut production with a 6% contribution.

Phosphorus is the second major essential nutrient element for crop growth and good-quality yield. The most obvious effect of P is on the plant root system. The requirement of P in nodulating legumes is higher compared to non-nodulating crops as it plays a significant role in nodule formation and fixation of atmospheric nitrogen. Due to the important role played by P in the physiological processes of plants, the application of P to soil deficient in this nutrient leads to an increase groundnut yield **(Islam *et al.* 2013).**it is necessary for the synthesis of protoplasm and chlorophyll, for cell division, and for the growth of meristematic tissues. aids in the maturation and growth of the seed plant. The production of this vitamin is necessary for is also engaged in oil, protein, acid, and the development of glucosinolates that have the amount of oil ~~is~~ increased through hydrolysis. Its deficit result in a significant restriction in the plant's top and root growth **(Mirvat *et al.* 2006)**.

Molybdenum is important for many enzymatic and physiological processes in the plants, with a clear contribution to nitrogen fixation in leguminous crops via root nodules. The nitrate reductase enzyme needs molybdenum to produce, and in legumes, it also participates in symbiotic nitrogen fixation. Without sufficient amounts of molybdenum and iron, the nitrogen-fixing enzyme nitrogenase cannot function and nitrogen fixation cannot take place. Molybdenum, improved groundnut production by increasing the vegetative development and weight of nodular materials.**(Togay *et al.* 2008).**

MATERIAL AND METHODS

The field experiment was conducted during the summer season of 2022 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam

Higginbottom University of Agriculture, Technology & Sciences, Prayagraj, Uttar Pradesh. The soil in the experimental area was sandy loam with pH (7.7), organic carbon (0.57%), available N (171.48 kg ha^{-1}), available P (27.0 kg ha^{-1}), and available K (291.2 kg ha^{-1}). The experiment was laid out in Randomised Block Design with ten treatments which are replicated thrice with three levels of application of Phosphorus 20, 40, 60 kg ha^{-1} and three levels of foliar application of Molybdenum 0.05, 0.15, 0.25%, and control. Treatment combinations are T1: Phosphorus 2Okg ha^{-1} + Molybdenum 0.05%, T2: Phosphorus 2Okg ha^{-1} + Molybdenum 0.15%, T3: Phosphorus 2Okg ha^{-1} + Molybdenum 0.25%, T4: Phosphorus 4Okg ha^{-1} + Molybdenum 0.05%, T5: Phosphorus 4Okg ha^{-1} + Molybdenum 0.15%, T6: Phosphorus 4Okg ha^{-1} + Molybdenum 0.25%, T7:Phosphorus 6Okg ha^{-1} + Molybdenum 0.05%, T8: Phosphorus 6Okg ha^{-1} + Molybdenum 0.15%, T9: Phosphorus 6Okg ha^{-1} + Molybdenum 0.25%, T10: RDF: 20-40-60 NPK kg ha^{-1}(Control) are used. Seeds are sown at a spacing of 30cm×10cm according to a seed rate of 90 kg/ha. The recommended dose of nitrogen (20 kg/ha) and potassium (60 kg/ha) was applied as basal dose just before sowing and phosphorus, and molybdenum(Foliar spray at 25 DAS) were applied as per the treatments. Urea, SSP, and MOP were taken as fertilizer sources of N, P, and K respectively.

RESULT AND DISCUSSION

GROWTH ATTRIBUTES

Plant height (cm) The data revealed that a significant and maximum plant height (67.83 cm) was recorded in treatment 8 [Phosphorus (60 kg ha^{-1}) + Molybdenum (0.15%)]. However, treatment 7 and treatment 9 were found to be statistically at par with treatment 8 in table no.1. Significant and maximum plant height~~was~~ recorded by the application of Phosphorus might be due to P application may be attributable to the fact that P is known to help in the development of more extensive root system and thus enables plants to absorb more water and nutrients from the depth of the soil. ~~Similar~~ A similarresult was reported by **Kabir *et al.* (2013).** Further, foliar application of molybdenum has a significant effect on the traits such as plant height and ~~the~~ biological performance. The result ~~were~~ wasin conformity with those of **Manjili *et al.*(2014).**

~~Number~~ A numberof nodules plant^{-1}The data revealed that a significant and maximum number of nodules plant^{-1} (107) was recorded in treatment 9 [Phosphorus (60 kg ha^{-1}) + Molybdenum (0.25%)]. treatment 8 and treatment 7 were found to be statistically at par with treatment 8. Phosphorus fertilizer is required for plant growth and development as it helps in root development and also serves as an energy source for the rhizobium which in turn may lead to increased nodule formation thereby enhancing N_2 fixation. ~~Similar~~ A similarresult was reported by **Badar et al. (2015)** Molybdenum can play a vital role in increasing the nitrogen fixation process by Rhizobium and is responsible for the formation of nodule tissue and increase in N_2 fixation. Molybdenum is a constituent of the nitrogenase enzyme and every bacterium, which fixes nitrogen, ~~need~~ needsmolybdenum during the fixation process reported by **Hirpara et al. (2019)**

Plant dry weight (g) The data revealed that significant and maximum plant dry weight (35.27 g) was recorded in treatment 8 [Phosphorus (60 kg ha^{-1}) + Molybdenum (0.15%)]. treatment 7 and treatment 9 were found to be statistically at par with treatment 8 in table 1. Significant and maximum dry weight by the application of Phosphorus might be due to phosphorus ~~is~~ beingknown to help ~~developing~~ developa more extensive root system and thus enabling plants to extract water and nutrients from more depth and thiscould enhance the plants to produce more assimilates which was reflected in high biomass. ~~Similar~~ A similarresult was reported by **Gobarah *et al.*(2006).** The improvement in nodulation might have resulted in a higher amount of nitrogen fixation and there by better vegetative growth and dry matter production. The results were similar ~~with~~ tofindings of**Balla*et al.* (2020).**

YIELD ATTRIBUTES

Number of pods plant^{-1}The data revealed that a significant maximum number of pods plant^{-1} (25.37) was recorded in treatment 8 [Phosphorus (60 kg ha^{-1}) + Molybdenum (0.15%)].However, treatment 9 and treatment 7 were found to be statistically at par with treatment 8 in table 2. The increased number of Pods/~~Plant~~ plantsmight be due to the effect of phosphatic fertilizer that increased nutrient availability, resulting in better nutrient absorption and crop growth.~~Similar~~ A similarresult was reported by **Sagar *et al.* (2020).**

Kernel yield (t ha^{-1}) The data revealed that ~~significant~~ significantlyhigher kernel yield (2.14 t ha^{-1}) was recorded in treatment 8 [Phosphorus (60 kg ha^{-1}) + Molybdenum (0.15%)]. treatment 9 and treatment 7 were found to be statistically at par with treatment 8 in table 2.Increasing phosphorus fertilizers rates increased all yield components. Such ~~favourable~~ favorableeffects on yield and yield attributes could be due to the stimulation effects of P on number of nodules and nitrogen activity which in turn reflected positively on groundnut yield attributes.~~Similar~~ A similarresult was reported by **Vali *et al.*(2020).**

Halum yield (t ha^{-1}) The data revealed that a significant higher haulm yield (3.23 t ha^{-1}) was recorded in treatment 8 [Phosphorus (60 kg ha^{-1}) + Molybdenum (0.15%)]. However, treatment 9 and treatment 7 were found to be statistically at par with treatment 8 in table 2. The improvement of dry matter was mainly responsible for the increased stover yieldThe effect of phosphorus will induce the uptake ability of roots to nutrients and a positive increase in the yield parameters because of improving the root system as a source-sink relationship to the reproductive part (shoot). ~~Similar~~ A similarresult was reported by **Mouri *et al.*(2018)**. Molybdenum increased nitrogen fixation which ~~effects~~ affectsplant growth rate and metabolism which results in higher ~~halum~~ haulmyields. ~~Similar~~ A similarresult was reported by **Bhagiya *et al.* (2005).**

ECONOMICS Highest gross return (INR 137458.00 ha^{-1}), net return (INR 86126.60 ha-1) and ~~Benefit cost~~Benefit-cost ratio (1.90) was obtained in the treatment 8 (Phosphorus 60 kg ha^{-1} + Molybdenum 0.15%) in table 3.

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Table 1 Effect of phosphorus and molybdenum on growth attributes of groundnut.

S.no.	Treatment combinations	Plant height (cm)	No. of nodules plant^{-1}	Plant dry weight (g)
1.	Phosphorus 20kg ha^{-1} + Molybdenum 0.05%	60.67	91.33	26.83
2.	Phosphorus 20kg ha^{-1} + Molybdenum 0.15%	59.00	91.67	27.53
3.	Phosphorus 20kg ha^{-1} + Molybdenum 0.25%	62.77	92.33	30.17
4.	Phosphorus 40kg ha^{-1} + Molybdenum 0.05%	63.90	98.00	28.67
5.	Phosphorus 40kg ha^{-1} + Molybdenum 0.15%	61.20	100.67	31.20
6.	Phosphorus 40kg ha^{-1} + Molybdenum 0.25%	63.73	98.00	31.10
7.	Phosphorus 60kg ha^{-1} + Molybdenum 0.05%	66.50	101.33	34.23
8.	Phosphorus 60kg ha^{-1} + Molybdenum 0.15%	67.83	100.67	35.27
9.	Phosphorus 60kg ha^{-1} + Molybdenum 0.25%	65.53	103.67	32.73
10.	Control RDF (20:40:60 kg ha^{-1})	54.43	71.33	26.33
	F test	S	S	S
	SEm.(±)	2.38	4.07	1.64
	CD (p=0.05)	6.65	12.08	4.88

Table 2 Effect of phosphorus and molybdenum on yield attributes of groundnut.

	Treatment Combinations	No. of pods $plan^{t-1}$ (No.)	Halum Yield t/ha	Kernel Yield t/ha
1.	Phosphorus 20kg ha^{-1} + Molybdenum 0.05%	18.07	2.30	1.51
2.	Phosphorus 20kg ha^{-1} + Molybdenum 0.15%	18.27	2.17	1.50
3.	Phosphorus 20kg ha^{-1} + Molybdenum 0.25%	19.43	2.50	1.59
4.	Phosphorus 40kg ha^{-1} + Molybdenum 0.05%	20.50	2.53	1.65
5.	Phosphorus 40kg ha^{-1} + Molybdenum 0.15%	20.83	2.67	1.67
6.	Phosphorus 40kg ha^{-1} + Molybdenum 0.25%	22.80	2.83	1.69
7.	Phosphorus 60kg ha^{-1} + Molybdenum 0.05%	23.20	3.10	2.05
8.	Phosphorus 60kg ha^{-1} + Molybdenum 0.15%	25.37	3.23	2.14
9.	Phosphorus 60kg ha^{-1} + Molybdenum 0.25%	24.47	3.17	2.10
10.	Control RDF (20:40:60 kg ha^{-1})	21.40	2.13	1.42
	F test	S	S	S
	SEm(±)	0.76	0.14	0.13
	CD (p=0.05)	2.26	0.42	0.39

Table 3Effect of phosphorus and molybdenum on Economics of groundnut

	Treatment Combination	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B:C ratio
1.	Phosphorus 20kg ha^{-1} + Molybdenum 0.05%	45854.80	97047.00	51192.00	1.12
2.	Phosphorus 20kg ha^{-1} + Molybdenum 0.15%	47054.80	96249.00	49194.00	1.05
3.	Phosphorus 20kg ha^{-1} + Molybdenum 0.25%	48254.80	102622.00	54367.20	1.13
4.	Phosphorus 40kg ha^{-1} + Molybdenum 0.05%	45999.60	105906.00	59906.40	1.30
5.	Phosphorus 40kg ha^{-1} + Molybdenum 0.15%	47199.60	107898.00	60698.40	1.29
6.	Phosphorus 40kg ha^{-1} + Molybdenum 0.25%	48399.60	109393.00	60993.40	1.26
7.	Phosphorus 60kg ha^{-1} + Molybdenum 0.05%	46144.40	131685.00	85540.60	1.85
8.	Phosphorus 60kg ha^{-1} + Molybdenum 0.15%	47344.40	137458.00	90113.60	1.90
9.	Phosphorus 60kg ha^{-1} + Molybdenum 0.25%	48544.40	134671.00	86126.60	1.77
10.	Control RDF (20:40:60 kg ha^{-1})	44510.00	90975.00	46175.40	1.03