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ISSN: 2320 – 7051
Int. J. Pure App. Biosci. SPI: **6 (1):** 105-110 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Phosphorus and Zinc on Yield and Quality of Groundnut (*Arachis hypogea* L.) in Inceptisol

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Received: 17.06.2018 | Revised: 22.07.2018 | Accepted: 30.07.2018

ABSTRACT

The experiment was laid out in FRBD with 16 treatments along with 3 replication. It was carried out during the Kharif season 2018, at farm of oilseed research station, College of Agriculture, Latur. The results of field trial on response of various levels of Phosphorus and zinc showed significant effect on yield and quality parameter of groundnut. The pod, kernel and haulm yield was significantly affected at P_2 - 50 kg P $_2O_5$ ha^{-1} and zinc level at Zn_2-30 kg $ZnSO_4$ ha^{-1} as compare to all other levels of phosphorus and zinc. The quality parameter like oil content, protein content and oil and protein yield showed maximum increases due to application of phosphorus at P_2 - 50 kg P $_2O_5$ ha^{-1} and zinc Zn_2-30 kg $ZnSO_4$ ha^{-1} in kernel of groundnut. Thus, it can be concluded that balanced fertilizer application of phosphorus at level of P_2 - 50 kg P $_2O_5$ ha^{-1} and zinc Zn_2-30 kg $ZnSO_4$ ha^{-1} showed superiority over all other levels of P and Zn. However, further increment of P, P_3-60 kg P_2O_5 ha^{-1} and Zn, Zn_3- 40 kg $ZnSO_4$ ha^{-1} was found be better when compared with P_1(40 kg P_2O_5 ha^{-1}) and Zn_1(20 kg $ZnSO_4$ ha^{-1}). Thus application of P_2 (50 kg P $_2O_5$ ha^{-1}) along with zinc level at Zn_2 (30 kg $ZnSO_4$ ha^{-1}) was found to be beneficial in increasing yield and quality of groundnut on low phosphorus and zinc containing inceptisol soil.

Key words: *Groundnut, Zinc, Kharif, Protein yield*

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) 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. It is premier oilseed crop of India popularly known as peanut, monkeynut, manila nut. 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.

Groundnut contains on an average 12-15 percent carbohydrate, 25-30 per cent protein and 45-50 per cent oil. Groundnut oil contains unsaturated fats which is highly nutritious and contains 50-60 percent oleic acid, 18- 30 percent linoleic acid as well as 7 percent of other fats.

Cite this article: Kadam, D.V., Indulkar, B.S., Kadam, V.S., Jadhav, L.S. and Sonune, P.N., Effect of Phosphorus and Zinc on Yield and Quality of Groundnut (*Arachis hypogea* L.) in Inceptisol, *Int. J. Pure App. Biosci.* SPI: **6(1):** 105-110 (2018).

Phosphours is an important primary nutrient and enhance root growth and required for synthesis of oil, protein, acid and is also involved in formation of glucosinolates which on hydrolysis increases the oil content[3]. Zinc known to be the constituent of enzyme and also involved in synthesis of pyruvic decarboxylase and indol acetic acid. 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.

Thus, proper plan nutrition is an important factor for improving yield and quality of crop. As balanced fertilization support the demands of plant by regulating the metabolic processes in yield formation towards quality. Thus zinc deficiency in soil is one of constraint for this region and to improve quality of oil in groundnut zinc and proper amount of NPK is important.

MATERIAL AND METHODS

The field experiment was conducted on farm of Oil seed research station, college of agriculture, Latur, VNMKV Parbhani during *kharif* 2017-2018. Experimental soil was clayey in texture, calcareous in nature and alkaline reaction; low in N, low in P and low in Zn, and high in K the experimental soil was deep black in color with good drainage.

The experiment was laid out in factorial randomized block design (FRBD) with 16 treatments combination along with 3 replication which consist of 4 levels of phosphorous and 4 levels of zinc *viz.* P_0 - 0 kg P_2O_5 ha^{-1}, P_1 – 40 kg P_2O_5 ha^{-1}, P_2 – 50 kg P_2O_5 ha^{-1}, P_3 – 60 kg P_2O_5 ha^{-1} and Zn_0- 0 Kg $ZnSO_4$ ha^{-1}, Zn_1- 20 Kg $ZnSO_4$ ha^{-1}, Zn_2- 30 Kg $ZnSO_4$ ha^{-1}, Zn_3- 40 Kg $ZnSO_4$ ha^{-1} respectively with recommended dose of fertilizer N, P_2O_5 (25:50 kg ha^{1}).To know the effect of different levels of p and Zn on yield and quality of groundnut in inceptisol. The uniform 25 kg N ha^{-1} was applied to each plot through urea at the time of sowing, different levels of P i.e. 0, 40, 50, and 60 kg P_2O_5 ha^{-1} was applied treatment were through single super phosphate and different levels of Zn i.e. 0, 20, 30 and 40 kg $ZnSO_4$ ha^{-1} was applied through zinc sulphate. The method of application of fertilizer was band placement. With spacing row to row 30 cm and plant to plant spacing 15cm.

RESULT AND DISCUSSION

1. Impact of phosphorus and zinc on yield attribute of groundnut

1.1 Pod yield

Data tabulated in table 1. Indicate the impact of different levels of phosphorus and zinc show significant effect on pod yield of groundnut crop. The application of P recorded maximum yield at P_2-50 kg P_2O_5 ha^{-1}(2117.19 kg ha^{-1}) followed by P_3-60 kg P_2O_5 ha^{-1}(2060.38 kg ha^{-1}) significant effect over control.

The pod yield of groundnut was significantly influenced by zinc application. The response of zinc recorded maximum pod yield at the level of Zn_2-30kg$ZnSO_4ha^{-1}$ (2140.56 kg/ha) as compare to Zn_3-40 kg $ZnSO_4$ ha^{-1} (2050.34 kg/ha). As increase in levels of P and Zn (P_3 Zn_3) pod yield recorded lower value as compare to level of (P_2 Zn_2).Interactive effect of P- Zn show non-significant in respect of pod yield of groundnut. It also point out that at levels up to P (50 kgP_2O_5 ha^{-1})and Zn(30kg $ZnSO_4$ ha^{-1})shows higher value of pod yield as compare to higher of levels P and Zn (P_3, Zn_3) thus observed antagonistic effect of both nutrient.

The application of different levels of P and Zn shows significant increase in pod yield. Among the different levels of P and Zn (P_2, Zn_2) shows 7.78 per cent increase in pod yield as compare to the levels of (P_3, Zn_3) recorded about 4.89 per cent increment over control. The application of phosphorus increases pod yield due it role in root growth, photosynthesis, metabolism activities in plant which ultimately increases absorption. The important role of zinc in nodulation and enzymes activities and use of sulphur also involved in metabolic activities in plant leads to increase in absorption thus attributing to increase in growth parameter and yield of groundnut.

1.2. Kernel yield

A presented data in Table 1. Indicated the effect of various levels of phosphorus and zinc on kernel yield of groundnut. Application of phosphorus at the levels of P_2-50 kg P_2O_5 ha^{-1}(867.59 kg ha^{-1}) recorded highest kernel yield followed by P_3-60 kg P_2O_5 ha^{-1} (863.35kg ha^{-1}) significant control (628.74kg ha^{-1}).

The effect of various levels of P and Zn shows significant increase in kernel yield. Highest kernel yield were recorded at 30 kg $ZnSO_4$ ha^{-1} (853.03kg ha^{-1}) as compared with 40 kg $ZnSO_4$ ha^{-1} (812.50 kg ha^{-1}) show significant effect over control. Thus further increment does not show beneficial effect on kernel yield of groundnut.

Table 1. Impact of different levels of phosphorus and zinc on pod yield and kernel yield of groundnut

P levels	Zinc levels				Mean
	Zn_0	Zn_1	Zn_2	Zn_3	
			Pod yield (kg ha^{-1})		
P_0	1834.21	1886.34	2116.40	2019.94	1964.22
P_1	1971.77	2056.98	2135.99	2065.09	2057.45
P_2	2045.85	2127.18	2173.19	2133.55	2117.19
P_3	2065.78	2045.32	2136.68	1993.77	2060.38
Mean	1979.40	202 8.96	2140.56	2050.34	
	P		Zn		P× Zn
SE±	31.50		31.50		63.00
CD at 5%	90.95		90.95		NS
			Kernel yield (kg ha^{-1})		
P_0	526.83	579.40	778.71	630.04	628.74
P_1	770.73	839.39	842.90	840.24	823.31
P_2	813.07	831.98	913.80	911.51	867.59
P_3	853.08	855.42	876.71	868.21	863.35
Mean	740.93	776.55	853.03	812.50	
	P		Zn		P×Zn
SE±	21.58		21.58		43.16
CD at 5%	62.30		62.30		NS
			Haulm yield (kg ha^{-1})		
P_0	2585.59	2726.68	3326.29	3361.59	3000.03
P_1	3324.56	3079.44	3288.20	3319.11	3263.45
P_2	3001.78	3735.47	3643.60	3619.11	3499.99
P_3	2903.11	3466.56	3515.86	3255.72	3285.31
Mean	2953.76	3252.04	3443.49	3399.51	
	P		Zn		P× Zn
SE±	101.30		101.30		202.61
CD at 5%	295.51		292.51		NS

The haulm yields of groundnut were significantly influenced by zinc application. Maximum haulm yield were found at levels of zinc, Zn_2-30 kg $ZnSO_4$ ha^{-1}(3443.49 kg/ha) as compare to Zn_3- 40 kg $ZnSO_4$ ha^{-1} (3399.51 kg/ha). Interactive effect between different levels of P and Zn found to be non-significant in respect of haulm yield. The response of various levels of P and Zn shows significant increase in haulm yield at the level of (P_2, Zn_2) recorded 8.36 per cent as compare to the level of (P_3,Zn_3) show 7.47 per cent increment over control.

Response of nutrient supply during experiment show significant effect on haulm yield as phosphorus plays an important role in cell division leading to development of a good root system, ensuring timely and uniform ripening of the crop, carbohydrate breakdown for release of energy and hastening maturity of plants. Zinc accelerates maximum translocation of photosynthates to sink. sulphur improve nutritional environment which in turn, favorably influenced the energy transformation activation of enzymes ultimately increase in carbohydrate enhance haulm yield.

2. Efficacy of phosphorus and zinc levels on quality of oil and protein content of groundnut.

2.1 Oil content and oil yield

Data narrated in Table 2. Shows that the effect of different levels of phosphorus and zinc on oil content and oil yield of groundnut crop.

Response of phosphorus shows significant effect on oil content and oil yield. Phosphorus at the level of P_2- 50 kg P_2O_5 ha^{-1} recorded highest oil content and yield 45.73 percent over all other levels of Phosphorus P_0- 44.15 percent, P_1- 44.61 percent and P_3-44.05 percent significant over control. The level of P_3 – 60 kg P_2O_5 ha^{-1} (395.00 kg ha^{-1}) recorded highest oil yield followed by P_2- 50 kg P_2O_5 ha^{-1}(390.92 kg ha^{-1}).

Application of zinc at various levels shows significant effect on oil content and oil yield. Zinc level at Zn_2-30 kg $ZnSO_4ha^{-1}$ (45.39 percent) recorded highest oil content as compare to Zn_3- 40 kg $ZnSO_4$ ha^{-1}(44.69 percent) significant over control.

Table 2. Effect of different levels of phosphorus and zinc on oil content and oil yield of groundnut

P levels	Zn levels				Mean
	Zn_0	Zn_1	Zn_2	Zn_3	
Oil content (%)					
P_0	44.11	44.12	44.17	44.20	44.15
P_1	44.36	44.37	45.28	44.45	44.61
P_2	45.16	45.38	46.12	46.26	45.73
P_3	44.75	44.48	46.01	44.93	45.04
Mean	44.60	44.59	45.39	44.69	
	P		Zn		P× Zn
SE±	0.14		0.14		0.29
CD at 5%	0.43		0.43		NS
		Oil yield (kg ha^{-1})			
P_0	232.42	255.64	343.92	278.47	277.61
P_1	341.71	372.51	381.45	373.55	367.30
P_2	363.65	370.08	420.45	409.53	390.92
P_3	385.00	388.89	404.42	401.74	395.00
Mean	330.69	346.78	387.56	365.82	
	P		Zn		P× Zn
SE±	9.85		9.85		19.70
CD at 5%	28.44		28.44		NS

The interaction between P-Zn shows non-significant effect in respect to oil content and oil yield this result might be due to increase in oil yield observed lower value of at higher levels of oil content thus antagonistic effect of nutrient.

The application of different levels of phosphorus shows significant effect on oil content and oil yield due its major role in formation of glucosinolates which on hydrolysis increases the oil content. Zinc application attributed for increase in oil content due to its role in metal activator of enzymes like cysteine which responsible for the production of oil and oil content. Sulphur was also supplied through SSP and $ZnSO_4$ as its having major role in oil synthesis because of essential component of S containing amino acid help in formation of glucoside. This might be reason for increases in oil content in groundnut

2.2 Protein content and protein yield.

Data pertaining on effect of various levels phosphorus and zinc on protein content and protein yield of groundnut presented in Table 3. Generally, protein content ranged from19.68 to 21.82 per cent.

Application of phosphorus at P_2- 50 kg P $_2O_5$ ha^{-1}(21.82 percent) recorded maximum protein content followed by P_3- 60 kg P $_2O_5$ ha^{-1}(21.51 per cent) percent significant over control (19.68 percent). The P_2- 50 kg P_2O_5 ha^{-1} level recorded highest protein yield (187.87 kg ha^{-1}). The response of zinc application recorded highest protein content at Zn_2- 30kg $ZnSO_4$ ha^{-1}(21.51 per cent) as compare to Zn_3- 40 kg $ZnSO_4$ ha^{-1}(21.30 per cent) significant over control. The protein yield was found maximum at the level of Zn_2- 30kg $ZnSO_4$ ha^{-1} (187.87 kg ha^{-1}). The interaction of different levels of P-Zn showed non-significant effect on protein content and protein yield.

Efficacy of different levels of P and Zn was found effective on protein content and protein yield as P attribute to growth and development of plant thus improves metabolic process which is responsible for synthesis of amino acid, tryptophan which are constituent of protein and carbohydrates.

Table 3: Effect of different levels of phosphorus and zinc on protein content, protein yield (kg ha^{-1})

P levels	Zinc levels				Mean
	Zn_0	Zn_1	Zn_2	Zn_3	
			Protein content (%)		
P_0	18.75	19.79	20.21	20.00	19.68
P_1	20.42	20.83	21.25	21.04	20.85
P_2	20.83	21.67	22.50	22.29	21.82
P_3	20.63	21.46	22.08	21.88	21.50
Mean	20.16	20.94	21.51	21.30	
	P		Zn		P× Zn
SE±	0.34		0.34		0.69
CD at 5%	1.007		1.007		NS
			Protein yield (kg ha^{-1})		
P_0	98.61	114.72	155.51	127.39	124.05
P_1	157.04	175.28	179.27	176.53	172.03
P_2	176.66	184.81	197.40	192.61	187.87
P_3	171.75	175.98	202.18	199.36	173.97
Mean	151.01	162.70	183.59	173.97	
	P		Zn		P× Zn
SE±	5.216		5.216		10.43
CD at 5%	15.06		15.06		NS

Zinc play important role in enzymatic activities helps in synthesis of growth hormones such as auxin and tryptophan but zinc protect the lipid and protein molecule against oxidation by increasing activity of superoxide dismutase. Due application of SSP and $ZnSO_4$ sulphur also contribute in synthesis of esseintial S containing amino acid like cysteine, cystine, and methionine this may be the reason for enhancing protein yield in groundnut crop.

CONCLUSION

The results indicated that among the various levels of P and Zn P_2 (50 kg P_2O_5 ha^{-1}) and Zn_2 (30 kg $ZnSO_4$ ha^{-1}) respectively showed superior response of pod, kernel and haulm yield over all other levels of phosphorus and zinc. As it recorded (7.78 and 8.36 percent) of increases as compare to levels of (P_3, Zn_3) which recorded (4.89 and 7.47 percent) of pod and haulm yield respectively over control. As P and S stimulating flowering and helps in seed formation while Zn helps in reproduction processes.

The oil content, protein content, oil and protein yield and test weight of seed were maximum at levels of P and Zn P_2 (50 kg P $_2O_5$ ha^{-1}) and Zn_2 (30 kg $ZnSO_4$ ha^{-1}) respectively. The positive response was may be due to P, S and Zn increases in the synthesis of gulcosinolates and S containing amino acid particularly cysteine and methionine which was responsible for increase in oil and protein content in groundnut.

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