Influence of different levels of potassium and zinc on growth, yield and economics of summer groundnut (*Arachis hypogaea* L.)

ABSTRACT

A field experiment was conducted during *Zaid* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) on determine the "Influence of different levels of potassium and zinc on growth and yield of summer groundnut (*Arachis hypogaea* L.)", and to study treatments consisting of three levels of Potassium (30,40,50 kg/ha) and three levels of Zinc (10, 15, 20 kg/ha). There were 10 treatments, each of which was replicated three times and laid out in a random block design. The results showed that treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] recorded significantly higher plant height (29.5 cm), higher number of nodules/plant (64.1), higher dry weight (47.30 g). Whereas, maximum number of pods/plant (28.1), maximum number of kernels/pod (2), higher seed index (40 g), higher seed yield (2.31 t/ha), maximum haulm yield (3.74 t/ha) and higher harvest index (32.30 %) was recorded in treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].Similarly, maximum gross return (1,34,970.00INR/ha), higher net return (93,865.00INR/ha) and highest benefit cost ratio (2.28) was also recorded in treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] as compared to other treatments.

Keywords: Potassium, Zinc, Growth, Yield, Economics

INTRODUCTION

“Groundnut (*Arachis hypogaea* L.) is one of the most important oil seed and supplementary food crop of India. Groundnut appeared to have originated in South America i.e., North-West of Brazil and the secondary center of its cultivation is in Africa and then spread to other parts of the world. It referred to as king of oil seeds and commonly known as poor man’s almond, monkey nut, earth nut, pea nut and locally called as moongphali . It is grown in most tropical, sub-tropical and warm temperate regions of world between 400 N and 400 S latitude. Throughout the world, groundnuts are utilised for 12% seed purposes, 37% confectionery uses, and 50% oil extraction uses” (**Nurezannat *et al.*, 2019**). “It is a major crop that contains around 45% to 51% high-quality hydrogenated edible oil, dietary proteins (26%) as well as soluble carbohydrates (24.2%) and minerals. The kernels are also high in vitamin K, E, and all B vitamins, apart from B12” (**Naiknaware *et al.*, 2015**). 20% of the fat in ground nut oil is saturated, whereas 80% is unsaturated. They are very nutrition and include oleic acid (50–60%), linoleic acid (18–30%), palmitic acid (8–10%), stearic acid (3-6%), and 7% of other fats includes arachidic acid and lignoceric acid **(Maharnor *et al*., 2018).** In addition to being a major cooking ingredient, groundnut oil is also commonly used to make cold creams, soap, and vanaspati tup. Cysteines, an amino acid that is necessary for animal development, are found in groundnuts. Groundnut cake, which is obtained after oil extraction and includes 7 to 8% N, 1.5% P, and 1% K, is regarded useful organic waste and animal feed because of its high protein content **(Dileep *et al*., 2021)**.

“Ground nut ranks first in area and second in terms of production after soyabean and is grown in almost all parts of the country over wide range of agro- climatic condition. Globally, groundnut covers 31.5 million hectares with the production of 53.6 million tonnes with the productivity of 1701 kg/ha” (FAOSTAT, 2020). “In India, groundnut is grown over an area about 5.571 million ha with a production of 10.21 million tonnes and productivity of 1831 kg/ha under 2020-21”(GOI, 2020). “During 2019-20 total area coverage under groundnut in Uttar Pradesh 93822.00 hectares with a production of 88371 tonnes and the productivity 940 kg/ha” (DAC, 2019). According to government fourth advance estimates groundnut production in 2021-22 is at 10.106 million tonnes.

Now a days, country is dealing with an edible oil crisis as well as increasing population demand for edible oil. Thus, farmers should use suitable and improved methods for producing groundnuts in order to overcome these problems. Groundnut crop maintain stable yields depending upon availability of macro and micro nutrient during crop period stage. According to **Vali *et al.*** (**2020)** "inadequate and imbalance use of fertilizers is one of the major factors responsible for low yield in groundnut, to overcome this issue appropriate application of potassium at 50kg/ha and zinc 20 kg/ha along with recommended dosage of nitrogen and phosphorous helped to improve the yield attributes like pods/plant, kernels/pod, seed yield and pod yield".

A widespread occurrence of groundnut yellowing due to zinc deficiency both midrib and veins of the leaves begins to yellow from the lamina to the base. Consequently, dorsal leaf veins become dark and necrotic brown patches begin to appear. Zinc deficiency reduces IAA production and slows down dehydrogenase enzyme activity, which results in poor plant metabolism and poor yield. An essential micronutrient reported to be deficient in Indian soil is zinc. Due to its various roles in plant metabolism, application of zinc promotes groundnut productivity by preventing the development of chlorosis, which increases the chlorophyl content and in turn increases groundnut seed and pod yield **(Radhika *et al.*, 2021)**.

"One of the three main basic nutrients that plants need is potassium. Although potassium is neither a component of any compound nor structurally bound in groundnut, it is necessary for the translocation of assimilates, involved in maintaining the water status of plants, particularly the turgor pressure of cells, and involved in the opening and closing of stomata, as well as increasing the availability of metabolic energy for the synthesis of starch and proteins. Moreover, it promoted peg formation, nodulation, the production of sugar and starch, as well as pod development and filling" (**Patel *et al.*, 2018**). "The balance of enzymatic, stomatal activity, the transportation of sugar and the production of proteins, photosynthesis, starch, and cell elongation are all regulated by potassium, which also plays a significant role in the synthesis of carbohydrates, photosynthesis, and starch" (**Sireesha and Joy, 2022**). "Potassium is involved in large number of physiological processes like osmoregulation, cation- anion balance and activation of enzymes. Being a major inorganic solute, it reduces lodging, imparts disease resistance and improves the quality and shelf life of crop produce" (**Sakarvadia *et al.*, 2019**).

“Zinc is a well-known enzyme component that is also necessary for the production of pyruvic decarboxylase and indole acetic acid. As catalysts, zinc is necessary for several metabolic processes. Moreover, zinc enhances the amount of fat, protein, and caloric value in oilseed crops. In plant cells, zinc catalyzes the oxidation process and is essential for the transformation of carbohydrates, controlling the intake of sugar, increasing the supply of energy for chlorophyll synthesis, helping to promote the growth of auxin, and promoting water absorption” (**Reddy *et al.,* 2022**). Zinc helps in the production of plant growth factors and enzyme systems and is a necessary mineral for the synthesis of IAA (Indole Acetic Acid), which has an impact on plant growth and development as a regulator of many biological processes. A condition for sufficient growth and development may be the proper supply of zinc to young and growing plants **(Vali *et al.,* 2020)**.

MATERIALS AND METHODS:

The experiment was conducted during summer season of 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). the soil of the field constituting a part of central Gangetic alluvium is neutral and deep. The soil of the experimental field was sandy loam in texture, nearly neutral in soil reaction (pH 7.8), low level of organic carbon (0.62%), available N (225 Kg/ha), P (38.2 kg/ha), K (240.7 kg/ha) and zinc (2.32 mg/kg). The treatment consist of three levels of potassium viz (30, 40, 50 kg/ha) with combination of different levels of Zinc. The experiment was laid out in RBD with 10 treatments each replicated thrice. The treatment combinations are T_1 - Potassium (30 kg/ha) + Zinc (10 kg/ha), T_2 - Potassium (30kg/ha) + Zinc (15kg/ha), T_3 - Potassium (30kg/ha) + Zinc (20kg/ha),T_4 - Potassium (40kg/ha) + Zinc (10kg/ha), T_5 - Potassium (40kg/ha) + Zinc (15kg/ha),T_6 - Potassium (40kg/ha) + Zinc (20kg/ha),T_7 - Potassium (50kg/ha) + Zinc (10kg/ha),T_8 -Potassium (50kg/ha) + Zinc (15kg/ha),T_9 - Potassium (50kg/ha) + Zinc (20kg/ha), T_{10}- Control N:P:K (25:50:25 Kg/ha).

All agronomic practices are followed in order in the crop period. 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.

RESULT AND DISSCUSSION

Growth parameters

Plant height (cm)

Data revealed that significant and higher plant height (29.5 cm) was recorded in treatment 9 [Potassium (50kg/ha + Zinc at 20kg/ha)]. However, treatment 6 [Potassium (40kg/ha) + Zinc (20kg/ha)],treatment 7[Potassium (50kg/ha) + Zinc (10kg/ha)] and treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] were statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

The significant and higher plant height was observed with the application of potassium (50 kg/ha) might be due the fact that higher doses of potassium enhanced the metabolic and meristematic activities of groundnut crop. Similar result was reported by **Sireesha and Joy (2022**).

Nodules/plant

The data recorded that treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] was recorded maximum number of nodules/plant (64.1) which was superior to all the treatment and the treatment 6 [Potassium (40kg/ha) + Zinc (20kg/ha)] and treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] were statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

The significant and maximum number of nodules/plant observed with the application of potassium (50kg/ha) due to K is required for translocation of assimilates and involved in maintenance of turgor pressure of cells and increase the availability of metabolic energy for the synthesis of starch and protein. These results were in conformity with those of **Patel *et al.* (2018)** . Further , the highest number of nodules/plants observed with the application of zinc (15 kg/ha) might be due to its role in enzymes activities as they are essential constituents of N2 fixing enzymes complex “nitrogenase” which are responsible for increase in leghemoglobin which ultimately increase nodulation and N-fixation. The results were in accordance with the findings of **Radhika and Meena (2021).**

Plant dry weight (g)

The results found that dry weight was recorded significantly higher (47.30g) in treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)]. However, treatment 5 [Potassium

(40kg/ha) + Zinc (15kg/ha)], treatment 6 [Potassium (40kg/ha) + Zinc (20kg/ha)], treatment 7 [Potassium (50kg/ha) + Zinc (10kg/ha)] and treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] were found to be statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

Increase in plant dry weight was observed with the application of potassium (50 kg/ha) due to improvement in nodulation might be due to the higher amount of nitrogen fixation, which may have helped in the better vegetative growth and dry matter production. These findings were similar to **Srikanth and Singh (2022)**. Further, maximum plant dry weight might be due to application of zinc plays as an activator of several enzymes in plants and it is directly involved in the biosynthesis of growth substances such as auxin thereby enhanced dry matter. The present findings are within the close proximity of **Christopher *et al.* (2019)**.

Crop Growth Rate (g/m^2/day)

The data revealed that during 60-80 DAS, no significant difference was found among all the treatments. However, highest crop growth rate (22.10g/m$^{2/}$day), was observed in treatment 1 [Potassium (30kg/ha) + Zinc (10kg/ha)].

Relative Growth Rate (g/g/day)

The data recorded that during 60-80 DAS, highest relative growth rate (0.0178g/g/day), was observed in treatment 1 [Potassium (30kg/ha) + Zinc (10kg/ha)]. However, no significant difference was found among all the treatments.

Yield parameters:

Number of pods/plant

The data found that Treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] recorded significantly higher Number of pods per plant (28.1). However, treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] was statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

Highest number of pods/plants with the application of potassium being involved in carbohydrate and protein metabolism that promotes cell division and enlargement resulting in more productive pods, observation were consistent with those of **Sireesha and Joy (2022)**. Further, increase in pods/plant with the application of zinc (15kg/ha) might be due to zinc involved in synthesis of auxins which favors retention of more flowers leading to more number of reproductive parts/plant, pod setting. This result was corroborated by **Nakum *et al.* (2019).**

Number of kernels/pod:

Data revealed that significant and higher number of kernels/pod (2) recorded in the Treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)]. However, treatment 3 [Potassium (30kg/ha) + Zinc (20kg/ha)], treatment 5 [Potassium (40kg/ha) + Zinc (15kg/ha)], treatment 6 [Potassium (40kg/ha) + Zinc (20kg/ha)], treatment 7 [Potassium (50kg/ha) + Zinc (10kg/ha)] and treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] were statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

Maximum number of kernels/pod obtained with the application of potassium might be due to K involved in maintaining balance in enzymatic , stomatal activity, transport of sugar and synthesis of protein , photosynthesis and starch. Findings agreed with those of **Sahay *et al.* (2013)**. Further increase in kernels/pod with the application of zinc might be due to increase in plant vigour, accumulation of photosynthates and better translocation from source to sink. The conclusion were in agreement with those of **Polara *et al.* (2010)**.

Seed index (g):

The data showed that Treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] recorded significantly higher Seed index (40.00 g). However, treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] was statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

The higher seed index obtained with the application of potassium (50 kg/ha) might be due to supply at early stage of crop, which might have improved adequate biomass production. **Srikanth and Singh (2022).** Further, higher seed index obtained with the application of zinc(20kg/ha) due to zinc is an important substrate involved in photo system-II of photosynthesis and plays vital role in energy metabolism process in plants. Thus, the increased availability and efficient absorption of zinc resulted in vibrant metabolism in plant which increase in weight of the kernels. The results were in conformity with those of **Prashantha *et al.* (2019).**

Seed Yield (t/ha):

The data showed that significantly higher Seed Yield (2.31 t/ha) recorded in the Treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)]. However, treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] was statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

"Maximum seed yield was obtained with the application of potassium vital role in physiological and metabolic processes, including photosynthesis, osmoregulation, transport of nutrients, transport and storage of carbohydrates from which fat has formed, nitrogen absorption and synthesis of protein and starch" **(Patel *et al.*, 2018).** Further, maximum seed yield was obtained with the application of Zn (20 kg/ha) might be due to it plays as an activator of several enzymes in plants, and it is directly involved in the biosynthesis of growth substances such as auxin which result in more dry matter that in turn will be stored in seeds as a sink. The findings were in accordance with **Christopher *et al.* (2019)**.

Haulm yield (t/ha)

The data revealed that Treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] recorded significantly higher Haulm Yield (3.74 t/ha), though there was significant difference among the treatments.

"Higher haulm yield was obtained with the application of potassium (50 kg/ha) may be due to increased nutrient absorption by root system, increased plant internal translocation capacity and transport of nutrients essential to metabolism in active areas" **(Baier and Baierova, 1999)**. Further, increase in halum yied with the application of zinc involved in activation of various enzymes and increased basic metabolic rate in plants, facilitated the synthesis of nucleic acids and hormones, which in turn enchanced the halum yield due to greater availability of nutrients and photosynthates. Observations were consistent with those of **Radhika and Meena (2021)**

Harvest Index (%)

The data showed that Significant and highest Harvest Index (32.30%) was recorded in Treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] recorded. However, treatment 8 [Potassium (50kg/ha) + Zinc (15kg/ha)] was statistically at par with the treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)].

The significant and higher harvest index with the application of potassium (50 kg/ha) might be due to K involved in photosynthesis, protein synthesis, carbohydrate metabolism, energy transfer reactions and it have important role in activation of oxidation process and enzymes. Findings agreed with those of **Sakarvadia *et al.* (2019).**

Economics:

The result showed that Maximum gross return (1,34,970.00INR/ha), higher net return (93,865.00INR/ha) and highest benefit cost ratio (2.28) was recorded in treatment 9 [Potassium (50kg/ha) + Zinc (20kg/ha)] as compared to other treatments.

Higher Gross returns, net returns, benefit cost ratio was recorded with application of potassium (50kg/ha) which might be due to sufficient availability of potassium with higher level to the crop at the early stages of growth, which may have increased the yield attributes and higher seed yield, resulted increased higher benefit cost ratio.

Table 1: **Effect of growth attributes of groundnut as influenced by Potassium and Zinc**.

S No	Treatments	Plant height(cm)	No. of Nodules/ plant	Dry weight (g)	CGR (g/m^2/day)	RGR (g/g/day)
1.	Potassium (30kg/ha) + Zinc (10kg/ha)	25.9	44.7	44.63	22.10	0.0178
2.	Potassium (30kg/ha) + Zinc (15kg/ha)	26.1	46.8	45.17	21.90	0.0173
3.	Potassium (30kg/ha) + Zinc (20kg/ha)	27.3	50.6	46.30	21.67	0.0168
4.	Potassium (40kg/ha) + Zinc (10kg/ha)	26.6	48.7	45.83	21.77	0.0170
5.	Potassium (40kg/ha) + Zinc (15kg/ha)	28.1	53.1	46.50	21.83	0.0169
6.	Potassium (40kg/ha) + Zinc (20kg/ha)	28.9	62.7	47.07	21.57	0.0162
7.	Potassium (50kg/ha) + Zinc (10kg/ha)	28.6	62.1	46.97	21.57	0.0163
8.	Potassium (50kg/ha) + Zinc (15kg/ha)	29.0	63.5	47.17	21.67	0.0162
9.	Potassium (50kg/ha) + Zinc (20kg/ha)	29.8	64.1	47.30	21.67	0.0162
10.	Control N P K (20:60:40 kg/ha)	25.6	42.5	43.57	21.40	0.0177
	F-test	S	S	S	NS	NS
	Sem±	0.41	0.57	0.27	0.9	0.0005
	CD at 5%	1.23	1.69	0.8	--	--

Table 2: **Effect of yield and yield attributes of groundnut as influenced by Potassium and Zinc**.

S No	Treatments	No. of pods/ plant	No. of Kernels/ Pod	Seed Index (g)	Seed yield (t/ha)	Haulm yield (t/ha)	Harvest Index (%)
1.	Potassium (30kg/ha) + Zinc (10kg/ha)	23.7	1.71	35.5	1.82	3.54	28.41
2.	Potassium (30kg/ha) + Zinc (15kg/ha)	24.5	1.73	35.7	1.85	3.59	28.48
3.	Potassium (30kg/ha) + Zinc (20kg/ha)	25.8	1.80	36.1	1.91	3.63	28.69
4.	Potassium (40kg/ha) + Zinc (10kg/ha)	25.1	1.75	35.8	1.88	3.60	28.50
5.	Potassium (40kg/ha) + Zinc (15kg/ha)	26.2	1.87	36.8	1.96	3.66	29.34
6.	Potassium (40kg/ha) + Zinc (20kg/ha)	27.0	1.93	37.5	2.10	3.70	30.76
7.	Potassium (50kg/ha) + Zinc (10kg/ha)	26.8	1.93	37.3	2.02	3.69	29.78
8.	Potassium (50kg/ha) + Zinc (15kg/ha)	27.5	1.98	39.3	2.20	3.71	32.17
9.	Potassium (50kg/ha) + Zinc (20kg/ha)	28.1	2.00	40.0	2.31	3.74	32.30
10.	Control N P K (20:60:40 kg/ha)	23.6	1.77	35.4	1.77	3.36	28.29
	F-test	S	S	S	S	S	S
	Sem±	0.21	0.07	0.24	0.04	0.01	0.13
	CD at 5%	0.61	0.20	0.70	0.12	0.05	0.38

Table:3 Effect of Economics of groundnut as influenced by potassium and zinc.

S No	Treatments	Cost of Cultivation	Gross returns	Net Returns	B:C ratio
1.	Potassium at 30kg/ha + Zinc at 10kg/ha	39865.00	107230.00	67365.00	1.69
2.	Potassium at 30kg/ha + Zinc at 15kg/ha	40365.00	108985.00	68620.00	1.70
3.	Potassium at 30kg/ha + Zinc at 20kg/ha	40865.00	112405.00	71540.00	1.75
4.	Potassium at 40kg/ha + Zinc at 10kg/ha	39985.00	110680.00	70695.00	1.77
5.	Potassium at 40kg/ha + Zinc at 15kg/ha	40485.00	115250.00	74765.00	1.85
6.	Potassium at 40kg/ha + Zinc at 20kg/ha	40985.00	123150.00	82165.00	2.00
7.	Potassium at 50kg/ha + Zinc at 10kg/ha	40105.00	118655.00	78550.00	1.96
8.	Potassium at 50kg/ha + Zinc at 15kg/ha	40605.00	128765.00	88160.00	2.17
9.	Potassium at 50kg/ha + Zinc at 20kg/ha	41105.00	134970.00	93865.00	2.28
10.	Control N P K (20:60:40 kg/ha)	38985.00	104160.00	65340.00	1.68

*Data was not subjected to statistical analysis.

CONCLUSION

Based on the above findings it can be concluded that application of Potassium (50kg/ha) along with Zin(20 kg/ha) has performed better in growth parameters and yield attributes of groundnut (Kadiri 6) and also proven profitable. Since the findings are based on one season, further trails are needed to confirm the results.

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