The Pharma Innovation Journal 2023; 12(12): 584-588

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 584-588

www.thepharmajournal.com
Received: 09-09-2023
Accepted: 19-11-2023

Effect of sulphur and zinc on uptake of nutrients and available soil nutrients status after harvest of cowpea (*Vigna unguiculata* L.)

Ankesh, Anand Naik, Ravi S, Pandit S Rathod and Bellakki MA

Ankesh
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, Karnataka, India

Anand Naik
Assistant Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, India

Ravi S
Scientist, Department of Soil Science, ICAR - KVK, Hagari, University of Agricultural Sciences, Raichur, Karnataka, India

Pandit S Rathod
Professor and Head, Department of Agronomy, College of Agriculture, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, India

Bellakki MA
Professor, Department of Soil Science and Agricultural Chemistry, College of Agriculture, Kalaburagi, University of Agricultural Sciences, Raichur, Karnataka, India

Corresponding Author:
Ankesh
Department of Soil Science and Agricultural Chemistry, College of Agriculture, Raichur, University of Agricultural Sciences, Raichur, Karnataka, India

Abstract
A field experiment on "Effect of sulphur and zinc on uptake of nutrients and available soil nutrients status after harvest of cowpea (*Vigna unguiculata* L.)" was conducted during *Kharif* 2022 at ICAR-KVK farm, Kalaburagi. The experimental site soil colour was black, shallow to medium in depth with moderately alkaline pH, low in EC and SOC, low in nitrogen, medium in phosphorus, high in potassium and medium in sulphur. The experiment was laid out in RCBD with eight treatments replicated thrice. Results revealed that, soil pH, Electrical Conductivity, SOC and $CaCO_3$ were not significantly affected by soil application of sulphur and zinc. Application of RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate recorded significantly higher available nutrients status and nutrient uptake like, uptake of nitrogen (88.03 kg ha^{-1}), phosphorus (20.87 kg ha^{-1}), potassium (58.7 kg ha^{-1}), sulphur (14.19 kg ha^{-1}), zinc (171.21 g ha^{-1}) and other micronutrients. Which was on par with RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate. Hence, for effective management of sulphur and zinc, the application of RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate was recommended.

Keywords: Sulphur, zinc, RDF, cowpea

1. Introduction

Cowpea (*Vigna unguiculata* L.) is one of the important *kharif* pulse crop in India. It belongs to Fabaceae and sub family Faboideae. It is originated in Sub-Saharan Africa. It is one of the most important vegetable crops grown as pulse, vegetable and fodder. The cowpea has often been referred to as "poor man's meat" due to the high levels of protein found in the seeds and leaves and considered one of the most ancient human food sources and has probably been used as a crop plant since Neolithic time. Nutritional value per (100 g), Protein 23.52 g, Energy 336 kcal, Carbohydrates 60.03 g, Sugars 6.9 g, Dietary fiber 10.6 g, Fat 1.26 g, Water 11.95 g, Vitamins and Minerals. According to Gopalan *et al*. (1995) [1] fresh green pods of cowpea contain 4 - 6.5 percent protein, iron (0.005%), calcium (0.08%) and vitamin B (500 mg) per 100g green pods. Dry seeds of vegetable cowpea are rich in protein (23-28%) therefore, it is called as vegetable meat.

The per capita availability of pulses in India is 35.5 g/day as against the minimum requirement of 70 g/day. Cowpea contributes to the improvement of soil fertility by the atmospheric nitrogen fixation in the soil (60-70 kg N ha^{-1} to the subsequent crop) in association with symbiotic bacteria under favourable conditions.

Cowpea (*Vigna unguiculata* L.) is one of the most important leguminaceae vegetable crop in India. It is grown throughout in India in both summer and rainy season as singly and as intercrop also. It is used as green vegetable, pulse and also as fodder for Miltch Cattles. It plays an important role in human diet and has importance in agriculture for various cropping systems. Pulse crop have always occupied an important position in our rainfed farming system for meeting the dietary needs of people as well as for sustaining the soil fertility. Vegetable cowpea has great importance because of short duration, high yielding and quick growing habit. It is fairly an inexpensive source of vegetable protein. Hence, it deserves to get a place in every farm and kitchen gardens.

Sulphur is recognized as the fourth major plant nutrient after nitrogen, phosphorus and potassium in crops and an essential element for plant growth particularly for legumes crops which play an important role in plant metabolism system, Sulphur containing amino acids (cystine, cysteine and methionine) and promotes nodulation in legumes.

Zinc which is important for growth and reproduction in plants, animals and humans, is one of the seventh essential micronutrients. In plants, it plays a key role during physiological growth, DNA stabilization, gene expression, enzyme activity, protein synthesis and improved chlorophyll function.

2. Materials and Methods

The experiment was conducted at ICAR-Krishi Vigyan Kendra farm, Kalaburagi (Karnataka) during *Kharif* season, 2022. Kalaburagi is situated in the North Eastern Dry Zone (Zone-2) of Karnataka between 17º 34' N latitude and 76º 79' E longitude with an altitude of 478 meters above the mean sea level.

The soil of the experimental site belongs to Vertisols (medium black soil). Regarding initial soil chemical properties, the soil was moderately alkaline in pH (8.11), low in EC (0.28 dS m^{-1}), low in organic carbon content (4.32 g kg^{-1}) and free $CaCO_3$ of 3.12%, the soil was low in available nitrogen (229.14 kg ha^{-1}), medium in available phosphorus (29.17 kg ha^{-1}), high in available potassium (342.15 kg ha^{-1}) and medium in sulphur (15.67 kg ha^{-1}). The concentrations of DTPA extractable (mg kg^{-1}) micronutrients *viz*., zinc, iron, copper and manganese, were 0.53, 2.46, 1.20 and 3.62, respectively and hot water soluble boron was recorded to be 0.26 mg kg^{-1}.

The experiment was laid out in a Randomized Complete Block Design (RCBD) with eight treatments *viz*., T_1 – Absolute control, T_2 – RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1}), T_3 - RDF + 10 kg ha^{-1} sulphur, T_4 - RDF + 20 kg ha^{-1} sulphur, T_5 - RDF + 5 kg ha^{-1} zinc sulphate, T_6 - RDF + 10 kg ha^{-1} zinc sulphate, T_7 - RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate and T_8 - RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate and were replicated thrice. Whereas, recommended dose of fertilizer in the form of urea, DAP, MOP, bentonite sulphur and zinc sulphate were applied as per treatments. FYM @ 10 tonnes ha^{-1} was applied to all the treatments except absolute control. The cowpea variety C-152 was selected for the study. Seeds were sown at 45 cm × 10 cm spacing in ridges and furrows on July 16, 2022 and harvested on October 26, 2022.

The collected soil samples were dried under shade and were analyzed for pH, EC, SOC and $CacO_3$ and available NPK and micronutrients. Standard procedures were adopted for analysis of the nutrients in the laboratory. The pH of the soil was determined by use of digital pH meter (Jackson, 1973) [2], the electrical conductivity (dS m^{-1}) by conductivity bridge (Jackson, 1973) [2], the soil organic carbon (g kg^{-1}) by wet oxidation method (Walkley & Black, 1934) [3], the free $CaCO_3$ (%) by rapid titration method (Piper, 1966) [4], the available nitrogen (kg ha^{-1}) content in soil was determined by adopting alkaline potassium permanganate method (Subbiah and Asija, 1956) [5], the available phosphorus (kg ha^{-1}) by Olsen's method (Jackson, 1973) [2], the available potassium (kg ha^{-1}) by flame photometer (Jackson, 1973) [2], the available sulphur (kg ha^{-1}) by turbidometric method (Piper, 1966) [4] and the available micronutrients (Fe, Cu, Zn, Mn) (mg kg^{-1}) by DTPA method (Lindsay & Norvell, 1978) [6], the available boron (mg kg^{-1}) by colorimetric method (Berger and Troug, 1939) [7]. Nutrient uptake was calculated by multiplying the nutrient (%) concentration with biomass (kg ha^{-1}) and whole divided by hundred. Data analysis and interpretation was done using Gomez and Gomez (1984) [8] technique.

3. Results and Discussion

3.1 Effect of sulphur and zinc on nutrient uptake

3.1.1 Macronutrients uptake

The nutrient uptake of N, P, K and S in cowpea was analyzed and represented in (Table 1).

Significantly higher uptake of nitrogen, phosphorus, potassium and sulphur (88.03, 20.87, 58.7 and 14.19 kg ha^{-1}, respectively) was recorded with the application of RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate. It was on par with an application of RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate (82.3, 19.35, 55.35 and 12.08 kg ha^{-1}, N, P, K and S, respectively). However, significantly lower uptake of nitrogen, phosphorus, potassium and sulphur (32.59, 5.30, 23.62 and 3.26 kg ha^{-1}, respectively) was recorded with absolute control. This might be due to soil application of sulphur and zinc sulphur increases root growth, extraction of nutrients from the soil and promotes nodule formation on roots of leguminous plants which directly influence on nutrients uptake. Zinc is essential for synthesis of DNA and RNA and for metabolism for the production of carbohydrate, lipids and proteins. Similar findings reported by Nayak *et al*. (2020) [9].

3.1.2 Micronutrients uptake

The results related to micronutrients (Zn, Fe, Cu, Mn and B) uptake at harvest in cowpea as effected by sulphur and zinc application is furnished in (Table 2).

Among the different treatments micronutrients uptake showed significantly differed. However, higher micronutrients uptake (171.21, 235.81, 34.55, 101.51 and 66.55 g ha^{-1}, Zn, Fe, Cu, Mn and B respectively) was recorded in RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate. Which was on par with RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate (155.69, 224.0, 29.99, 96.12 and 62.63 g ha^{-1}, Zn, Fe, Cu, Mn and B respectively). While, absolute control recorded lower micronutrients uptake (42.55, 102.66, 11.04, 44.22 and 23.92 g ha^{-1}, Zn, Fe, Cu, Mn and B respectively). This might be due to there was synergistic effect between sulphur on iron and manganese concentration. However, iron and manganese uptake was significantly increased with sulphur application. There was synergetic effect between sulphur and copper and zinc. Due to this, copper and zinc content increased. The increase in zinc uptake at harvest might be due to the presence of increased amount of zinc in soil solution by the application of zinc that might have facilitated the absorption of zinc through phloem. Similar findings reported by Pandey (2018). [10].

3.2 Effect of sulphur and zinc on Soil chemical properties

The data related to soil chemical properties such as pH, EC, soil organic carbon and free $CaCO_3$ as effected by sulphur and zinc application in cowpea are furnished in (Table 3).

The soil chemical properties (pH, EC, organic carbon and free $CaCO_3$) are no significant impact was observed among different treatments combinations. Because inorganic fertilizer application like urea, DAP and nano DAP for only one season of experimentation has not much effect on pH, EC, OC and $CaCO_3$ of soil.

3.3 Effect of sulphur and zinc on Available nutrients status in soil: The data regarding the nutrient availability status (available N, P, K, S and micronutrients) in the soil after crop harvest as effected by sulphur and zinc application in cowpea are depicted in (Tables 4, 5 and Fig. 1).

3.3.1 Available macronutrients status
The treatment with the application of RDF + 20 kg S ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} was recorded significantly higher soil available nitrogen, phosphorus, potassium and sulphur (215.06, 34.29, 307.07 and 22.95 kg ha^{-1}, respectively) and was statistically on par with treatment applied with RDF + 10 kg S ha^{-1} + 5 kg $ZnSO_4$ ha^{-1} (208.14, 32.36, 298.52 and 20.71 kg ha^{-1}, N, P_2O_5, K_2O and SO_4^{-2}, respectively). However, the absolute control treatment recorded lower soil available nitrogen, phosphorus, potassium and sulphur (165.12, 17.28, 266.01 and 8.22 kg ha^{-1}, respectively) after crop harvest. It might be due to a higher rate of nutrients were applied through two sources, *viz.*, soil application of 10 tonnes FYM, conventional fertilizers @ RDF + 20 kg S ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} which might have resulted in higher levels of available nutrients after meeting the crop nutrient requirement at different crop growth stages. The results are in agreement with the findings of Dawar *et al*. (2022) [11].

3.3.2 Available micronutrients status
No significant difference was observed among the various treatments for iron, copper and manganese and boron.
The application of RDF + 20 kg S ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} was recorded significantly higher soil available zinc (1.51 mg kg^{-1}). It was on par with treatment applied with RDF + 10 kg S ha^{-1} + 5 kg $ZnSO_4$ ha^{-1} (1.20 mg kg^{-1} Zn). However, the absolute control treatment recorded lower soil zinc availability (0.29) after crop harvest. The increment in the availability of zinc may be due to micronutrients held tightly both in various form such as organic and inorganic combination and become slowly available to crop through chemical weathering and microbial decomposition. The results are in accordance with findings of Kannan *et al*. (2014) [12].

Table 1: Effect of different levels of sulphur and zinc on uptake of macronutrients (kg ha^{-1}) after the harvest of cowpea crop

Treatments	Macronutrients uptake (kg ha^{-1})			
	N	P	K	S
T_1 - Absolute control	32.59	5.30	23.62	3.26
T_2 – RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1})	57.04	10.75	37.61	6.08
T_3 - RDF + 10 kg ha^{-1} sulphur	69.01	14.64	45.94	9.83
T_4 - RDF + 20 kg ha^{-1} sulphur	74.29	16.05	49.40	11.84
T_5 - RDF + 5 kg ha^{-1} zinc sulphate	59.44	11.42	39.36	7.00
T_6 - RDF + 10 kg ha^{-1} zinc sulphate	62.66	12.14	40.99	8.05
T_7 - RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate	82.30	19.35	55.35	12.08
T_8 - RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate	88.03	20.87	58.70	14.19
S.Em. ±	4.15	1.08	2.56	0.69
CD @ 5%	12.61	3.27	7.78	2.11

Note: RDF – Recommended Dose of Fertilizer

Table 2: Effect of different levels of sulphur and zinc on uptake of micronutrients (g ha^{-1}) after the harvest of cowpea crop

Treatments	Micronutrients uptake (g ha^{-1})				
	Zn	Fe	Cu	Mn	B
T_1 - Absolute control	42.55	102.66	11.04	44.22	23.92
T_2 – RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1})	68.88	159.16	19.33	67.18	41.85
T_3 - RDF + 10 kg ha^{-1} sulphur	105.57	189.77	24.58	81.78	51.62
T_4 - RDF + 20 kg ha^{-1} sulphur	117.9	202.52	26.27	87.66	55.49
T_5 - RDF + 5 kg ha^{-1} zinc sulphate	93.33	166.54	20.73	71.55	44.55
T_6 - RDF + 10 kg ha^{-1} zinc sulphate	111.12	172.22	22.02	74.48	46.22
T_7 - RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate	155.69	224	29.99	96.12	62.63
T_8 - RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate	171.21	235.81	34.55	101.51	66.55
S.Em. ±	8.25	8.07	1.84	2.54	1.79
C.D. @ 5%	25.01	24.48	5.60	7.73	5.43

Note: RDF – Recommended Dose of Fertilizer

Table 3: Effect of different levels of sulphur and zinc on soil pH, EC, organic carbon and calcium carbonate of soil after the harvest of cowpea crop

Treatments	Soil pH	EC (dsm^{-1})	Organic carbon (g kg^{-1})	$CaCO_3$ (%)
	(1:2.5) (Soil to water ratio)			
T_1 - Absolute control	8.09	0.31	4.29	3.10
T_2 – RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1})	8.13	0.35	4.31	3.14
T_3 - RDF + 10 kg ha^{-1} sulphur	8.20	0.39	4.36	3.21
T_4 - RDF + 20 kg ha^{-1} sulphur	8.22	0.40	4.38	3.22
T_5 - RDF + 5 kg ha^{-1} zinc sulphate	8.16	0.38	4.32	3.17
T_6 - RDF + 10 kg ha^{-1} zinc sulphate	8.18	0.38	4.33	3.18
T_7 - RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate	8.25	0.45	4.40	3.24
T_8 - RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate	8.26	0.46	4.41	3.26
S. Em. ±	0.08	0.03	0.04	0.05
CD @ 5%	NS	NS	NS	NS

Note: RDF – Recommended Dose of Fertilizer

Table 4: Effect of different levels of sulphur and zinc on available major and secondary nutrients status (kg ha^{-1}) in soil after the harvest of cowpea crop

Treatments	Available Nutrients (kg ha^{-1})			
	N	P_2O_5	K_2O	SO_4^{-2}
T_1 - Absolute control	165.12	17.28	266.01	8.22
T_2 – RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1})	182.20	23.36	277.48	10.29
T_3 - RDF + 10 kg ha^{-1} sulphur	201.61	27.36	289.62	20.62
T_4 - RDF + 20 kg ha^{-1} sulphur	205.14	29.57	293.22	22.90
T_5 - RDF + 5 kg ha^{-1} zinc sulphate	191.08	24.32	281.58	12.56
T_6 - RDF + 10 kg ha^{-1} zinc sulphate	194.29	25.56	283.38	14.38
T_7 - RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate	208.14	32.36	298.52	20.71
T_8 - RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate	215.06	34.29	307.07	22.95
S. Em. ±	2.82	0.79	4.14	0.49
CD @ 5%	8.55	2.39	12.57	1.48

Note: RDF – Recommended Dose of Fertilizer

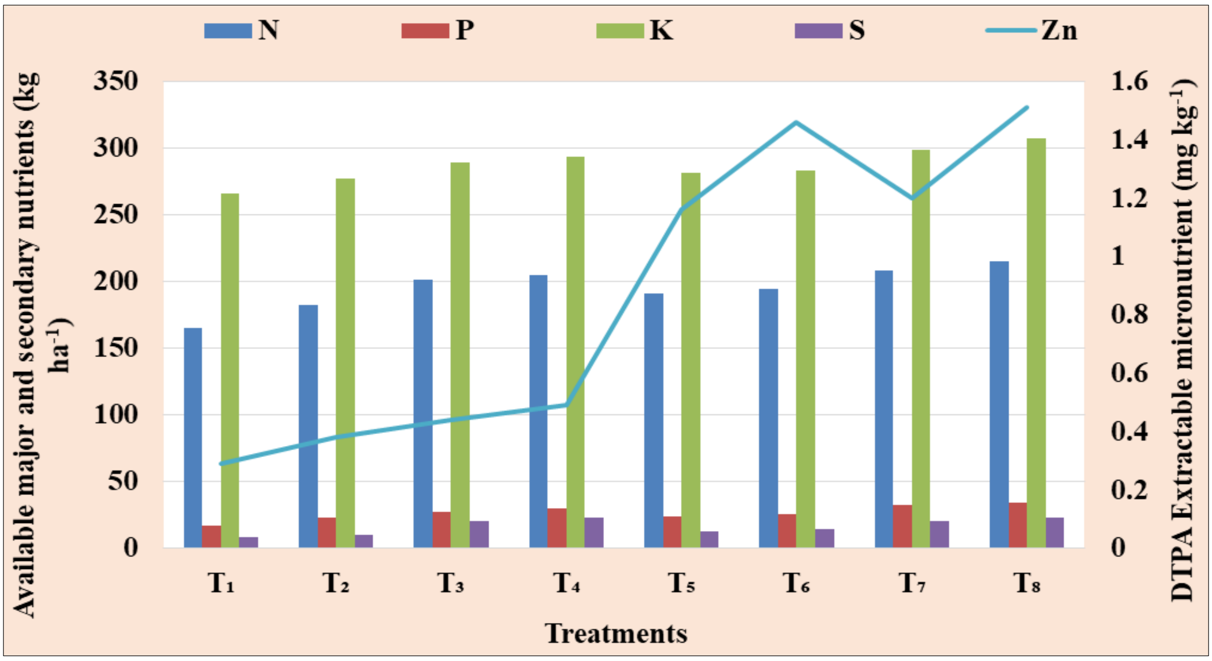

Fig 1: Effect of different levels of sulphur and zinc on available major, secondary nutrients status (kg ha^{-1}) and DTPA Extractable micronutrients (mg kg^{-1}) in soil after the harvest of cowpea crop

Table 5: Effect of different levels of sulphur and zinc on DTPA Extractable micronutrients status (mg kg^{-1}) in soil after the harvest of cowpea crop

Treatments	DTPA Extractable micronutrients (mg kg^{-1})				Available boron (mg kg^{-1})
	Zn	Fe	Cu	Mn	
T_1 - Absolute control	0.29	2.34	1.22	3.81	0.12
T_2 – RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1})	0.38	3.02	1.26	3.94	0.14
T_3 - RDF + 10 kg ha^{-1} sulphur	0.44	3.26	1.35	4.16	0.18
T_4 - RDF + 20 kg ha^{-1} sulphur	0.49	3.27	1.36	4.20	0.19
T_5 - RDF + 5 kg ha^{-1} zinc sulphate	1.16	3.16	1.31	4.04	0.15
T_6 - RDF + 10 kg ha^{-1} zinc sulphate	1.46	3.17	1.33	4.08	0.17
T_7 - RDF + 10 kg ha^{-1} sulphur + 5 kg ha^{-1} zinc sulphate	1.20	3.41	1.39	4.27	0.22
T_8 - RDF + 20 kg ha^{-1} sulphur + 10 kg ha^{-1} zinc sulphate	1.51	3.43	1.41	4.31	0.23
S. Em. ±	0.03	0.23	0.04	0.12	0.02
CD @ 5%	0.08	NS	NS	NS	NS

Note: RDF – Recommended Dose of Fertilizer

4. Conclusion

Application of RDF (25:50:25; N: P_2O_5: K_2O: kg ha^{-1}) + 20 kg S ha^{-1} + 10 kg $ZnSO_4$ ha^{-1} of cowpea was found to be on par with RDF + 10 kg S ha^{-1} + 5 kg $ZnSO_4$ ha^{-1} in terms of nutrients uptake and available nutrients status in soil after harvest of crop. Hence, for effective management of sulphur and zinc in cowpea, the application of RDF + 10 kg S ha^{-1} + 5 kg $ZnSO_4$ ha^{-1} was recommended.

5. References

1. Gopalan C, Ramasastri BV, Balasubramanian SC. Nutritive value of Indian foods. ICMR, Hyderabad, India; c1995. p. 5000.
2. Jackson ML. Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd. New Delhi; c1973. p. 498.
3. Walkley AJ, Black CA. Estimation of soil organic carbon by the chromic acid and titration method. Journal of

Agricultural Science. 1934;25:598-609.
4. Piper CS. Soil Plant Analysis. Academic Press, New York; c1966. p. 367.
5. Subbiah, Asija. A rapid procedure for estimation of available Nitrogen in soils. Current Science. 1956;25:259-260.
6. Lindsay WL, Norvell WA. Development of DTPA soil test for zinc, iron, manganese and copper. Soil Science Society of American Journal. 1978;42:421-428.
7. Berger KC, Truog E. Boron determination in soils and plants. Industrial and Engineering Chemistry Analytical Edition. 1939;11(10):540-545.
8. Gomez KA, Gomez AA. Statistical procedures for Agricultural Research. 2nd Ed. John Wiley and Sons, New York; c1984. p. 680.
9. Nayak BK, Adhikary S, Pattnaik M, Pal AK. Effect of Sulphur and zinc with combination of FYM on yield and uptake of nutrients in Mustard (*Brassica juncea* L.) under Alfisols of Odisha. Journal of Pharmacognosy and Phytochemistry. 2020;9(2):2310-2313.
10. Pandey M. Effect of integrated nutrient management on yield, quality and uptake of nutrients in oat (*Avena sativa* L.) in alluvial soil. Annals of Plant and Soil Research. 2018;20(1):1-6.
11. Dawar K, Khan N, Fahad S, Alam SS, Khan S, Mian IA, *et al*. Effect of Sulfur and Zinc Nutrition on Yield and Uptake by Wheat. Journal of Plant Growth Regulation; c2021. p. 1-9.
12. Kannan S, Mishra A, Verma M. Effect of multi micronutrient mixtures on nutrient status of post-harvest soil of Blackgam. Madras Agricultural Journal. 2014;44(3):173-175.