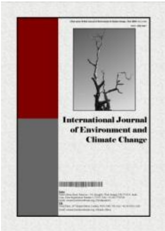

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Effect of Vermicompost and Foliar Application of Zinc on Soil Properties and Nutrients Uptake by Groundnut (*Arachis hypogaea* L)

Sunil Kumar Dadhich [a] and Govind Kumar Yadav [a*]

[a] *Department of Soil Science and Agricultural Chemistry, Sri Karan Narendra Agriculture University, Jobner, Rajasthan-303329, India.*

Authors' contributions

This work was carried out in collaboration between both authors. Author SKD performed study and managed the analysis. Author GKY wrote the protocol and first draft of manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

A field experiment was conducted to investigate the effect of vermicompost and foliar application of zinc on soil properties and nutrients uptake by groundnut (*Arachis hypogaea* L.) during 2018-19 and 2019-20. The ten treatments in the experiment *viz*., T_1 (N:P:K, 15:60:30), T_2 (N:P:K +Vermicompost), T_3 (N:P:K +Vermicompost + Soil Zn 100%), T_4 (N:P:K + Vermicompost + Soil Zn 75%), T_5 (N:P:K + foliar application of 0.25% $ZnSO_4$), T_6 (N:P:K + foliar application of 0.50% ZnSO4), T_7 (N:P:K + foliar application of 0.75% $ZnSO_4$), T_8 (N:P:K + Vermicompost + foliar application of 0.25% $ZnSO_4$), T_9 (N:P:K + Vermicompost + foliar application of 0.50% $ZnSO_4$) and T_{10} (N:P:K + Vermicompost + foliar application of 0.75% $ZnSO_4$) were replicated thrice under randomized block design (RBD). The results of the experiment revealed that the treatment receiving N:P:K (15:60:30) + Vermicompost (5 t ha^{-1}) + Soil Zn 100% (T_3) had significantly higher values of organic carbon (0.56 percent), available nitrogen (156.59 kg ha^{-1}), available P_2O_5 (50.39 kg ha^{-1}), available K_2O (183.14 kg ha^{-1}), Zn (0.65 mg kg^{-1}), lower values of pH (7.34), EC (0.22 dSm^{-1}) and higher values of nutrients uptake over control (T_1), while at par with the application of N:P:K + Vermicompost + Soil Zn 75% (T_4), N:P:K + Vermicompost + foliar application of 0.25% $ZnSO_4$ (T_8), N:P:K + Vermicompost + foliar application of 0.50% $ZnSO_4$ (T_9) and N:P:K + Vermicompost + foliar application of 0.75% $ZnSO_4$ (T_{10}).

**Corresponding author: E-mail: yadav.govi004@gmail.com;*

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1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is a South American native annual legume crop. The groundnut crop is unique among the leguminous crops and it's designated as "Wonder legume". It also has various names such as earthnuts, peanuts, goober peas, pindas, jacknuts, pindars, manilanuts and monkeynuts [1]. Poor man's almond is another name of groundnut. Because it's a great source of edible oil and protein, groundnut can help with offspring inadequacies. It's also a staple in the Indian cuisine. As a result, groundnut is regarded as the king of oilseed crops [2] and a significant food legume in tropical and subtropical regions of the globe. Groundnut is one of the most popular and widely grown crops, being grown in over 120 countries. Groundnut has a wide range of applications; all parts of the plant can be employed. Its seed includes a high grade of 45-50 percent edible oil, 25-30 percent digestible protein, 20 percent carbs, and 5% fibre and ash, all of which contribute to human nutrition on a long-term basis [3,4]. The oil is mostly used in cooking, margarine, shortening, and soap production. Seeds can be eaten raw or roasted, chopped into confectioners, or processed into peanut butter. Vegetables can be made from the young pod.

Inadequate and imbalanced nutrient utilization, as well as nutritional shortages, are the major causes of low groundnut production. Groundnut crop suffers from deficiency of nutrients, especially immobile elements in soil viz; phosphorus and zinc, which are essential for plant growth and pod formation besides N-fixation activity [5].

Organic sources are beneficial for enhancing soil aggregation, structure, and fertility, as well as boosting moisture retention capacity and crop output [6]. Organic manures made / created from a variety of organic wastes can help conserve the ecosystem as a whole [7,8]. By increasing the physical, chemical, and biological qualities of soil, organic manures serve to mitigate several nutrient deficits while also providing a better environment for growth and development [9]. In this context, organic manures such as farmyard manure (FYM), vermicompost (VC), and press mud cake (PMC) may provide adequate micronutrients in usable form to crops while also improving the quality of agricultural products [10]. Farmers do not apply the recommended doses of nutrients to these energy-rich legume crops due to the prohibitive cost of chemical fertilizers. Organic nutrient sources that are locally available have improved efficiency and reduced the need for chemical fertilizers [11]. As a result, multiple sources of nutrients must be combined to suit the crop's nutritional needs. Groundnut yields may be sustained with the application of both organic and inorganic fertilizers in tandem [12]. When native micronutrients are utilized in combination with organic manures, their efficacy is increased even more, especially in dry and semi-arid soils with light texture, low organic carbon, low moisture retention and low microbial activity. The delayed breakdown of organic manure and increased soil biological activity might be linked to the improvement in available nutrient status of the soil with the addition of vermicompost alone or in combination with chemical fertilizer. As a result, the physical environment is more pleasant, soil nitrogen is conserved, and other nutrients are more readily available. Organic manures improve the physical, chemical, and biological aspects of soils while also increasing the effectiveness of applied nutrients, particularly in light soils [13]. Chemical fertilizer usage is expanding on a daily basis, which is a severe cause for worry, and their frequent application is damaging soil bio-physicochemical characteristics [14]. As a result, soil fertility is rapidly dwindling. This, in turn, causes a decrease in agricultural production per unit area.

Micronutrients that are known to be necessary for plant growth. In Indian soils, it's a micronutrient that's known for lowering agricultural yields. Diffusion transports zinc to the root surface of plants. It is necessary for the production of plant growth chemicals and enzyme systems, as well as the promotion of specific metabolic reactions. It's required for chlorophyll and glucose synthesis. Iron is necessary for the production of chlorophyll and aids in the absorption of other nutrients. It controls respiration, photosynthesis, and the reduction of nitrates and sulphates as a component of chlorophyll [3,4]. Thus, using organic manure (vermicompost) and supplementing soil fertility with mineral fertilizers is critical not just for increasing crop yields but also for maintaining the soil's physical, chemical and biological properties. As a result, the purpose of this study was to see the effect of vermicompost and foliar application of zinc on soil properties and nutrients uptake by groundnut.

2. MATERIALS AND METHODS

The experiment was carried out at the Rajasthan Agricultural Research Institute's research farm in Durgapura, Jaipur (Raj.) during *kharif*, 2018-19 and 2019-20. Geographically, the research farm is located at 75^0 47" East longitude, at 26^0 51" North latitude and at altitude of 390 m above mean sea level in Jaipur district of Rajasthan. Rajasthan's agro-climatic zone IIIA (Semi-arid Eastern Plain Zone) encompasses this area. Durgapura's climate is semi-arid, with extremes in temperature in both summer and winter, little rainfall and moderate relative humidity. The average annual rainfall is around 500 mm, with the most of it falling between July and early September occasional rainfall are also prevalent in the winter. During May and June, the maximum temperature varies from 28 to 45 degrees Celsius, while it drops below 5 degrees Celsius in December and January. The evaporation rate varies between 1.3 and 17.5 mm per day. The ten treatments in the experiment *viz*., T_1 (N:P:K, 15:60:30), T_2 (N:P:K +Vermicompost), T_3 (N:P:K +Vermicompost + Soil Zn 100%), T_4 (N:P:K + Vermicompost + Soil Zn 75%), T_5 (N:P:K + foliar application of 0.25% $ZnSO_4$), T_6 (N:P:K + foliar application of 0.50% ZnSO4), T_7 (N:P:K + foliar application of 0.75% $ZnSO_4$), T_8 (N:P:K + Vermicompost + foliar application of 0.25% $ZnSO_4$), T_9 (N:P:K + Vermicompost + foliar application of 0.50% $ZnSO_4$) and T_{10} (N:P:K + Vermicompost + foliar application of 0.75% $ZnSO_4$) were evaluated in randomized block design with three replications. The experimental plot's soil had a loamy sand texture and was somewhat alkaline in response, with a pH of 7.78, EC of 0.22 dSm^{-1} and an organic carbon content of 0.13 percent. The soil had a low available nitrogen content (134.2 kg ha^{-1}), high available phosphorus content (41.0 kg ha^{-1}) and medium in potash content (169.1 kg ha^{-1}). Groundnut cv. RG 559-3 was seeded with 100 kg seed ha^{-1} at 30 cm x 10 cm spacing. pH and electrical conductivity [15], organic carbon [16], available nitrogen [17], phosphorus [18], potassium [19] and zinc [20] were all measured in soil samples after crop harvest. The contents of N, P, K and Zn in the plant were calculated using the standard protocols [21]. The uptakes of these nutrients were estimated by multiplying concentrations by the yield data for each nutrient.

3. RESULTS AND DISCUSSION

3.1 Soil Properties

The data in Table (1) showed that the pH and electrical conductivity of the soil decreased significantly with increasing vermicompost and zinc application in soil. The lowest pH (7.42) and EC (0.16 dSm^{-1}) were recorded with the application of treatment T_3 (N:P:K +Vermicompost + Soil Zn 100%), whereas minimum under control (T_1). The decrease in pH and EC of soil with the application of vermicompost is due to the fact that the production of organic acid through the decomposition of organic matter and improvement in soil aggregation might have resulted into lowering of soil pH and EC [22,23]. The maximum organic carban (0.56 %), available nitrogen (156.6 kg ha^{-1}), phosphorus (50.39 kg ha^{-1}), potassium (183.14 kg ha^{-1}) and Zn (0.65 mg kg^{-1}) were observed under treatment T_3 (N:P:K + Vermicompost + Soil Zn 100%) over the control. It might be attributed to vermicompost's helpful effect in mineralization of native as well as its own nutrient content by fostering microbial and chemical activities that increased the soil's available nutrients pool. In reality, not all available nutrients are taken up by the plant, and the remainder stays in the soil, improving the soil's available nutrient status following crop harvest [22,24].

3.2 Uptake of Nutrients

The data presented in Table (2) show that the uptake of N, P, K and Zn in plants, the highest uptake of nitrogen (103.65 kg ha^{-1}), phosphorus (79.6 kg ha^{-1}), potassium (321.1 kg ha^{-1}) and Zn (0.143 mg kg^{-1}) in plant were observed under treatment T_3 (N:P:K +Vermicompost + Soil Zn 100%), whereas minimum under control (T_1). A sufficient supply of nutrients in the root zone and plant system was responsible for vermicompost's beneficial effects. Increased food availability in the root zone, along with increased metabolic activity at the cellular level, may have resulted in the production of additional nutrients and their accumulation in diverse plant sections. As a consequence, crops given larger doses of vermicompost used more nutrients than those given lower doses, resulting in higher nitrogen, phosphorous, potassium and sulphur content in the plant. Increased nutrient absorption appears to be attributable to the fact that nutrient uptake is a function of biomass and nutrient concentration [23,24]. The enhanced availability

Table 1. Effect of vermicompost and foliar application of zinc on soil properties (two years pooled data)

	Soil properties						
Treatments	**pH**	**EC (dSm^{-1})**	**OC (%)**	**N ($kg\ ha^{-1}$)**	**P ($kg\ ha^{-1}$)**	**K ($kg\ ha^{-1}$)**	**Zn ($mg\ kg^{-1}$)**
T_1	7.78	0.98	0.14	134.20	41.00	169.10	0.33
T_2	7.65	0.66	0.36	142.20	44.30	176.12	0.47
T_3	7.34	0.22	0.56	156.59	50.39	183.14	0.65
T_4	7.55	0.23	0.51	148.40	46.98	180.54	0.61
T_5	7.60	0.90	0.20	135.40	42.78	170.30	0.37
T_6	7.69	0.82	0.28	136.80	43.15	169.42	0.40
T_7	7.71	0.32	0.32	139.60	43.49	170.96	0.43
T_8	7.36	0.25	0.46	149.80	47.93	174.46	0.63
T_9	7.42	0.24	0.49	149.20	48.02	179.11	0.62
T_{10}	7.40	0.26	0.52	152.40	49.98	180.92	0.64
SEm±	0.18	0.014	0.009	2.86	1.30	4.78	0.01
CD (P = 0.05)	0.23	0.04	0.12	8.48	3.85	11.22	0.03
CV	4.10	4.41	4.17	3.44	4.98	4.68	4.66

Table 2. Effect of vermicompost and foliar application of zinc on nutrients uptake (two years pooled data)

	Nutrients uptake			
Treatments	**N ($kg\ ha^{-1}$)**	**P ($kg\ ha^{-1}$)**	**K ($kg\ ha^{-1}$)**	**Zn (ppm)**
T_1	59.69	59.69	234.43	0.07
T_2	78.95	65.32	274.75	0.10
T_3	103.65	79.60	321.10	0.14
T_4	96.45	76.41	296.15	0.13
T_5	68.50	61.19	261.35	0.08
T_6	72.68	63.24	269.35	0.08
T_7	76.20	64.15	271.21	0.09
T_8	95.09	73.34	287.68	0.12
T_9	96.35	74.38	292.16	0.12
T_{10}	100.25	77.20	294.86	0.13
SEm±	3.44	2.79	11.74	0.01
CD (P = 0.05)	10.23	8.28	34.88	0.02
CV	7.14	7.06	7.30	7.03

of native micronutrients cations may explain the rise in zinc content with the application of vermicompost and zinc. This is because their solid phase shape was transformed into soluble metalo-complexes, and the addition of micronutrients boosted their concentration [25].

4. CONCLUSION

Based on two-year field experimentation, it can be concluded that treatment T_3 [N:P:K (15:60:30) + Vermicompost (5 t ha^{-1}) + Soil Zn 100%] increased soil organic carbon, available N, P_2O_5, K_2O, Zn and nutrients uptake (N, P, K and Zn) by plants and decreased the values of pH and EC, over the control (T_1). It can be inferred from above study that the application of vermicompost along with NPK and Zn is helpful on improving macro and micro nutrients uptake in groundnut and improves availability of nutrients in the soil.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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