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Effect of zinc and phosphorus on growth and yield of groundnut (Arachis hypogaea)

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Abstract
A field experimental trail on groundnut was conducted during Zaid, 2021 at Krishi Vigyan Kendra (KVK), Department of Agronomy, SHUATS, Prayagraj (U.P.). To evaluate the effect of zinc and phosphorus on growth and yield of groundnut. The soil of experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha), available K (92 kg/ha). The experiment was laid out in Randomized Block Design (RBD) with ten treatments replicated thrice. In the view of this experiment, zinc and phosphorus were applied thrice at different levels (ZnSO4 at 10, 20, 30 kg/ha and P at 20, 40, 60 kg/ha respectively) along with RDF and control plot with RDF alone. Results revealed that growth parameters at 60 DAS and yield parameters at harvest *viz*: plant height (24.13 cm), number of nodules/plant (180.53), plant dry weight (59.10 g), number of pods/plant (27.53), number of kernels/ pod (2), seed index (39.77 g), shelling percentage (69.90%), pod yield (3 t/ha), seed yield (2.10 t/ha), haulm yield (3.35 t/ha) and harvest index (32.10%) were recorded significantly higher with the application of ZnSO4 30 kg/ha + Phosphorus 60 kg/ha as compared to other treatments.

Keywords: Zinc, phosphorus, growth and yield

Introduction
Groundnut (Arachis hypogaea) is an important oilseed and supplementary food crop of the world. It is fourth most important source of edible oil and third most important source of vegetable protein. It belongs to family Leguminaceae. India occupies first place in terms of area and second in terms of production of groundnut. Groundnut crop area in India is at 40.12 lakh per ha in 2018-2019. Similarly, production is estimated at 37.70 lakh tones per ha (Vali *et al*., 2020) [22]. It is premier oil seed crop of India popularly known as peanut, monkey nut, manila nut. Globally 50% of groundnut is used for oil extraction, 37% confectionary and 12% seed purpose (Nurezannat *et al*., 2019) [17]. Peanut is a poorman's nut due to its high-energy, protein and minerals at a comparatively low cost, is consumed by a large number of people world- wide, and is also a rich source of micronutrients including Zn which makes the crop more important. The 100 g peanut contains 567 Kcal of energy with carbohydrate of 16.13 g, protein of 25.8 g, total fat of 49.24 g, dietary fibre of 8.5 g and Cholesterol free. Among the vitamins and minerals, peanut has high folic acid content (240 µg) and 3.27 mg of zinc, respectively (USDA National Nutrient data base). Peanut is a good source of zinc (Singh, 2007) [21].
Zinc is required in various metabolic processes as catalysts. Zinc also increases the content of protein, calorific value, amino acid and fat in oilseed crop Balanced fertilization helps to improve the quality of the produce. Thus, use of fertilizer for a particular crop should be considered from quality point of view. Zinc deficiency start yellowing of leaves from lamina to base, mid-rib and veins remain green (Maharnor *et al*., 2018) [12]. Zinc is an important micronutrient reported deficient in Indian soils. Zinc deficiency in crop plants is a widespread nutritional disorder in variety of soils. It is assumed that application of micronutrient may increase the productivity of groundnut due to its multifarious role in plant metabolism (Radhika *et al*., 2021) [18].
Phosphorus is essential for the formation of chlorophyll and protoplasm, cell division and development of meristematic tissues, also helps in the seed development and maturity of plant. This nutrient is required for synthesis of oil, protein, acid and is also involved in formation of glucosinolates which on hydrolysis increases the oil content. Its deficiency causes severe restriction in the growth of plant tops and root (Mirvat *et al*., 2006) [14].

Phosphorus (P) 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 (Brady *et al*., 2002) [3]. Due to the important role played by P in the physiological processes of plants, application of P to soil deficient in this nutrient leads to increase groundnut yield (Kabir *et al*. 2013) [10].

Materials and Methods

A field trial was conducted during Zaid, 2021 at Krishi Vigyan Kendra (KVK), Department of Agronomy, SHUATS, Prayagraj (U.P.), India which is located at 25.40˚ N latitude, 81.85 ˚ E longitude, and 98 m altitude above the mean sea level (MSL). The soil of the experiment plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low in organic carbon (0.28%), available N (225 kg/ha), available P (19.50 kg/ha), available K (92 kg/ha). Nutrient sources were Urea, Single Super Phosphate, Murate of Potash and Zinc Sulphate to fulfill the requirement of Nitrogen, Phosphorus, Potassium and Zinc respectively. The experiment was laid out in Randomized Block Design (RBD) which consisting of ten treatments with T1: Zinc 10 kg/ha + Phosphorus 20 kg/ha, T2: Zinc 10 kg/ha + Phosphorus 40 kg/ha, T3: Zinc 10 kg/ha + Phosphorus 60 kg/ha, T4: Zinc 20 kg/ha + Phosphorus 20 kg/ha, T5: Zinc 20 kg/ha + Phosphorus 40 kg/ha, T6: Zinc 20 kg/ha + Phosphorus 60 kg/ha, T7: Zinc 30 kg/ha + Phosphorus 20 kg/ha, T8: Zinc 30 kg/ha + Phosphorus 40 kg/ha, T9: Zinc 30 kg/ha + Phosphorus 60 kg/ha, T10: Control are used. RDF of 25:40 Nitrogen and potassium kg/ha was used in all treatments as basal dose, also Zinc Sulphate and Single super phosphate were applied basally according to the treatments. Seeds were dibbled manually at the seed rate of 120 kg/ha. The growth parameters of the plants were recorded at frequent intervals from germination up until harvest and finally, the yield parameters were recorded after harvest. These parameters were statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

Results and Discussion

Plant height (cm)

The significantly taller plant height (24.13 cm) at 60 DAS was recoded in treatment 9 with 20 kg/ha + Phosphorus 60 kg/ha and ZnSO4 30 kg/ha + phosphorus 40 kg/ha were statistically at par with ZnSO4 30 kg/ha + Phosphorus 60 kg/ha. The minimum plant height (19.33 cm) was recorded with the treatment ZnSO4 10 kg/ha + Phosphorus 20 kg/ha.

The increase in plant height due to Phosphorus application may be attributable to the fact that P is known to help in the development of more extensive root system and nodulation and thus enables plants to absorb more water and nutrients from depth of the soil (Vali *et al*., 2020) [22]. Kabir *et al*. (2013) [10] was reported that plant height increased with the application of 50 kg phosphorus/ha.

Number of nodules per plant

The significantly highest Number of nodules/plant (180.53) at 60 DAS was recoded in treatment 9 with application of ZnSO4 30 kg/ha + Phosphorus 60 kg/ha. However, treatment with Zinc 20 kg/ha + Phosphorus 60 kg/ha, Zinc 30 kg/ha + Phosphorus 40 kg/ha, Zinc10 kg + Phosphorus 60 kg/ha and Zinc 30 kg/ha + Phosphorus 20 kg/ha were observed statistically at par with treatment Zinc 30 kg/ha + Phosphorus 60 kg/ha.

The increase in nodulation with increasing phosphorus levels may be accrued to the Phosphorus availability, which plays an important role in nodules formation (Vali *et al*., 2020) [22]. Dekhane (2011), Nkaa *et al*. (2014) [16], Baboo and Mishra (2001) also obtained the similar results in garden pea. These The combined analysis of variance of nodulation assessment at 50% flowering stage revealed that the main factors N, P and VC and their interactions significantly influenced both total and effective number of nodules/plant. The number of total and effective nodules obtained in response to the combined application of 23:46 kg N: P2O5/ha. The present investigation is in cognizance with the findings (Bekele *et al*., 2019) [2].

Plant dry weight (g)

The significantly highest Plant Dry matter (59.10 g/plant) at 60 DAS was recoded in treatment 9 with application of ZnSO4 30 kg/ha + Phosphorus 60 kg/ha. However, treatment with Zinc 20 kg/ha + Phosphorus 60 kg/ha, Zinc 30 kg/ha + Phosphorus 40 kg/ha, Zinc 10 kg/ha + Phosphorus 60 kg/ha, Control, Zinc 20 kg/ha + Phosphorus 40 kg/ha, Zinc 10 kg/ha + Phosphorus 40 kg/ha, were observed statistically at par with treatment Zinc 30 kg/ha + Phosphorus 60 kg/ha.

The increases in dry weight due to phosphorus application may be due to the fact that phosphorus is known to help in the development of more extensive root system, Sharma and Yaday (1997) [20] and thus enables plants absorb more water and nutrients from depth of the soil. This in turn could enhance the plant's ability to produce more assimilates which were reflected in the enhanced biomass production (Sagar *et al*., 2020) [19]. The effect of phosphorus on dry matter was significant. Dry matter was the highest (50.45 g/plant) in 60 kg P/ha followed by 40, 20 and 0 kg P/ha, respectively. The improvement of number of primary and secondary branches plant-1 and leaf area index were mainly responsible for the increased dry matter in 60 kg P/ha. (Mouri *et al*. 2018) [15].

Crop growth rate (g/m2/day) and Relative growth rate (g/g/day) 40-60 DAS Crop Growth Rate was recorded highest (80.67 g/m2/day) in treatment 8 with application of ZnSO4 30 kg/ha + Phosphorus 40 kg/ha which showed significant difference with other treatments.

40-60 DAS Relative Growth Rate was recorded significantly highest (0.0887g/g/day) in treatment 1 with application of ZnSO4 10 kg/ha + Phosphorus 20 kg/ha which showed significant difference with other treatments.

The improved nutritional environment at cellular level and leaf chlorophyll content appears to have increased the photosynthetic rate. Thus, it is obvious that the improved growth and development of the crop plants in the present investigation might be the result of enhanced metabolic activities and photosynthetic rate resulting in improvement in the accumulation of dry matter at the successive growth stages further leads to increase the crop growth rate and relative growth rate in all stages of plants. Present investigation is in cognizance with the findings of (Das *et al*. 2016) [5].

Yield attributes

Treatment with Zinc 30 kg/ha + Phosphorus 60 kg/ha was recorded significantly highest number of pods per plant (27.53), number of kernels per pod (2), Seed index (39.77 g) and Shelling (69.9%). However, treatment with Zinc 20 kg/ha + Phosphorus 60 kg/ha and Zinc 30 kg/ha + Phosphorus 40 kg/ha were observed statistically at par with treatment Zinc 30 kg/ha + Phosphorus 60 kg/ha.

The higher yield could be attributed to higher dry matter production and cumulative effect of yield attributes. Indeed, the yield of crop is a function of yield attributes like pods/plant, pod weight, 100 kernel weight and shelling percentage which ultimately resulted in significantly higher pod and haulm yield. (Gowthami *et al*. 2017) [9]. Application of 60 kg phosphorus/ha gave highest number of pods/plant (Mauri *et al*. 2018) [15]

Yield

Significantly higher pod yield (3.00 t/ha), seed yield (2.1 t/ha) and haulm yield (3.54 t/ha) and Harvest index (32.10%) were found in treatment 9 with ZnSO4 30 kg/ha + Phosphorus 60 kg/ha. However, treatment with ZnSO4 20 kg/ha + Phosphorus 60 kg/ha was found to be statistically at par with the treatment ZnSO4 30 kg/ha + Phosphorus 60 kg/ha.

The higher seed yield may be attributed to higher total dry matter accumulation due to better total nitrogen as well as Zn and Fe uptake and their translocation to the reproductive parts and improvement in yield attributing characters like number of pods/plant, pod weight, 100 kernel weight and shelling percentage. The data on haulm yield also differed significantly due to micronutrient application. Soil application of ZnSO4 at 25 kg/ha + foliar application of ZnSO4 at 0.5% recorded significantly higher haulm yield (3080 kg/ha) (Gowthami *et al*. 2017) [9]. Similar results were also observed by Meena *et al*. (2007) [13]. Such favourable effects 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. Furthermore, the increment in yield due to phosphorus fertilizer maybe attributed to the activation of metabolic processes, where its role in building phospholipids and nucleic acid in known. These findings endorse the results of Mirvat *et al*. (2006) [14], kamdi *et al*. (2014) [11] and El-Habbasha *et al*. (2005) [8]. Zn plays as an activator of several enzymes in plants, and it is directly involved in the biosynthesis of growth substances such as auxin which produces more plant cells and more dry matter that in turn will be stored in seeds as a sink. Thus, the increase in seed yield is more expected. Increasing in application of zinc fertilizer increased the yield and yield attributes might be due to the significant improvement in growth parameters through activation of various enzymes and the basic metabolic rate in plants, which in turn enhanced the pod yield due to greater availability of nutrients and photosynthates. Similar finding were reported by Christopher *et al*. (2019) and Ved *et al*. (2002) [23].

Table 1: Effect of Zinc and Phosphorus on growth and growth attributes of groundnut

60-S0 DAS		60-S0 DAS				
S. No.	Treatments	Plant height (cm)	Number of nodules: Plant	Plant thy weight (g)	Crop growth rate (gim²iday)	Relative growth rate (g/g/day)
1	10 kg/ha ZnSO4+ 20 kg/ha Phosphorus	19.33	140.20	55.53	76.77	0.0887
2	10 kg/ha ZnSO4+ 40 kg/ha Phosphorus	20.50	150.07	57.57	79.33	0.0879
3	10 kg/ha ZnSO4+ 60 kg/ha Phosphorus	23.10	157.07	58.83	80.60	0.0865
4	20 kg/ha ZnSO4+ 20 kg/ha Phosphorus	19.60	144.07	56.17	77.45	0.0881
5	20 kg/ha ZnSO4+ 40 kg/ha Phosphorus	22.10	154.20	58.10	79.88	0.0874
6	20 kg/ha ZnSO4+ 60 kg/ha Phosphorus	23.87	174.50	58.97	80.45	0.0857
7	30 kg/ha ZnSO4+ 20 kg/ha Phosphorus'	21.67	156.80	56.83	78.27	0.0879
8	30 kg/ha ZnSO4+ 40 kg/ha Phosphorus	23.57	171.80	58.93	80.67	0.0863
9	30 kg/ha ZnSO4+ 60 kg/ha Phosphorus	24.13	180.53	59.10	80.38	0.0849
Control		22.30	134.53	58.20	79.72	0.0865
F-Test		S	S	S	NS	NS
S Em (--t)		0.27	8.62	0.66	1.12	0.0012
CD (p=0.05)		0.81	25.62	1.95		--

Table 2: Effect of Zinc and Phosphorus on yield and yield attributes of groundnut

S.no	Treatment combination	No. of pods/plant	No. of kernel	Seed Pod Index (g)	Shelling (%)	Pod yield (t/ha)	Seed yield (t/ha)	Haulm Yield (t/ha)	Harvest Index (%)
1.	10 kg/ha ZnSO4 + 20 kg/ha Phosphorus	23.40	1.80	35.17	67.07	1.58	3.27	2.36	28.09
2.	10 kg/ha ZnSO4 + 40 kg/ha Phosphorus	24.60	1.80	35.57	67.70	1.65	3.40	2.44	28.28
3.	10 kg/ha ZnSO4 + 60 kg/ha Phosphorus	26.47	1.87	37.07	68.33	1.82	3.49	2.67	29.58
4.	20 kg/ha ZnSO4 + 20 kg/ha Phosphorus	23.60	1.83	35.33	67.27	1.63	3.34	2.42	28.30
5.	20 kg/ha ZnSO4 + 40 kg/ha Phosphorus	25.67	1.87	35.90	67.77	1.68	3.43	2.48	28.49
6.	20 kg/ha ZnSO4 + 60 kg/ha Phosphorus	27.33	2.00	39.07	69.87	2.07	3.51	2.97	31.97
7.	30 kg/ha ZnSO4 + 20 kg/ha Phosphorus	24.33	1.77	35.53	67.47	1.65	3.39	2.44	28.21
8.	30 kg/ha ZnSO4 + 40 kg/ha Phosphorus	26.53	1.97	37.33	69.37	1.91	3.50	2.75	30.56
9.	30 kg/ha ZnSO4 + 60 kg/ha Phosphorus	27.53	2.00	39.77	69.90	2.10	3.54	3.00	32.10
10.	Control	25.60	1.97	36.60	68.20	1.76	3.46	2.58	29.14
	F-Test	S	S	S	S	S	S	S	S
	SEm (±)	0.10	0.04	0.24	0.23	0.01	0.01	0.02	0.13
	CD (p=0.05)	0.30	0.12	0.70	0.67	0.04	0.02	0.06	0.38

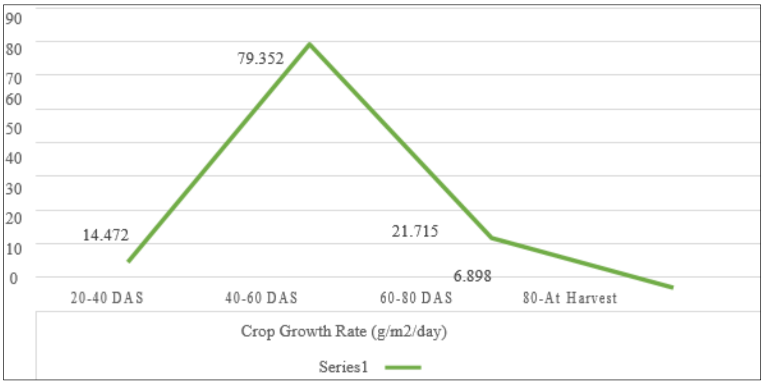

Fig 1: Crop Growth Rate (g/m2/day)

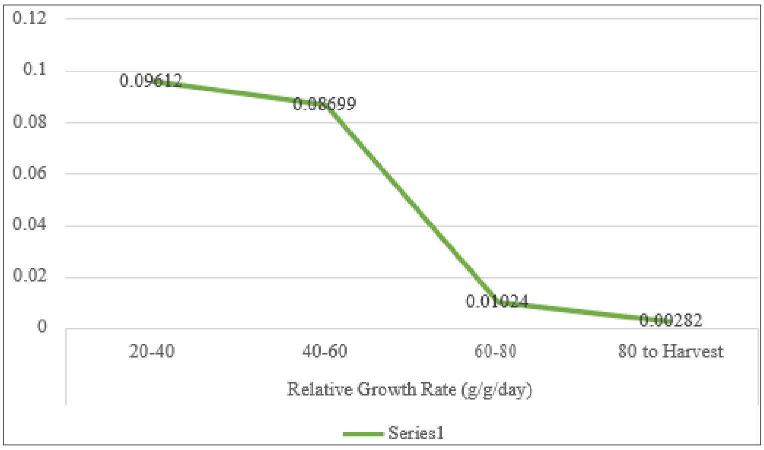

Fig 2: Relative Growth Rate (g/g/day)

Conclusion

Based on my research trail, the treatment combination of ZnSO4 30 kg/ha + Phosphorus 60 kg/ha was found to be more productive. Although the findings are based on one season further research is needed to confirm the findings and their recommendation.

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