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Effect of phosphorus and molybdenum on growth and yield of summer groundnut (Arachis hypogea L.)

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Abstract
The experiment was conducted in the CRF, Department of Agronomy, SHUATS, Prayagraj, Uttar Pradesh, during the summer season of 2022. Ten treatments, each duplicated three times, were used in the experiment's Randomised Block Design layout. Result revealed that significant increase dry weight per plant (35.27g) at 80 DAS, kernel yield (2.14 t/ha), B:C ratio (1.90) was found with the application of Phosphorus at the rate 60 kg/ha + Molybdenum 0.15% whereas crop growth rate (31.89 g m^{-2} day^{-1}) at 40-60 DAS was acquired by Phosphorus 60 kg/ha + Molybdenum 0.25%. Whereas relative growth rate (0.015 g/g/day) and harvest index (40.72) found Non-significant.

Keywords: Groundnut, phosphorus, molybdenum, dry weight, CGR, RGR, yield

Introduction
The leguminous plant known as groundnut is valued for its high-oil edible seeds, which rank it as the third and fourth-most important source of vegetable protein in the world. Contains 45-50% oil, 27-33% protein, and important minerals and vitamins, groundnut is a great source of plant nutrition. They are essential for providing moms and kids who live in poverty with the nourishment they require, and they are also used as livestock feed. Oleic and linoleic acids make up the majority of the unsaturated fatty acids in groundnut oil, which is made up of mixed glycerides.

The second most important nutrient for crop growth and high-quality output is phosphorus. The root system of the plant is where P has the most evident impact. Due to P's important involvement in nodule development and atmospheric nitrogen fixation, nodulating legumes have higher P requirements than non-nodulating crops. P has a key part in the physiological processes of plants, hence adding P to soil deficient in this nutrient boosts groundnut production (Islam *et al.* 2013) [3, 4]. It is necessary for the synthesis of protoplasm and chlorophyll, cell division, and the growth of meristematic tissues. Assists in the seed plant's development and expansion. This vitamin is made for the synthesis of glucosinolates, which can boost oil through hydrolysis, as well as for the production of oil, protein, acid, and other substances. The plant's top and roots can develop much more slowly without it. (Mirvat *et al.* 2006) [5].

Molybdenum has a key role in several enzymatic and physiological processes in plants, with its root nodules clearly contributing to nitrogen fixation in leguminous crops. The synthesis of the nitrate reductive enzyme depends on molybdenum, which also participates in symbiotic nitrogen fixation in pulse crops. Without sufficient quantities of molybdenum and iron, the nitrogen-fixing enzyme nitrogenase cannot function and nitrogen fixation cannot take place. By promoting vegetative growth and nodular material weight, molybdenum increased groundnut yield. (Togay *et al.* 2008) [8].

Material and Methods
At the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology, and Sciences, Prayagraj, Uttar Pradesh, the field experiment was carried out in the summer of 2022. The soil in the experimental area was Sandy loam with a pH of 7.7, organic carbon of 0.57 percent, available N (171.48 kg/ha), available P (27.0 kg/ha), and available K (291.2 kg/ha). The experiment used a Randomised Block Design with 10 treatments that were reproduced three times. Phosphorus was applied at three different levels—20, 40, and 60 kg/ha and Molybdenum was applied at three different levels 0.05, 0.15, and 0.25% as well as a control.

In accordance with a seed rate of 90 kg/ha, seeds are sown at a spacing of 30 cm ×10 cm. Prior to sowing, the base doses of N @ 20 kg/ha and K @ 60 kg/ha as well as the treatments indicated doses of P and Mo (foliar spray at 25 DAS) were applied. As sources of N, P, and K in fertilisers, urea, SSP, and MOP were used, respectively.

Treatment Combinations

Treatment No	Treatment combinations
T_1	P 20 kg/ha + Molybdenum 0.05%
T_2	P 20 kg/ha + Molybdenum 0.15%
T_3	P 20 kg/ha + Molybdenum 0.25%
T_4	P 40 kg/ha + Molybdenum 0.05%
T_5	P 40 kg/ha + Molybdenum 0.15%
T_6	P 40 kg/ha + Molybdenum 0.25%
T_7	P 60 kg/ha + Molybdenum 0.05%
T_8	P 60 kg/ha + Molybdenum 0.15%
T_9	P 60 kg/ha + Molybdenum 0.25%
T_{10}	Control RDF

Result and Discussion

Growth attributes

Dry weight per plant (g): The data revealed that significant and higher dry weight per plant (35.27 g) was recorded in treatment 8 [P (60 kg/ha) + Molybdenum (0.15%)]. treatment 7 and treatment 9 were found to be statistically at par with treatment 8 in table 3. Due to the ability of the plants to produce more assimilates may be improved as a result of the application of phosphorus, which is known to aid in the establishment of a more extensive root system that allows plants to draw water and nutrients from deeper soil. This was reflected in high biomass. According to Gobarah *et al.* (2006) [2], a similar outcome was obtained. The improvement in nodulation may have resulted in a rise in nitrogen fixation, resulting in improved vegetative growth and dry matter production. Balla *et al.* (2020) [1] found comparable results to those that were obtained.

Crop Growth Rate (g m^{-2} day^{-1}): At 60-80 DAS, the highest CGR was obtained in T_8 (60 kg Phosphorus/ha + molybdenum 0.15%) i.e. 14.22 g/m^2/day and lowest CGR though it was non-significant. At 40-60 DAS, higher CGR (31.89 g/m^2 /day) was observed in T_9 (60 kg Phosphorus /ha + molybdenum 0.25%). However, T_3 (20 kg Phosphorus/ha + molybdenum 0.25%), T_8 (60 kg Phosphorus/ ha+ molybdenum 0.15%) were found to be statistically at par with T_9 (20kg Phosphorus/ha + molybdenum 0.25%). At 20-40 DAS, the maximum CGR was obtained in T_8 (60 kg Phosphorus/ha + molybdenum 0.15%) i.e., 15.02 g/m^2/ day$^-$which was 19% higher than the lowest CGR though it was non-significant among the treatments in table 1.

Relative growth rate (g/g/day): At 60-80 DAS, the highest RGR was obtained in T_5 (Phosphorus 40 kg/ha + molybdenum 0.15%) i.e., 0.015 g/g/day. Which was 10.8% higher than the lowest RGR though it was non-significant. At 40-60 DAS, maximum RGR (0.056 g/g/day) was observed in T_3 (Phosphorus 20 kg/ha + molybdenum 0.25%) and lowest RGR (0.041 g/g/day). Was observed in T_6 (40 kg Phosphorus/ha + molybdenum 0.25%). At 20-40 DAS, the highest RGR was obtained in T_5 (40 kg Phosphorus/ha + molybdenum 0.15%) i.e., 0.105 g/day which was 18.4% higher than the lowest RGR though it was non-significant among the treatments.

Yield Attributes

Kernel yield (t/ha)

In Table 3, the data resulted that significant and maximum kernel yield (2.14 t/ha) was record in treatment 8 [Phosphorus (60 kg/ha) + Molybdenum (0.15%)]. treatment 9 and treatment 7 were found to be statistically at par with treatment 8 in table 3. As phosphorus fertiliser rates grew, so did every aspect of the output. P's stimulation of nodule number and nitrogen activity, which in turn had a positive impact on groundnut yield attributes, may be the cause of these beneficial effects on yield and yield characteristics. The same outcome was reported by Vali *et al.* in 2020.

Benefit cost ratio

In table 4, the data revealed that maximum B:C(1.90) were resulted in treatment 8 [Phosphorus (60 kg/ha) + Molybdenum (0.15%)]. The increased number of pods/plant and kernel production may be the consequence of phosphatic fertilizer's enhanced nutrient availability, which led to higher crop development and nutrient uptake. Sagar *et al.* (2020) [9] reported a comparable finding. The same outcome was noted by Mouri *et al.* (2018) [7]. The greater halum yields that arise from molybdenum's improved nitrogen fixation on plants' development and metabolism. In 2005, Bhagiya *et al.* reported a similar outcome.

Table 1: Effect of phosphorus and molybdenum on crop growth rate (g.m^2/day) at different growth intervals of groundnut

	Treatment combinations	Crop growth rate		
		20-40 DAS	40-60 DAS	60-80 DAS
1.	P 20 kg/ha + Molybdenum 0.05%	12.37	22.61	7.33
2.	P 20 kg/ha + Molybdenum 0.15%	12.09	22.72	9.00
3.	P 20 kg/ha + Molybdenum 0.25%	11.04	27.67	9.39
4.	P 40 kg/ha + Molybdenum 0.05%	13.17	22.84	9.61
5.	P 40 kg/ha + Molybdenum 0.15%	13.84	23.06	13.16
6.	P 40 kg/ha + Molybdenum 0.25%	14.79	21.83	13.05
7.	P 60 kg/ha + Molybdenum 0.05%	14.51	26.94	13.39
8.	P 60 kg/ha + Molybdenum 0.15%	15.02	27.17	14.22
9.	P 60 kg/ha + Molybdenum 0.25%	12.96	31.89	5.67
10.	Control RDF	9.53	18.29	12.11
	F test	NS	S	NS
	S.Em (±)	1.13	2.18	3.41
	CD (P=0.05)	-	6.47	-

Table 2: Effect of phosphorus and molybdenum on relative growth rate (g/g/day) at different growth intervals of groundnut

	Treatment combinations	Relative growth rate		
		20-40 DAS	40-60 DAS	60-80 DAS
1.	P 20 kg/ha + Molybdenum 0.05%	0.091	0.046	0.009
2.	P 20 kg/ha + Molybdenum 0.15%	0.096	0.048	0.011
3.	P 20 kg/ha + Molybdenum 0.25%	0.090	0.056	0.011
4.	P 40 kg/ha + Molybdenum 0.05%	0.098	0.046	0.011
5.	P 40 kg/ha + Molybdenum 0.15%	0.105	0.045	0.015
6.	P 40 kg/ha + Molybdenum 0.25%	0.103	0.041	0.014
7.	P 60 kg/ha + Molybdenum 0.05%	0.102	0.048	0.013
8.	P 60 kg/ha + Molybdenum 0.15%	0.100	0.047	0.014
9.	P 60 kg/ha + Molybdenum 0.25%	0.075	0.053	0.005
10.	Control RDF	0.075	0.045	0.002
	F test	NS	NS	NS
	SEm (±)	0.008	0.004	0.004
	CD (P=0.05)	-	-	-

Table 3: Effect of phosphorus and molybdenum on growth and yield attributes of groundnut

Sr. No	Treatment combinations	Dry weight Per plant(g)	Kernel Yield t/ha	Harvest Index (%)
1	P 20 kg/ha + Molybdenum 0.05%	26.83	1.51	34.71
2	P 20 kg/ha + Molybdenum 0.15%	27.53	1.50	40.18
3	P 20 kg/ha + Molybdenum 0.25%	30.17	1.59	33.30
4	P 40 kg/ha + Molybdenum 0.05%	28.67	1.65	30.44
5	P 40 kg/ha + Molybdenum 0.15%	31.20	1.67	33.05
6	P 40 kg/ha + Molybdenum 0.25%	31.10	1.69	33.53
7	P 60 kg/ha + Molybdenum 0.05%	34.23	2.05	37.88
8	P 60 kg/ha + Molybdenum 0.15%	35.27	2.14	36.36
9	P 60 kg/ha + Molybdenum 0.25%	32.73	2.10	36.66
10	Control RDF	26.33	1.42	40.72
	F test	S	S	S
	S.Em (±)	1.64	0.13	1.64
	CD (P=0.05)	4.88	0.39	4.88

Table 4: Effect of phosphorus and molybdenum on Economics of groundnut

Sr. No	Treatment combinations	B:C ratio
1	P 20 kg/ha + Molybdenum 0.05%	1.12
2	P 20 kg/ha + Molybdenum 0.15%	1.05
3	P 20 kg/ha + Molybdenum 0.25%	1.13
4	P 40 kg/ha + Molybdenum 0.05%	1.30
5	P 40 kg/ha + Molybdenum 0.15%	1.29
6	P 40 kg/ha + Molybdenum 0.25%	1.26
7	P 60 kg/ha + Molybdenum 0.05%	1.85
8	P 60 kg/ha + Molybdenum 0.15%	1.90
9	P 60 kg/ha + Molybdenum 0.25%	1.77
10	Control RDF	1.03

Conclusion

The study findings support the notion that groundnut benefits from the combination of phosphorus and molybdenum spray. Therefore, increasing both the production and the number of morphological traits.

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